Watercourse Management and Political Centralization in Third-Millennium B.C. Southern Mesopotamia: A Case Study of the Umma Province of the Ur III Period (2112–2004 B.C.).

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Stephanie Rost

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Abstract of the Dissertation

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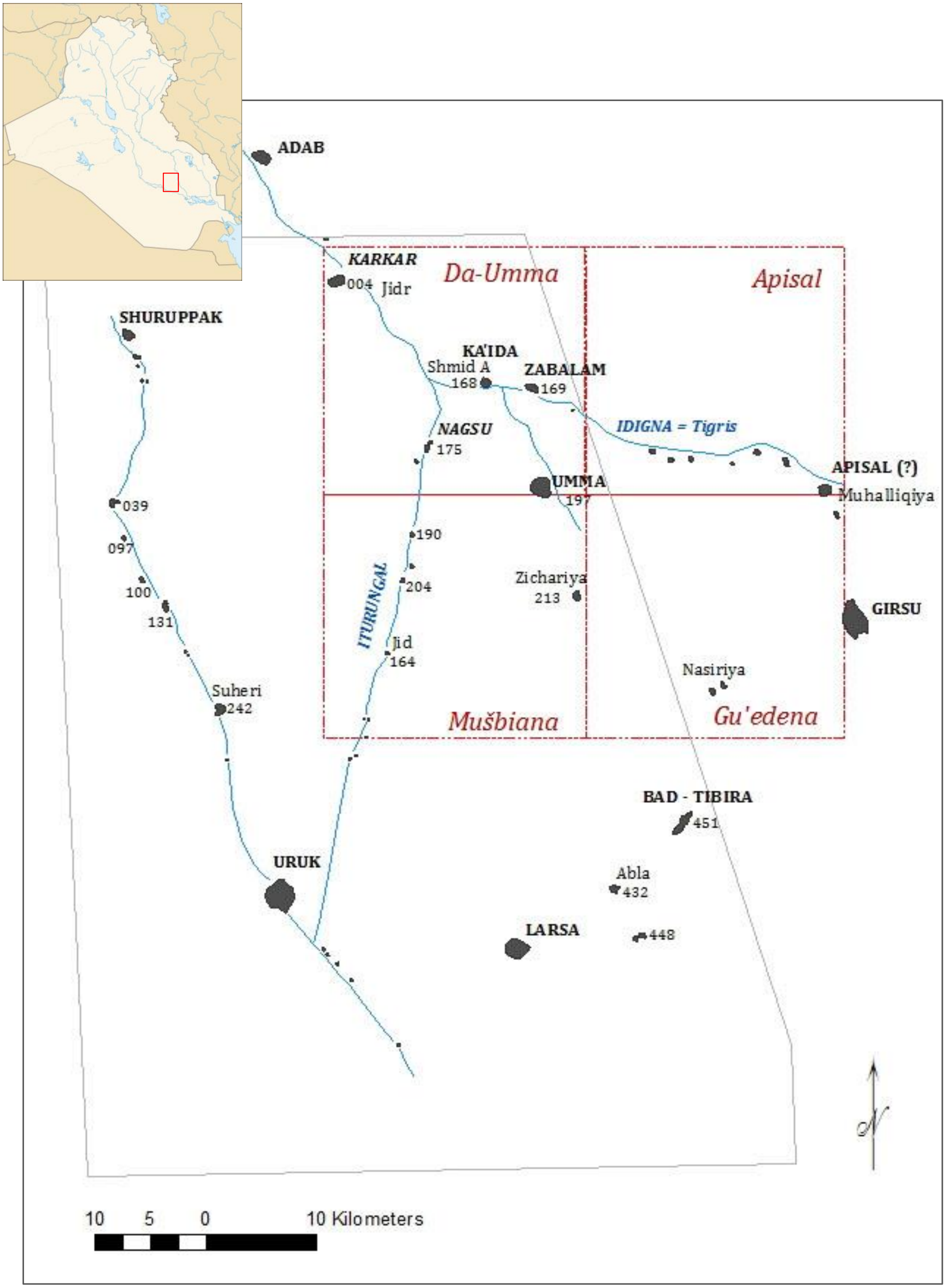
Ancient water management, especially for irrigation purposes, has featured prominently in anthropological theories on the development of socio-political and economic complexity. Traditional approaches have assumed that centralized control was needed to meet the managerial requirements of water control on a large scale. However, recent ethnographic and archaeological studies have shown that centralized control is a choice rather than a necessity. To date, there has been no empirical study on the exact nature of state control (if any) in the organization of ancient water control and irrigation. This is problematic as understanding the role of the state is at the center of how the function of water control (whether for irrigation and other purposes) in early complex societies is conceptualized. This shortcoming is primarily due to the lack of empirical data on the management of ancient water control systems and relatively few data on their physical attributes (layout, size and technical complexity) for most of the relevant ancient cases (Nile Valley [Egypt], Indus Valley [Pakistan/India], Yangtze and Yellow Rivers in China).

The only exception is ancient Mesopotamia with its extraordinarily rich archaeological and historical record on ancient water control. This thesis presents an analysis of the oldest and most comprehensive record on ancient water control from the archive of the Umma province of the Ur III state (2112–2004 B.C.). This rich data set has allowed, the development of a detailed insight into the technological and social aspects of ancient water control, which allows us to address larger theoretical questions regarding the role of the state in ancient water management and its importance for the functioning of an early state society. This research is based on the analysis of cuneiform administrative documents, complimented by archaeological and comparative ethnographic/ethno-historical data. The results show that water courses in the Umma province were managed not only for irrigation but also for navigation and flood control. While irrigation was crucial for the production of agricultural surplus, it was waterborne transportation that allowed for its efficient distribution throughout the state and its urban centers. Moreover, given that peak flooding of the Euphrates and Tigris coincides with the harvest, flood control was as important as irrigation. Thus, a major component of the water course management system of Umma was the effective control of the fluctuating water levels of the ancient Tigris in order to coordinate irrigation activities together with the requirements for navigation and flood control.

The textual data also allowed a detailed description of the social aspects of the water management system, including labor organization, social inequality, gender relations, bureaucracy, and political centralization. Records of the names of officials in charge of supervising and authorizing the various work projects made it possible to reconstruct the chain of command and develop a precise description of the degree of centralized control of the watercourse management system. The management of the watercourses for navigation, irrigation and flood control was highly centralized at the provincial level under the authority of the governor (ensi$_2$). The system was organized by a staff of full- and part-time state administrators and workers who planned and scheduled the timely execution of the required work projects all the way down to the field level. Planning and scheduling work projects was based on a complex accounting system and computational procedures that allowed for assessing the workload, converting it into the labor and the material costs on which basis labor was mobilized and materials gathered. The role of the central government, on the other hand, was restricted to the occasional resolution of water disputes between towns and cities. Beyond that there is no indication of any interference of the central government in the management of watercourses at the local level, providing important insights into how state control was realized on the local level in an ancient state society.

To my beloved mother

Margarete Rost



Map 1 The province Umma, with the districts in red (after Adams and Nissen 1972: 36, fig. 17 and Steinkeller 2001: 50)

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Abbreviations and Conventions

Abbreviations for this thesis follow the Chicago Assyrian Dictionary, the websites of the Data basis of Neo-Sumerian Text (BDTNS, http://bdtns.filol.csic.es/) and the Cuneiform Digital Library Initiative (CDLI, http://cdli.ucla.edu/). Texts are cited using the abbreviations of the above mentioned sources. Further abbreviations are used in this thesis:

PN: Personal Name
CN: Canal Name
FN: Field Name
GN: Geographical Name
Ur III: Third Dynasty of Ur

The representation of dates follows the conventions used in the Database of Neo-Sumerian Texts (BDTNS). Years in Ur III records consist of a year name, which commemorates a specific event (e.g., battle, coronation of a king, etc.). These are converted into the regnal year of each of the kings of the Dynasty of Ur, followed by the month and the day (e.g., AS05-01-12 = 5th year of Amar-Suen's reign, first month, 12th day).

Kings Name	Abbreviation	Number of regnal years	Dates
Ur-Namma	UN	18	2112–2095 B.C.
Šulgi	SH	48	2094–2047 B.C.
Amar-Suen	AS	9	2046–2038 B.C.
Šu-Suen	SS	9	2037–2029 B.C.
Ibbi-Suen	IS	25	2028–2004 B.C.

Months are also named after specific events in the year, such as "the month of early barley cutting" (iti še-sag/sag$_{11}$-ku$_5$) for the first month of the year (April). The month names are transliterated with upper case roman numbers. As the calendric information is crucial for the topic of this thesis, the month names of the Gregorian calendar were added in brackets. The reader should be aware that the Ur III calendar was very different from our Gregorian calendar. For one, April/May was considered the beginning of the year was and the Sumerian month consisted of 30 days and therefor shifted annually somewhat within the solar year. Sumerian bureaucrats were aware of this discrepancy and inserted an intercalary month (diri) at a certain frequency that has not been well understood so far. There is however an indication (see chapter 2, section 2.4) that the Ur III calendar was frequently adjusted to prevent month names from wandering full circle within the solar year. It is on this basis, that I would argue that equating Sumerian month names with that of the Gregorian calendar is acceptable for the sake of clarity. The day of a month is usually listed as the number of days passed (zal) of a particular month. Metrological notations used follow the standard conversion of the field and are discussed in greater detail in chapter 7 (table 7.6). Sumerian metrological units have been converted into metric units in order to make the information accessible to a wider audience.

Acknowledgments

At the end of a long graduate career, the list of people that have played a meaningful role in my education is very long. I sincerely hope that I will do justice to everyone that has helped me along the way. As the list of people is long, so is the acknowledgement – but there are so few occasions when we have the chance to express our gratitude. Thus, bear with me.

First and foremost, I want to thank my adviser Professor Elizabeth C. Stone for her continued support throughout my graduate career. As an international student from a different country and academic background, there was a good deal of training to be done. Above all, to beat out all the grammatical errors (economical vs. economic, farther instead of father …and the list goes on) which in my mind were proper English – if not American than certainly British English! More important, though, was her perseverance in getting me to think outside the box and asking the "so what" question, by which I learned to make my research relevant to a broader audience and helped me formulate significantly more interesting research questions. While she insisted on me thinking like anthropologist, I always felt that there was ample space and freedom to pursue my own research agenda. Professor Stone did everything possible to facilitate my academic progress.

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Robert's support was not limited to scholarly matters. He and his wife, Professor Emeritus Irene Winter, have been mentors in all areas of my life – career, life planning, personal happiness, navigating social and professional relationships. Their hospitality is truly oriental, which they extended to anyone and everyone in a house that became a second home to me. Not only was I fed royally with the most delicious food but I received undivided attention and was part of the most inspiring, interesting and fun conversations around the little white kitchen table. If that table will learn to speak one day – it would have lots to tell.

I want give a special thanks to Professor Steinkeller whose advice was indispensable to my dissertation research. Starting in 2009, he spent two straight weeks with me reading tablet after tablet to get me acquainted with the complexity of the Umma archive. He instilled confidence in me to take on the analysis of the written documents. Professor Steinkeller was always exceedingly generous with his time; proofreading my translations and drafts of my dissertations and pointing me to evidence which made many of my arguments significantly stronger. He taught me diligence and thoroughness in the interpretation of the ancient record and always emphasized the importance of making use of both texts and archaeology.

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Graduate school is not only about academic endeavors but also the time when you forge friendships for life. Meeting Arzu Demirergi, Jennifer Henecke and Helen Malko, made going through graduate school worthwhile. I did not want to miss a single hour in the lab, where we worked like donkeys, fought gloriously, consoled each other in times of hardship, chatted each other's ears off instead of working and where we laughed so hard we nearly suffered heart attacks. Had I not decided to come to the United States I would have missed out on making a friend for life – Tarun Banerjee. I will always cherish the time I shared with him filled with ceaseless discussions on walks that lasted half a day and more, the constant planning of distractions – holidays, family visits, and dinner parties – and most importantly the surgical dissection of the family gossip. I am most grateful to him for introducing me to many wonderful people, including his family, his friends (Idil, Lakshmi, Druve and more) and his partner Aaron – and most importantly Juhi Tyagi who has become such a dear friend. I am also grateful to my friend and colleague Amir Hamdani for his genuine interest in my work and for being so generous sharing his inside knowledge of traditional agricultural practices in Iraq. I want to thank Carola Borris for not only being the best Spazier – buddy but for being a true friend and mentor in all there is to deal with in life.

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Chapter 1 Introduction

Irrigation management has been a classic topic of interest in anthropology. The fact that most early civilizations of the Old World developed in large river valleys, such as in Egypt, Mesopotamia, Ancient China, and India/Pakistan has triggered an interest in the cross-cultural comparison of so-called hydraulic civilizations (Steward 1955). It has been argued that irrigation was of great economic importance in the development of early states, as it played a key role in the intensification of agriculture (Harrower 2009: 58–59). Agricultural surplus was the main source of wealth in early state societies, and political power was mainly based on control of these surpluses by a small centralized group (Eisenstadt 1963; Trigger 2003). In many early state societies, the production of the agricultural surplus needed to maintain the very features of statehood, such as urbanism, full-time labor specialization, state institutions, and status hierarchy was based on irrigation (Adams 1965; Butzer 1976; Dales 1965; Doolittle 1990; Jacobsen and Adams 1958; Lowdermilk and Wickes 1942; Millon 1954; Park 1983). As a result, the organization of irrigation has often been presented as central to understanding these early state societies (Downing and Gibson 1974; Sanders and Marino 1970; Steward 1955).

It has been thought that the managerial requirements of constructing and operating large-scale irrigation systems and the distribution of water had social consequences with regard to the development of social and political complexity (Child 1950: 8; Kang 2006: 196; Millon 1954: 178; Sanders and Price 1968: 177–187; Sanders and Marion 1970: 104–106; Steward 1955). Earlier approaches argued that the development of large-scale irrigation systems was closely tied to state formation in the Near East, China, Mesoamerica and the Central Andes. In turn, the size of a society's irrigation system is often though to reflect the degree of state involvement in irrigation management. Furthermore, royal building inscriptions of major hydraulic devices and canals (e.g.,the dam of Ma'arib in Ancient Yemen and the Menua-canal in Urartu, Anatolia) are frequently understood as indications of state control over all aspects of irrigation. In turn, evidence of state involvement in the organization of irrigation has also frequently been used to generalize about the degree of political centralization in early state societies (Belli 1997: 42; 2001; Brunner 2000: 8; Hehmeyer 1991: 97–101; Hruška 1988; Walter 1970: 165–166).

The assumed correlation between size and complexity and the implied causality of irrigation and state formation is largely based on Wittfogel's hydraulic hypothesis (1938, 1957) and a considerable misunderstanding thereof (Mitchell 1973). Wittfogel (1957: 18–19; 23–24) argued that the construction and maintenance of "massive hydraulic devices" was institutionally decisive only *if* this large-scale irrigation ("hydraulic agriculture") took place in an arid or semi-arid river plain. In order to be successful, massive hydraulic devices are needed for a) irrigation (preparatory operations) and b) flood control (protective operations) (Wittfogel 1957: 23–24). The construction and maintenance of hydraulic devices would require tremendous amounts of labor, which could only have been recruited and supervised by a central "directing authority" (Wittfogel 1956: 18, 25–29, 50–54). Further, the need for centralized oversight led to greater political integration and eventually to the concentration of power into the hands of a single despotic ruler (Wittfogel 1957: 100ff; 187ff; 303–348).

Wittfogel does not suggest, as has been assumed by a number of scholars, that the performance of irrigation per se led to political centralization, but rather that a series of conditions, including large-scale hydraulic structures, led to this result. Mitchell (1973: 533) drew attention to this misunderstanding of Wittfogel's hypothesis and further noted that criticisms against it were frequently misdirected. He points out that "a number of scholars have assumed that large-scale irrigation must be found prior to the centralized state in order for the irrigation hypothesis to be verified." However, if the hypothesis were correct, one would expect the two to develop together. Instead, he states that the actual problem in Wittfogel's hypothesis lies in the assumption that large-scale irrigation requires centralized control.

Scholars have tested Wittfogel's hypothesis and demonstrated that centralized control is a choice rather than a necessity (Hunt 1988a). Ethnographic evidence (Downing and Gibson 1974, Hunt 1988a, b, 1996; Fernea 1970; Goldfrank 1945, etc.) and, in particular, Hunt's (1988a) comparative study have shown that there is no positive correlation between the size of an irrigation system and the organization of its management as envisioned by Wittfogel (1957).

Hunt's (1988a) sample included a system of 458,000 ha that was organized by the local irrigation community, while another system of much smaller size (700 ha) was state run. In addition, there are archaeologically attested irrigation systems of considerable size (8,000+ ha) associated with the Hohokam period in the Phoenix Basin (Arizona) without evidence of the existence of a state (Hunt et al. 2005, Woodson 2010). Mitchell (1973: 533) concludes that "any society may or may not direct its irrigation activities centrally; such direction is not necessary." Centralized control cannot be assumed on the basis of the physical attributes (e.g., size or technical complexity) of an irrigation system but needs to be empirically demonstrated. Moreover, ethnographic and historical cases show that the degree of state involvement in irrigation management varies from case to case, as do the motivations to assume or abstain from assuming centralized control (Lees 1986; Fernea 1970; Glick 1970).

Over the last few decades, interest in the cross-cultural study of ancient irrigation has diminished. As a result, many important questions regarding the role of irrigation in early states have been only partially answered. Irrigation systems, designed to divert water from a natural course via a head gate in order to allocate it to crops via a system of control works (e.g., canals of varying sizes, gates, and fields) are highly diverse (Hunt 1988a: 339–340). They vary depending on the environment in which irrigation occurs, the water source controlled, the irrigation method practiced, the kind of crop irrigated, and most importantly, the size of the system itself. As such, irrigation systems have structuring properties with regard to labor input, economic output, and dictating a rhythm of tasks to be performed to ensure watering efficiency (Ertsen 2010). Furthermore, the practice of irrigation transforms the social landscape, as it brings together individuals and social groups that enter socio-political arrangements to participate in and coordinate the operation of the system (Ertsen 2010: 166). This diversity, in particular the variation in size and its potential socio-political and economic implications, has thus far not been addressed in the study of irrigation and early states. This is problematic as size is central to how the function of irrigation in early states was (and still is) conceptualized (see above). In turn, the potential that the study of ancient irrigation offers to gain important insights into the socio-political and economic organization of early states has never been fully explored. Moreover, how —but more importantly, why—states might assume or abstain from assuming control over irrigation management is rarely addressed, and the consequences of either choice have never been systematically assessed in a cross-cultural comparison.

This shortcoming is in part due to the fact that management of irrigation is at the center of how the function of irrigation in early states is conceptualized, yet in most areas of the world, the study of ancient irrigation practices is based entirely on archaeological remains. It is frequently difficult to reconstruct the linkages between these material remains and the social organization of irrigation, particularly with respect to state administration and centralization, as different social realities can lead to similar material manifestations (Geertz 1972; 24–26). It is only when the archaeological data set can be supplemented with textual data that insight into the management of an ancient irrigation system can be gained. There are few places in the world that have as extensive an archaeological and historical record on irrigation as Mesopotamia, making it possible to provide empirical evidence of the management of irrigation. The most comprehensive and oldest record on ancient irrigation management derives from the archives of the provincial capital Umma of the Umma province in the Ur III state (2112–2004 B.C.).

Due to the unique richness provided by Ur III administrative texts this dissertation research provides the first and so far the only empirical study on irrigation management in an early state society. The primary finding is that irrigation was only one of three major functions for which watercourses in Umma province were managed. River navigation and flood control were of equal importance. While irrigation was crucial for the production of the much-needed agricultural surplus, it was waterborne transportation that made efficient distribution throughout the state and its urban centers possible. Moreover, given that peak flooding of the Euphrates and Tigris coincides with the harvest, flood control was as important as irrigation. This finding might be true for other early states located in large river valleys such as in Egypt, China, or the Indus Valley. This dissertation will describe the technical complexity of the watercourse management system of the Umma province, which rested upon a well-coordinated scheme of manipulating water levels (low vs. high) of the ancient Tigris for irrigation, flood control and navigation. Furthermore, the textual data enabled the description of the social dimension of the watercourse management system of the Umma province, including that of labor organization, social inequality, gender relations, bureaucracy, and political centralization. The textual data allowed me to empirically determine the level of state control over the management of watercourses with a degree of precision not possible for any other early state society.

1.1 The Study Area

I have chosen to focus on the Umma province during the Ur III state (2112–2004 B.C.), as the Ur III period is one of the best-documented eras in antiquity (Garfinkel 2008: 55; Steinkeller 1987a: 20–21). There are administrative records on many aspects of economic life, including the management of watercourses. 30,000 out of approximately 120,000 cuneiform tablets derive from the Umma province, primarily dating to a period of thirty-eight years (2062–2025 B.C.) (Molina 2008; Steinkeller 2003: 40). Approximately 3,000 tablets of the Umma record pertain to irrigation and water management more generally. The dynasty that ruled the Ur III state is denoted in the Sumerian king's list as the "Third Dynasty of Ur" (Jacobsen 1939), reflecting the fact that the king, the royal family, and the court were located in the ancient city of Ur. The Dynasty was founded by king Ur-Namma, who was succeeded by four kings: Šulgi, Amar-Suen, Šu-Sin, and Ibbi-Suen.

The formation of the Ur III State underwent four stages, according to Dahl (2007: 1, fn 1): consolidation, expansion, stability, and decline. The consolidation of the states' core area rested on the subjugation of the former city-states of Sumer in the south (between Sippar and Ur) and the conquest of the Akkadian area to the north during Ur-Namma's and Šulgi's reigns. During the period of expansion, areas to the east and northeast (the periphery) were brought under the control of Ur by means of military campaigns and political alliances. The dominion of the Ur III state extended as far as Iran (periphery), including a set of vassal states in eastern Iran and upper Mesopotamia (modern Syria) (e.g., Anšan, Niniveh, Pašimeh, Šimanum, Šimški) (Steinkeller 1987a: 31, fig. 6). The period of stability is characterized by the management of the empire with an administrative machinery of previously unknown dimensions that was established during Šulgi's reign and fully developed by Amar-Suen and Šu-Sin. The decline of the empire is mainly associated with territorial losses, culminating in the invasion of Ur by troops from Elam (Iran) and the capture of the last king of the Third Dynasty of Ur, Ibbi-Suen.

The core of the Ur III state embraced an area roughly equivalent to modern-day southern Iraq and was divided into approximately twenty-one provinces.[1] Each province consisted of two sectors: the governor-run sector, which was run by the governor (ensi$_2$), and the royal sector, which was run by a hierarchy of military officials headed by a general (šagina) (Hallo 1953: 74, 81–82; Sallaberger 1999: 191; Maekawa 1996). Our knowledge of the socio-political organization of the Ur III state derives primarily from ancient texts and limited archaeological data. The majority of the available documents come from the archives of the provincial capitals, Umma and Girsu/Lagaš, and the state administrative center Puzriš-Dagan (Molina 2008: 52). Our understanding of the Ur III state is thus biased toward the provincial sectors run by governors. However, the recent acquisition and publication of the GARšana[2] archives, which document the management of a royal estate in the Umma province, has provided some insight into the state/royal sector (Owen 2007; Heimpel 2009; Steinkeller 2011). The fact that there is very little evidence of direct interaction between the crown and the governor-run and royal sectors of any given province makes it very difficult to fully establish the nature of the power relationship between these three entities beyond the system of taxation (Dahl 2007: 56–57; Steinkeller 2003: 41–42).

It appears that the land and resources controlled by the governor had previously constituted a city-state (Steinkeller 2013a: 351). In Umma, the agricultural land managed by the governor-run sector only amounted to 13,154.76 ha, equaling 7% of the entire area of the province. The much larger portion of the province constituted the royal sector, which consisted of newly established settlements of royal dependents (eren$_2$), who made up two-thirds of Umma's population (Steinkeller 2013a: 360, 2007: 204). These settlers received land allotments (gana$_2$ zi-ga lugal) from the crown (the king, as the head of state) in return for corvée labor (Maaijer 1998: 55). While it is difficult to determine the size of all arable land and the percentages cultivated by the governor-run and royal sector respectively, it is certain that the portion managed by royal settlers was considerably larger (Steinkeller 2013a: 353–356). There is hardly any information on the organization of the royal sector, as the two sectors operated as almost entirely separate economic entities, each with its own administrative and accounting system. Thus, it is important to keep in mind that the textual sources used in this thesis derive exclusively from the governor-run sector

[1] The exact number of provinces in the Ur III state is still not known (Sharlach 2008: 80).
[2] For the reading of the name of this settlement and possible location, see Steinkeller (2011: 377; 2013b).

and describe the watercourse management under the control of the provincial government as represented by the governor.

1.2 Theoretical Scope of the Dissertation

My assessment of the degree of state control in the management of watercourses is based on ethnographically informed research models developed mainly by Hunt (1988a, b) and others (Kelly 1983, Mitchell 1973, Uphoff 1986) for the management of irrigation. Hunt's (1988a, b) research model in particular takes a task-based approach, which makes his model universally applicable. Hunt defines a set of parameters within which irrigation systems, regardless of their physical or organizational complexity, operate. The planning and operation of every irrigation system, regardless of time or place, must deal with certain basic problems, such as sedimentation, flooding, salinization, water scarcity, and water theft. In order to manage these, there are several general operative and organizational tasks which must be performed. The operational tasks consist of the construction of the system and later its maintenance (including the removal of accumulated sediment in canals and the repair of water control structures). The performance of these operational tasks is connected to several organizational tasks. The managerial tasks include assessing the amount of work to be done, dividing up the jobs, and assigning them to the various water users and/or workers. In addition, water allocation might require a schedule, the operation of water control facilities, and the payment of fees in the form of goods or services. Accounting may or may not be a part of these organizational tasks, but it is usually necessary for keeping track of who a) received water, b) paid the fees and c) fulfilled labor duties (Hunt and Hunt 1974: 132–135; Hunt 1988b: 198–199; Sagardoy et al. 1982: 28; Vermillion and Sagardoy 1999: 36–37).

In order to ensure that the system runs efficiently and that all necessary tasks are performed in a timely fashion, management is frequently handled by a body of administrators. Frequently, administrative roles are created to be filled by one or more officials put in charge of managing one or more tasks. For example, a water guard might be in charge of allocation of water as well as inspection of the water control facilities and/or inspection of the rise and fall of water levels in the river. The size of an irrigation system seems to be decisive in how formalized this overseeing body is. In small-scale irrigation systems, the administrative tasks might be performed by the water users themselves, frequently on a part-time basis (Downing 1974: 116). The person who is put in charge either is elected or assumes this role when it is his or her turn in the rotation of these roles among the participating water users. The management of larger irrigation systems requires a greater degree of labor division, as a greater number of water users need to be coordinated and larger devices need to be constructed, maintained, and operated. In such a system, there might be a team of administrators and specialists, consisting of a chief administrative officer and subordinate personnel and workers, who are responsible for the organizational tasks related to the management of the system (Hunt et al. 2005: 447; Hunt 1996: 663). Hunt's comparative study (1988a: 345) showed that all ethnographically documented systems greater than 10 ha in size possess a formalized organizational apparatus.

Central to the issue of centralized versus decentralized irrigation management is the source from which the organizational apparatus draws its authority (Hunt et al. 2005: 447; Hunt 1996: 663). The source of authority can lie either inside or outside the irrigation system. There are three primary sources of this authority: the state government (outside), the irrigation community[3] (inside), and private investors (inside) (Hunt 1988b: 200). Only in the first case is irrigation management centralized, since the organizational staff derives its authority directly from the central government. In the other two cases, management is more or less autonomous of the state and the authority of the organizational apparatus is vested in local groups (Hunt 1988b: 200). The ethnographic examples of private investors occur only in monetized economies (Hunt et al. 2005: 450) and can be excluded as models for the organization of irrigation in the Ur III period. There is also evidence of state involvement in irrigation management during the Ur III period (Rost 2011, in press), which further excludes the possibility of a charter deriving its authority solely from the irrigation community.

Furthermore, there are varying degrees to which irrigation systems are and were managed by states. As has been correctly noted by Kelly (1983: 881, 883), the terms "centralized" and "decentralized" have traditionally been used to describe the dichotomy of "local water-user autonomy" versus "elite/state control." These two possible structures have been perceived as

[3] According to Hunt et al. (2005: 441), an irrigation community is "a corporate group of all and only the users" of the irrigation system.

poles of a “single continuum of organizational possibilities.” However, there are irrigation systems that are entirely state-run (e.g., the Gezirah irrigation system in Sudan) and systems in which the state only organizes certain aspects, such as water distribution or conflict resolution (e.g., Iraq, see below). It is important to determine how each of the necessary tasks is organized and by whom. In addition, according to Hunt (1988a: 341), how the charter of authority responsible for the organization of the irrigation system is embedded in the overall political structure of the state will determine the degree to which a system is politically centralized.

I would argue that this model is applicable for investigating the degree of state control in the management of watercourses. While the scope is larger, the proper functioning of the system depends as much as that of an irrigation system on the timely execution of all the tasks involved in keeping with a crop cultivation calendar and natural events such as flooding and fluctuation of water levels. The analytical scope here entails an approximately 40 km section of the ancient Tigris and multiple irrigation systems consisting of a primary canal and all related water control devices and fields. The number of irrigation systems that were in operation in the Umma province during the Ur III period cannot be assessed at this point due to the lack of archaeological data and the difficulty of distinguishing between canals of varying sizes in the written record (see method section). However, the tasks that needed to be performed to irrigate crops can be well discerned from the written record.

As the watercourse management systems rested upon the construction and upkeep of water control devices, the monitoring of water levels and water distribution involved administrative processes very similar to those of an irrigation system. A fair amount of administration was needed to assess the amount of work to be done, recruit the necessary labor and resources, and schedule the timely execution of all the necessary tasks. Furthermore, the concurrence, for example, of the harvest and flood control does create labor bottlenecks (see also Hunt and Ingram 2014: 254) that needed to be dealt with. Meeting the labor demands of tasks related to the management of watercourses as well as those of other productive systems (e.g., crop cultivation, weaving, milling, animal husbandry, etc.) frequently required a complex system of labor organization. Accounting played an important part in managing the complexity of the adopted labor organization system in Ur III Umma (Rost in press). In addition, the ancient records document the officials in charge of tasks related to the management of watercourses and allow us to determine the level of state control very precisely.

1.3 Analytical Model and Expectation

One way of measuring the degree of state control in irrigation management, for example, is to determine which of the irrigation-related tasks were managed by the state (e.g., water distribution, construction, maintenance, etc.) and, if possible, how far down the irrigation system state control extended (e.g., the primary canal only or also secondary canals) (Hunt 1988a; Kelly 1983). I hypothesize that if irrigation management was entirely state run, as has been argued by a number of scholars (De Maaijer 1998; Falkenstein 1956; Hruška 1988; Renger 1990), the state must have managed all irrigation-related tasks at all levels of the irrigation system. If, however, ancient irrigation management was less centralized, the state would have controlled only certain aspects, such as water distribution, and/or state control may have only extended to certain levels of the irrigation system (e.g., the primary canal) (Rost 2011). The same applies to tasks related to river navigation and flood control.

In order to evaluate and interpret an incomplete data set like the Umma texts, it is useful to test it against two models that represent possible degrees of state involvement in irrigation management. I use models dealing with irrigation, since there are to my knowledge no case studies that investigate state control in the management of watercourses for irrigation and other functions. The models used are based on two case studies from Sudan and Iraq. These have been chosen because they represent cases at opposite ends of the degree of state involvement in irrigation management. Further, these cases have pragmatic similarities to the ancient system at Umma, such as dendritic, open-surface canals that draw water from rivers and are located in arid zones.

1.3.1 Model 1: Gezira Irrigation Scheme (Sudan)

The organization of the Gezira Irrigation Scheme in Sudan is the best case of an entirely state-run system in which centralized control reaches all the way down to the field level (Allen 1926; Beer 1955). The irrigation system was put into place by the British colonial government in 1926. It covered an area of 3,780,000 hectares at its onset (Bernal 1997: 447ff; Gaitskell 1959: 99;

Lees 1986: 614–616). The scheme was subdivided into administrative blocks of ca. 189,000 ha, which were managed by a block inspector and two subordinate junior field officers (Gaitskell 1959: 99). Six to ten blocks were under the supervision of a group inspector, who was directly responsible to the headquarters of the government-contracted syndicate. The syndicate organized all maintenance works, water allocation, and even plowing of the individual fields by relying on seasonally employed labor. Individual farmers were responsible for planting government-mandated crops and for all other cultivation activities (e.g., weeding) (Bernal 1997: 454, 462; Gaitskell 1959: 86–88).

According to this model, the state employs an organizational apparatus with a chief administrative officer and staff who manage tasks by delegating responsibility. These administrators determine and keep track of labor and/or water allocation schedules and supervise work crews (Hunt 1988b: 199; Hunt et al. 2005: 447–448). The organizational apparatus consists of full-time specialists, and the size and complexity of the administrative hierarchy depends on the size of the irrigation system (Willmott 1989: 148). Accounting, in particular, will be extensive in a state-run system, since a mechanism is needed to ensure that the tasks are executed as well as to communicate with the lower levels of the irrigation systems (e.g., tertiary canals and the field level). Furthermore, precise data on expenses are needed so that the state can collect water fees and/or taxes.

1.3.2 Model 2: Iraq

In contrast to the above case, Iraq is an example where the state is only responsible for certain aspects of the irrigation system. State involvement by irrigation engineers and their staff is restricted to managing the primary canal. These officials handle all tasks related to the upkeep of the canals and water distribution down to the outlets of secondary canals (Fernea 1970: 123). The construction, maintenance, and operation of the irrigation system beyond the inlets of the secondary canals are the responsibility of the water users. The water users are different tribes, each of which makes use of at least one secondary canal (Fernea 1970: 122–133, 167). The secondary canal is shared by the entire tribe and is overseen by the tribal leader (sheikh) and his family. Tertiary canals, on the other hand, are shared by members of family groups, and their construction and upkeep is organized and enforced informally by the family groups. Water distribution is organized without the aid of a state administrator. Instead, each water user is entitled to a certain number of water shares (*waqts* = time periods from sunrise to sunset) corresponding to the size of their land holding. The right to draw water from the secondary canal rotates among the water users, and this rotation is determined by lot at the beginning of each agricultural season. The local sheikh acts as the judicial authority in cases of water theft and conflict (Fernea 1970: 124–125).

According to this model, the state manages only certain tasks or specific levels (e.g., the primary canal) through an administrative hierarchy of responsible full-time specialists. Beyond a certain level of the irrigation systems or beyond certain tasks (e.g., conflict resolution), there is no administrative body engaged in handling the irrigation system. The water distribution and maintenance tasks of the rest of the system or the remaining tasks are handled by the water users and may or may not be formally organized. Usually, though, there is a local arbitrator to deal with conflict and distribution issues (Downing 1974: 117; Hunt et al 2005: 445).

Determining the degree of state control in the management of watercourses also needs to take the political organization and level of political centralization of a state in consideration. States exercise and maintain administrative and political control over a given territory by delegating authority to lower-order institutions and staff that represent and protect the states' interests on the local level. The delegation of authority can be done for areas (e.g., districts or provinces), functions, or both. According to Hutchcroft (2001), the varying degrees of political centralization can be measured by investigating how authority and decision-making power is delegated from the center to the local level (administrative centralization) and whether or not local executives are elected or appointed (political centralization). The latter refers to the political factors that determine the outcome of the distribution of authority. In a highly centralized state, the delegation of authority to local levels is restricted and clearly delimited and officials are appointed, rotated frequently to avoid the formation of local fiefdoms, and put under close supervision. This includes the existence of a punitive means to keep the behavior of state officials in line with states' interests. In addition, decision-making power over many aspects of the state administration is retained at the center (e.g., interior ministries) and limited amounts are allocated to the lower levels.

On the other end of the continuum are states with a low degree of political centralization, which can be the result of the lack of integration of the various entities within a state structure (Hutchcroft 2001: 29). In such a situation local officials, such as governors of provinces, operate nearly autonomously from the state's oversight or interference and have staff at their disposal that is more likely to report to them rather than to the central government. Such a system is also called "prefectoralism," which describes the subdivision of a state into units that are put under the control of a prefect. The prefect represents the government as whole, with all related functions in the area under his supervision. Such autonomous prefects can become a considerable threat to state power, particularly when they have economic and military powers. Frequently, however, prefectoralism is the most effective way to maintain law and order and extract revenues when the established administrative organization is not large enough to extend to all levels of the state (Hutchcroft 2001:29–31).

To apply these different degrees of political centralization to the topic of interest, an irrigation system or watercourse management system is considered highly centralized if it is operated by state-appointed officials who report back to the center. In such a case, a central ministry retains decision-making power over major aspects of the system in place. The authority and decision-making power of officials handling the day-to-day operations is limited. While such a system hardly seems practical in a context that frequently requires immediate response (e.g., flood control), this dissertation will show that the central government of the Ur III state did retain decision-making power at the center. This power mainly concerned conflict resolution. Irrigation systems that were operated by local state officials who did not report directly to the center but rather to the provincial governor, for example, would still be considered centrally managed, though to a lesser degree. As this dissertation will show, a lower degree of centralization does not necessarily mean that farmers had a greater degree of control over the management of the system. In the case of the Umma, the opposite is true. The irrigation systems that are recorded in the texts were managed in a very top-down fashion by the provincial government as represented by the governor, with farmers exercising no control over the system.

1.4 Outline of the Dissertation

In order to investigate the degree of state control in the management of watercourses for river navigation, irrigation, and flood control, the environmental context in which it all occurred will be described (chapter 2). This includes understanding the regime of the controlled water source, the local topography, and the climate regime as related to temperature and the distribution of precipitation rates throughout the year. A detailed grain cultivation calendar describes the specific growth conditions (e.g., water demand, temperature, soil) needed to cultivate crops and how and when humans must have manipulated the local environment in order to meet the crops demands. This calendar is therefor based on ethnographic, agronomic and environmental data and outlines the timing of when each task had to be accomplished in order to grow grain successfully and protect the harvest from the flood efficiently. As past and present environmental conditions as well the focus on the cultivation of winter grains (barley and wheat) were similar, I was able to use this calendar as a research tool to analyze the Sumerian terminology pertaining to ancient watercourse management. As one-fourth of the ancient Ur III texts are dated by month, the grain cultivation calendar was instrumental in enabling me to distinguish between tasks and devices recorded in texts related to irrigation, flood control, and river navigation. The importance of river navigation became apparent through the difference in the timing of tasks related to the control of the rivers' water levels in ancient versus modern times.

In order to evaluate the degree of state involvement in the management of watercourses, chapter 3 will provide the necessary background information on the history and socio-political and economic organization of the Ur III state. Special attention will be paid to the political structure of the Ur III state with regard to the delegation of authority and the organization of the provinces. The information available allows a fairly precise analysis of the degree of political centralization of the Ur III state. In turn, this information will be crucial in the discussion of the level of centralization adopted in the management of watercourses in the Umma province. This chapter will also discuss the geography of the Umma province in order to orient the reader for the following thee chapters (4–6), which outline the technical complexity of the watercourse management system.

Chapter 4 will primarily discuss how the fluctuating water levels of the ancient Tigris were controlled in order to coordinate the demands for irrigation with the requirements of navigation and flood control. Chapter 5 describes the size, layout, and management of irrigation systems under the control of the governor-run sector in the Umma province. While a full reconstruction of these systems cannot be offered at this point, these data allow us to discern the major irrigation canals that were in operation during the Ur III period. In addition, the sequence of irrigation-related tasks can be fully described, and the data provides valuable insights into the paleoclimatic conditions of southern Mesopotamia in late third millennium B.C. Chapter 6 will review the various flood protection strategies and methods that can be gleaned from the texts. As I will show, the methods are very similar to those practiced until very recently in Iraq.

Chapter 7 will outline the social organization of the management of watercourses in the Umma province. This will be preceded by a detailed description of the management of agricultural land, as the agricultural bureau of Umma also managed tasks related to irrigation, flood control, and river navigation. The description of the administrative hierarchy of the agricultural bureau of various sectors will be necessary to outline the chain of command for the planning and execution of works related to the management of watercourses. This includes the description of the complex system of labor organization that was adopted to mitigate the labor bottlenecks that occurred at various points in the agricultural and the solar year. I will also investigate how the position of the officials in charge of tasks related to the watercourse management system was embedded in the overall political structure of the Ur III state. The result of this investigation will allow me to determine to what degree the watercourse management system was centralized.

Finally, this thesis will conclude (chapter 8) with a discussion of the degree of centralization adopted in the management of watercourses for the three key functions. This chapter will evaluate the relevance of the findings to understanding the socio-political and economic organization of the Ur III state and, more importantly, the degree of political centralization adopted in the Ur III period. Finally, the results of this thesis will be evaluated with regard to our understanding of ancient irrigation management and the function of irrigation in early states.

1.5 Methodology

This study of watercourse management in Umma is based on four main data sources: cuneiform administrative documents, archaeological data, and comparative ethnographic data and ethno-archaeological research (Rost and Hamdani 2011, visit to Iraq 2011/2012). The archaeological reconnaissance of the province Umma is very limited. Located in the southeastern part of the Ur III state, covering an area of approximately 2,000 km^2 (see red box on map 1), the province was covered only partially by the regional site survey efforts of Adams (1981) and Adams and Nissen (1971). Only nineteen sites were documented at the time dating to the Ur III Period and the following Isin-Larsa Period (Adams 1981: 151, see map 1). Textual evidence, however, indicates that there were at least 110, and possibly 158, settlements in the Umma province in the Ur III period (Steinkeller 2007). This was confirmed by a recent archaeological settlement survey conducted by Abdulamir al Hamdani and his team in 2003–2009, which recorded approximately sixty sites dating to the late third millennium B.C. (Hamdani 2008). These results are preliminary, as the main goal was to detect and record archaeological sites for the planning of a large-scale heritage protection effort, and no site identification was attempted. Only the location of the provincial capital Umma, identified with Tell Djokha, is known so far. The identification of other sites was based on the geographic information recorded in texts and can only be considered preliminary at best.

The city of Umma itself has never been scientifically excavated except for two excavation campaigns by the State Board of Antiquities in 2000–2001. All tablets known from the archive of Umma derive exclusively from illicit excavations.[4] The contextual information is lost which is particularly problematic as the internal organization of the archive cannot be reconstructed. In turn, this has made the reconstruction of the internal economic and administrative organization of the Umma province exceedingly difficult. In addition, it remains totally unclear if the archive was unearthed in full or only partially and how much of the illicitly excavated documents are accessible for scientific research. In turn, since so little is known about the circumstances under which these records were unearthed and sold it is very difficult to assess the degree and nature of the discovery bias introduced. In other words, it is frequently difficult to tell whether an observed

[4] According to Steinkeller (2003: 40–41), their interconnectedness seems to indicate that they were found in one specific location and might have been the result of a single discovery.

pattern reflects past realities or is a result of the discovery bias. This situation can most likely not be remedied with future scientific excavations, as Umma and other sites were greatly damaged from looting activities in the aftermath of the 2003 war. Looting was still going on in 2012 when I visited the site. Two-thirds of the site is now covered with a mesh of adjoined looting holes, most of them 2–3 m below the surface, which have completely destroyed the integrity of the archaeological record of the city (Hamdani 2008). Any future scientific study of the site will face tremendous challenges.

Given these circumstances, my analysis of the watercourse management system of the Umma province relies primarily on analysis of the textual record and comparative ethnographic and historical data. A detailed reconstruction of the hydrology of Umma cannot be offered at this point but will be possible with further archaeological research. Steinkeller (2001) has, however, provided compelling evidence for a reconstruction of the course of the ancient Tigris in the Umma province. Based on an extensive textual analysis, Steinkeller argues (2001: 25) that the ancient cities of Maškan-Šapir (Tell Abu Duwari), Adab, Karkar (Tell Jidr), Zabalam, and Apisal (Tell Muhalliqiya) were located on the Tigris and reconstructs the river's course along the line that had previously been identified as the "eastern branch of the Euphrates" (see map 1, also chapter 2, map 2).

In addition, Steinkeller (2001: 41–49) offered a reconstruction of the course of the so-called Iturungal, most likely a major tributary of the ancient Tigris with a length of approximately 60 km. This tributary branched off the Tigris north of Ka'ida and took a course south via Nagsu to join the Euphrates a little south of Uruk. The course of the Tigris and the Iturungal as reconstructed by Steinkeller (2001) will function as the baseline for my analysis of the textual record. Even though a reconstruction of Umma's hydrology is not possible at this point, the textual data allow for a fairly comprehensive description of the basic physical layout and the technical functioning of the watercourse management system adopted in the Umma province.

1.5.1 The Problem of Translation

My description of the watercourse management system rests upon an analysis and more accurate translation of the relevant Sumerian terminology pertaining to river navigation, irrigation, and flood control. While there has been substantial progress over the last four decades (e.g., Bagg 2000; Civil 1994; Kang 1973; Liverani 1990, 1996; Pemberton et. al. 1988; Renger 1990; Steinkeller 1988; Waetzoldt 1990), there is still considerable confusion surrounding the Sumerian terms referring to hydraulic devices or tasks. This confusion is related to the fact that archaeological evidence is largely lacking. Thus far, only the locations of the former courses of the Euphrates and Tigris and some primary canals have been detected archaeologically, and these identifications have been made at varying degrees of confidence (Adams 1981; Adams and Nissen 1972; Hritz 2005; Jacobsen 1960, 1969; see also Gasche and Tanret 1998). Except for the so-called "water regulator" found near the city Girsu, there is hardly any archaeological evidence for water control facilities (Huh 2008: 181–189; Jacobsen 1969: 103–109; Parrot 1948: 216; Pemberton et al. 1988: 220). Furthermore, textual records only very rarely provide the dimensions of water control devices, which would make it possible to describe their size and construction design, providing clues about their function and in turn the meaning of the Sumerian term used to describe it. Moreover, while the texts do indicate the geographic location of the water control devices, determining their exact position within the larger hydraulic context could only rarely be accomplished due to our limited understanding of Umma's geography and hydrology.

This problem is amplified by the fact that the Sumerian vocabulary is limited and the meaning of words is frequently context depended. The Sumerian word kab_2-ku_5, for example, describes a flow divider in the context of an irrigation system, but describes an artificial breach when used in the context of flood control alongside the river. In addition, every natural language[5] is based "folk concepts" about the observations and experiences of the natural, social and sacral world. The most accurate translation can only be achieved by fully describing the folk concepts behind each of the native terms to be able to choose the most appropriate and least ambiguous translation (Hunt 2007: 19–28). For that reason the translations of the Sumerian water control terminology is still a work in progress until further archaeological research will allow for determining the location of the water control devices mentioned in the texts more accurately. In order to limit the ambiguity deriving from the language into which Sumerian terms are

[5] As opposite to a scientific language, which ideally consists of terminologies and definitions with little to no degree of ambiguity in the concepts they describe to allow for cross-cultural communication and comparison (Hunt 2007: 10, 23–28).

translated, I made use of the *Multilingual Technical Dictionary on Irrigation and Drainage* (*MTDID*) (International Commission on Irrigation and Drainage 1996). When translating Sumerian words related to irrigation or water control I choose a term from that dictionary whose definition was closest to the meaning of the Sumerian term.

1.5.2 Research Approach Adopted

As the archaeological counterpart is lacking I used a research model to aid the analysis and translation of the Sumerian water control terminology. As has been mentioned in 1.4, the research model was built on the basis of modern environmental data and ethnographic/historical data on traditional methods of irrigation and flood control. The goal was to gain a comprehensive knowledge of the topography, river, climate, and precipitation regimes to understand how the growth conditions of grain are met by the local environmental conditions. This in turn gave me a sense of what the Mesopotamian irrigator was up against. In addition, the ethnographic/historical data provided insights into the possible technological solutions to mitigate these environmental constraints for cultivation and irrigation purposes. This model was then used as a reference point for the analysis of the texts.

The majority of administrative texts consist of primary accounts that record the expenditure of labor and goods, in most cases for a single event or work project (Molina 2008: fig. 2). These accounts were then used to compile year-end accounts that record the labor and/or goods provided by an individual official or institution as part of his or its obligation to the provincial government and the state (Englund 1991; Nissen et al. 1993; Steinkeller 2004a: 38–39). Irrigation-related texts (see AOS 32 I 49) provide detailed information on work projects, such as a) the number of workmen involved, b) the duration of the project, c) the types of activities involved (e.g., cleaning a canal or irrigating a field), d) the project's location, e) the supervisor's name and the name of the official who authorized the execution of the project, and f) the date (year and/or month). The amount of quantitative data on labor and construction materials for water works is unmatched in history and even surpasses more recent ethnographic accounts of the organization of irrigation.

AOS 32 I 49	
obverse	**o. 1–3**
o. 1 7 guruš u4 1-$\check{s}e_3$	7 workmen for one day cleaned the Kun-Nagar-canal
o. 2 i_7-Kun-nagar	**o. 4–5**
o. 3 šu-luh ak	supervisor (was) Insasa
o. 4 ugula In-sa_6-sa_6	(tablet was) sealed by Akala, the inspector of the plow oxen
o. 5 kišib A-kal-la nu-$banda_3$	
reverse	**r. 1–2**
r. 1 iti RI	**Month**: V (August)
r. 2 mu En-unu_6-gal ^{d}Inanna ba-hun	**Year:** Enunugal was installed as en-priest of Inanna
r.	**Seal:** Akala, scribe, son of Ur-nigar, the chief livestock manager
s. 1 A-kal-la	
s. 2 dub-sar	
s. 3 dumu Ur-nigar^{gar} $ku\check{s}_7$	

Based on earlier studies I selected twenty-two Sumerian terms describing hydraulic devices and tasks. The result of my analysis shows that these terms describe Ur III watercourse management systems quite comprehensively. All texts containing one or more of the twenty-two terms were analyzed, amounting to approximately 2500–3000 individual tablets. I created a searchable database of each relevant Sumerian term, which could be sorted for specific criteria. Since the identification of the function of the individual hydraulic devices mentioned in these texts was critical to this research, the initial criterion **(1)** was to identity the location/context in which a certain device was found. The context provided clues about the function of a device by determining its approximate location in relation to the river. The location/context could be determined by the name of the device. Devices such as barrages, weirs (kun-zi-da), flow dividers (kab_2-ku_5), inlets (ka), and outlets (kun) are usually named after the canal or watercourse in which they were found. It many instances, though, they are also named after fields, hamlets, towns, and cities in immediate proximity to which they were located. Given our limited knowledge of the historical geography of the Umma province, determining the exact position of water control devices within the larger hydraulic context could only rarely be accomplished. In turn, their exact functions in the larger water management scheme often remained ambiguous. Though, clear patterns could still be discerned of certain devices being primarily associated with the river itself or major canals or primarily with fields, which provided important clues about their function.

The other important criterion **(2)** recorded was the kind and amount of material used in the construction or repair of the devices mentioned in the texts. My research indicates that ancient irrigation systems in southern Iraq in the third millennium B.C. consisted mainly of earth canals. Hydraulic devices, such as barrages, weirs, flow dividers, inlets, and outlets of canals were constructed mainly from earth, reeds, and sometimes brushwood. Given the construction materials used, the water control devices were very prone to erosion, and the most frequently attested maintenance work is that of inserting earth into the eroded parts (sahar si.g) or reinforcing them with an adobe mixture (kin u_2 sahar-ba). This information provided a sense of the size of these devices and in turn further clues about their function. Finally, **(3)** the range of tasks performed at a certain water control structures were identified and, more importantly, **(4)** the timing of their performance was recorded.

Even though the percentage of texts dated by month is usually low (20% or less), clear patterns could frequently be discerned that were statistically robust. The range and the timing of the tasks performed frequently made it possible to identify whether a device's function was related to irrigation, navigation, or flood control or a combination thereof. For example, the task of "cleaning" (šu/$šu_2$ luh-ak) was primarily performed at canals. Most of the references dated by month fell in the period of August/September, clearly indicating that this task described the annual removal of sediment from the irrigation canals. In turn, this made it possible to distinguish between irrigation canals and other watercourses. In addition, **(5)** the number of workdays spent on each of the tasks is also indicative of the size of the device and its functions and was also recorded. Also of importance was information on the employed workforce **(6)**. The Sumerian words for male and female workers are guruš and $geme_2$, respectively, and these are the most commonly used terms in the ancient records to refer to the employed workforce. However, there are specific terms that refer to distinct working classes of different socio-economic statuses, incomes, and gender, which will be discussed in detail in chapter 3. In addition, a considerable amount of seasonal labor was employed from other industries (e.g., mill houses and weaving establishments). The information on the employed workforce provided important insight into the underlying labor organization of ancient watercourse management. Finally, **(7)** the names of the responsible supervisor (ugula) of the work crew and the official who authorized and confirmed (kišib) the execution of a specific project were documented. At times, multiple records documenting one work project were sorted according to the authorizing official, which made it possible to reconstruct the *chaine operatoire*. By doing so, the construction design of the inlet of the so-called Amar-Suen-kegara-canal, for example, could be reconstructed fairly comprehensively. The names of the officials were crucial for determining the chain of command and the level of centralization adopted in the management of watercourses in Umma.

Chapter 2 Environment

Our understanding of the Ur III watercourse management system is based primarily on three sources: archaeological settlement survey data from the 1970s and 1980s (Adams 1965, 1974, 1981; Adams und Nissen 1972; Gibson and Field 1972; Jacobsen 1960, 1969; Wright 1981), and more recent remote sensing data (Gasche and Tanret 1998; Hritz 2005, Pournelle 2003, Ur 2005), and administrative documents. The archaeological data allowed the outlining of the fluvial development of Euphrates and Tigris as well as the determination of the location of some primary canals. However, there is very little archaeological evidence for water control facilities[6] prior to the Neo-Assyrian Period (911–609 B.C.) that would allow us to understand how watercourses were managed in ancient Mesopotamia. In addition, very little archaeological information exists on the size and layout of ancient irrigation systems. Therefore, this dissertation research is primarily based on an analysis of written records.[7] The Ur III records are exceptional in the amount of detail they provide on the ancient riverine environment of third-millennium B.C. southern Mesopotamia and its manipulation for navigation, irrigation, and flood control. These texts, however, are limited in that they record (frequently in abbreviated form) the perspective of the people of ancient Umma on their immediate environment. Furthermore, these texts fulfilled a specific function: they were designed to only record information that was relevant to the administration of the Umma province. In addition, the absence of archaeological data impacts our ability to understand and interpret texts that refer to water control devices and tasks related to managing watercourses. This has led to a degree of confusion surrounding the translation of Sumerian terms referring to the management of watercourses.

One way of dealing with these difficulties is to make use of analogies[8] that are informed by comparative ethnographic data. There has been considerable debate about what should be

[6] See regulator next to Girsu (Huh 2005: 181–189; Jacobsen 1969: 103–109; Parrot 1948: 216; Pemberton, Postgate und Smyth 1988: 220).
[7] For previous studies, see *Bulletin on Sumerian Agriculture* IV (1988) and V (1990).
[8] According to Renfew and Bahn (1996: 182), an analogy is defined as “the belief that where certain processes or materials resemble each other in some respects, they may resemble each other in others ways also. It may be

considered a valid analogy and how analogies should be deployed in interpreting archaeological remains and, as in my case, ancient texts (Asher 1961; Binford 1967, 1968, 1977; Freeman1968; Gould and Watson 1982; Hodder 1982, 1987; Stiles 1977; Wobst 1978). I recognize that the validity of an analogy depends on the strength of the links between the past and the present, and I have therefor chosen to take the direct historic approach. The direct historic or folk culture approach makes use of analogies deriving from roughly the same geographic area in which the archaeological investigation is located and assumes cultural continuity. The strength of analogies from the direct historic approach derives from the possibility that certain practices, technologies, beliefs, and various aspects of societal organization have been preserved from the past to the present (Ascher 1961: 317–318).

The analogy that will be used for my textual analysis consists of modern environmental data and a grain cultivation calendar. As our understanding of paleoenvironmental conditions of southern Mesopotamia is very fragmentary, my description of topography, temperatures, precipitation rates throughout the year and the regime of the controlled water source—the Tigris—is based on modern data. I use river flow data from a period prior to the British Colonial Government's construction of the major Tigris and Euphrates barrages, which altered the rivers' water regimes considerably, making more recent data unfit to be used as an analogy for past conditions. Based on the environmental data and modern agronomic data, I constructed a grain cultivation calendar outlining the timing of when various tasks needed to be performed in order to plant seeds, irrigate the crops multiple times during the growing season and to protect them sufficiently from flood damage, and harvest them at the appropriate time. This calendar contains both irrigation and agricultural tasks that needed to be coordinated with natural events (e.g., flooding, increases and decreases in temperature, precipitation, etc.) as dictated by the local environment. The description of how these tasks were carried out and what kind of technology was used is based entirely on ethnographic accounts and ethno-archaeological research on traditional irrigation and cultivation methods (prior to mechanization).

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possible to use details from one body of information to fill gaps in another body of information from which those details are missing". According to Binford (1967: 1-2) "an analogy is not strictly a demonstration of formal similarities between entities; rather it is an inferential argument based on implied relationships between demonstrably similar entities." He (1967: 2) further notes: "The more numerous the similarities between analogues, the greater the probability that inferred properties are similar."

The environmental data and the grain cultivation calendar provide a frame of reference for understanding the environmental challenges that southern Mesopotamians faced in their efforts to control watercourses for navigation, irrigation, and flood control. Research has also shown (see 2.2) that past environmental conditions were similar to those of the present, as was the prime focus on winter grains (wheat and barley) in agricultural production (see 2.4). Both factors strengthen and validate the analogies used here. Furthermore, outlining how irrigation and river management was traditionally carried out in Iraq allows us to anticipate what texts pertaining to watercourse management are most likely to record. Additionally, contrasting the evidence of the past with that of modern times will also allow us to clearly describe the difference between ancient and modern ecology. Finally, as one-fourth of the administrative documents are dated by month, the timeline provided by the grain cultivation calendar allows us to distinguish between tasks related to irrigation and those related to navigation and flood control.

2.1 The Alluvial Plain of Southern Mesopotamia

Southern Mesopotamia is an alluvial plain,[9] which appears flat and featureless at first glance but in fact consists of a diverse landscape of high ground and low depressions. The alluvial plain is a classic flood plain that has been shaped and reshaped by cycles of sediment aggradation and erosion as a result of the movement of the rivers and 6000 years of irrigation. Due to the flatness of the alluvial plain (less than 1% gradient[10]), flow velocity in the Euphrates and Tigris is drastically diminished. This increases the deposition of the sediment load during floods within

[9] The alluvial plain was formed during the Pliocene (5–1.7 million years B.C.) through the collision of the Arabian and the Eurasian plates. As a result, an asymmetrical depression was formed that stretches from the Hormuz to Syria. This depression, also called the Mesopotamian block, is an unstable shelf that is to this day sliding underneath the budding Zagros mountain range. The Mesopotamian block is further demarcated by the stable land shelf of the Salmon Zone to the west, the stable lower Jezirah terrace to the north, the Pleistocene (1.7–10.000 B.C.)–Holocene (10.000 B.C.–present) alluvial fans of the Zagros mountain range to the east, and the coastline of the Persian Gulf to the south (Cole and Gasche 1998: 4–5; Pournelle 2003: 67–68; Verhoeven1998: 161). The flow behavior of the Euphrates and Tigris is determined by the underlying tectonic or geosyncline of the Mesopotamian plain, as water always seeks the lowest point. The entire Mesopotamian zone dips from northwest to southeast, and the flow of the Tigris (below Samarra) assumes a south–southeast trend, while that of the Euphrates (below Kut) assumes an eastward trend. Both rivers join in the Shatt al-Arab and traverse the Zubair Subzone, which causes the river to flow straight southward (Pournelle 2003: 68–72). There are no data on the nature of the geosyncline of the end of the third millennium B.C., but archaeological settlement data (Adams 1981, Adams and Nissen 1972, Hamdani 2008) suggest that the northwest–southeast flow pattern already persisted throughout the plain.

[10] The gradient of the alluvial plain north of the city Hit amounts to 30cm/km. South of Hit, the gradient diminishes to 10cm/km until it reaches 3 cm/km at the delta of the Persian Gulf (Charles 1988: 7). The slope in the Gharraf area diminishes to 5 cm/km – which is also the study area of this dissertation (Wilkinson 2013: 42). In other words, there is a 30 m drop in elevation over the course of the 445 km between Baghdad in the north and Basra in the south (Hritz and Pournelle in press).

and adjacent to the rivers' watercourse, leading to the formation of large soil ridges called river levees, and the river basins in between.

Levee systems are elevated 2–4 m above the flood plain. Their cross section is triangular in shape and has an average width of 2–6 km, with the river running at the center of the levees' crest. The shape of the levees is determined by the sediment deposition processes. That is, heavier and coarser materials are deposited first within and next to the river's bed, while the particle size of the deposited sediment decreases the further the water moves from its source (Buringh 1960: 143–146; Hritz and Wilkinson 2006; Hritz 2005: 238; Pournelle 2007: 43). Due to its higher elevation, the soil on the levees' crests and slopes is well drained and constitutes the agricultural ground in southern Iraq. Further, the levees' topographic relief is well suited for irrigation, as the location of canals along the levees' back slope enables adequate flow velocity within the canal and onto agricultural fields. The river basins constitute the drainage areas for both irrigation and floodwater and over time develop into lakes, marshes, and wetlands due to their poor drainage. Agricultural land located closer to the depression is at greater risk of salinizing, as water tables are closer to the surface and soil drainage is poor (Pollock 1999: 32; Verhoeven 1998: 171–173; Wilkinson 2003: 76–79, 2013: 35–43). The sediment load of the Euphrates and Tigris is four to five times that transported by the river Nile (Nützel 2004: 72; Verhoeven 1998: 199–100). Over the millennia the Euphrates and Tigris have filled their floodplain with layer upon layer of sediment. These aggradation processes result in a relatively unstable river system, and over time the Euphrates and Tigris have shifted their course across the alluvial plain (Verhoeven 1998: 164–166; Wilkinson 2003: 76–77).

The central alluvial plain consists of the active flood plain of the Euphrates and Tigris to the west and east and two large fossil alluvia at its center. These fossil alluvia are the remnants of the ancient course of the Euphrates and Tigris, which were once interconnected and ran parallel within a narrow corridor from northwest to southeast at the center of the central alluvial plain. The rivers migrated progressively over several millennia to the east and to the west, respectively, until they assumed their current course. Robert McCormik Adams argues (1981: 14–22) that humans had a profound impact on the landscape formation of the central alluvial plain. The practice of irrigation over nearly 6000 years, according to Adams, led to greater sedimentation of the ancient alluvial plain than would have occurred under natural conditions and consequently accelerated the drift of the course of the rivers eastwards and westwards. Even though it is difficult to discern which forces were primarily responsible for the westward and eastward drift of Euphrates and Tigris, it is commonly accepted that anthropogenic forces played an important role in the process (Cole and Gasche 1998: 6; Verhoeven 1998: 175–178; Wilkinson 2003: 76–77).

The southernmost part of the central alluvial plain is demarcated by marshes, which until recently extended in a triangle between Amara and Nasiriyah to the west and east and Basra to the south. This marsh landscape consisted of sweet water marshes, brackish water, and saltwater marshes as well as seasonal and permanent marshes. Marshes, both seasonal and permanent, are large biomass producers and have been an important economic resource throughout Mesopotamian history (Pournelle 2003: 107).

2.1.1 The Rivers Euphrates and Tigris

The modern Euphrates and Tigris originate in the Anatolian highlands of eastern Turkey. From there, the Euphrates travels 2700 km[11] and the Tigris 1840 km through Syria to Iraq, and the two rivers meet at the city Qurna in southern Iraq to form the Shat-al Arab, which runs 77 km and then drains into the Persian Gulf.[12] Due to its larger number of tributaries, the water volume of the Tigris is four times greater than that of the Euphrates River. As a result, the river today incises itself deeper into the alluvial plain on its southeastern path and remains for the most part a single-channel river (Food and Agriculture Organization 1997: 104, Nissen 1999: 9, Pournelle 2003: 101; Verhoeven 1998: 199, 211).

The configurations of the modern Euphrates and Tigris are determined by the rivers' adjustment to the terrain they traverse and the size of the transported sediment load, as well as water volume and flow velocity. From their origins in northeastern Turkey to their entry into the

[11] 40% of the route of the Euphrates is in Turkey, 20% in Syria, and 40% in Iraq. 22% of the route of the Tigris is in Turkey, only 1% in Syria, and 77% in Iraq. In other words, 1000 km of the Euphrates and 1300 km of the Tigris are located in Iraq (Food and Agriculture Organization 1997: 104–106; Zawahri 2006: 1044).

[12] The Euphrates receives 90% of its water from Turkey and only 10% from Syria, where it is joined by the Balikh and Khabur rivers. The Tigris, on the other hand, receives only 53% of its water from Turkey and 47% from Iran through the tributaries of the Greater and Lesser Zab, the Al-Adheim, the Diyala, the Nahr, the Dewarege, the Shehabi, and the Al-Karkha rivers (Food and Agriculture Organization 1997: 106; Zawahri 2006: 1044).

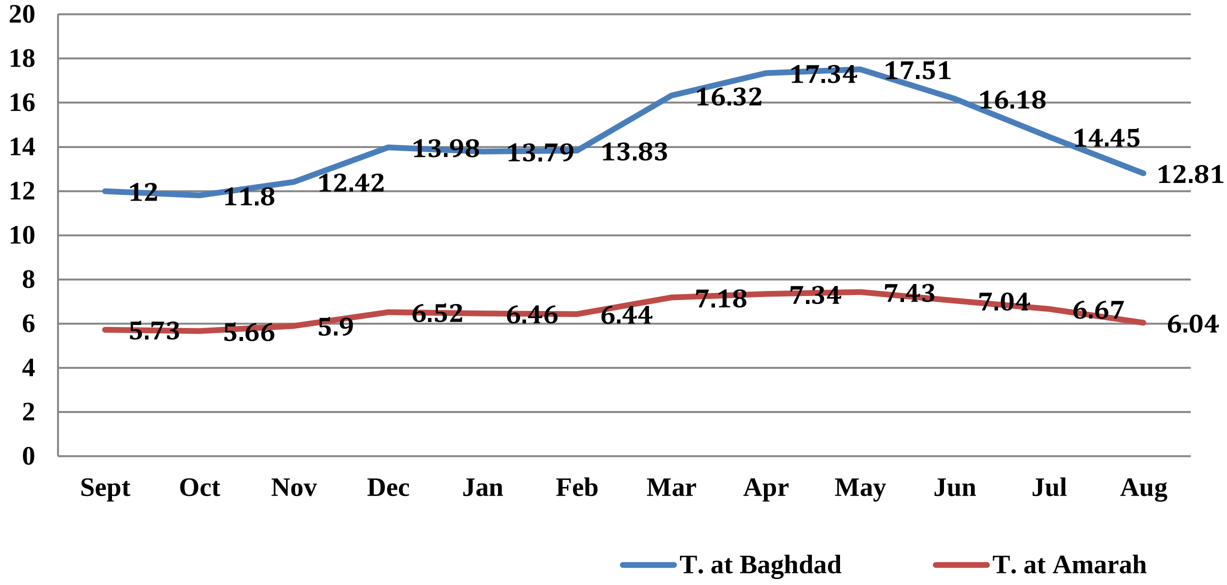
alluvial plain at Samara/Baghdad, both rivers today take the form of a dendritic river system with numerous tributaries that are deeply incised into the Syrian and Arabian plateau. Once they enter the alluvial plain, the flow velocity of the Euphrates and Tigris is drastically diminished due to the general flatness of the terrain. The Euphrates rides elevated above the floodplain at the crest of large levees, adopting a sinusoidal course up to the city Hindiyah. Due to the difference in water volume, velocity, and gradient, the Tigris River does not form as distinct a levee as the Euphrates and is today more deeply incised into the alluvial plain, adopting a meandering course up to the city Al-Kut. Both rivers form an anastomosing river system consisting of a web of multiple interconnected major and minor branches as the gradient of the alluvial plain further diminishes towards the Persian Gulf Delta (Food and Agriculture Organization 1997: 104; Hritz 2005: 24; Nissen 1999: 8; Verhoeven 1998: 199; Wilkinson 2003: 77).

The water regimes of the Tigris and Euphrates Rivers are characterized by strong and often unpredictable fluctuations. Furthermore, unlike the Nile floods, annual flooding does not coincide with the crop cycle of winter grain (barley and wheat). The water level is low during the sowing of winter grain in September/November and peaks just prior to the harvest in April/May (Postgate 1992: 181–183; Pournelle 2003: Table 6; Verhoeven 1998: 199, 201–203). As the Tigris is considerably shorter, it usually floods a month earlier than the Euphrates (Ionides 1937: 247–259). The difference between low and high water levels in the river can range from 1.5 to 5 m for the Euphrates at Hit[13] and 2 to 5 m for the Tigris at Baghdad[14] (Ionides 1937: 45, 153). The difference in the water levels is less dramatic along secondary and tertiary branches (see Table 2.1). At Amara, where the Tigris splits into two main branches (main Tigris branch and Shat al-Gharraf), the difference between high and low water levels varies only from 1.4 to 1.66 m and showed considerable consistency in these fluctuations over a period of 15 years (1918–1932) (Ionides 1937: 180, Table 96, 191, Table 98).

[13] The gauge readings range from the years 1924 to 1932 (Ionides 1937: 45).
[14] The gauge readings fall between the years 1906 and 1932 (Ionides 1937: 151).

Table 2.1

Monthly average river gage reading of the Tigris at Baghdad (1906-1932) and Amarah



The control of these rivers for irrigation purposes therefor requires management of the fluctuation of the river water levels. High water requires a means of flood control to protect the harvest, fields, settlements, and water control facilities. Low water levels at the beginning of the agricultural season are particularly problematic, as the inlets of primary canals will be located above the water level. The water level needs to be raised in order to force water into primary canals. As will be discussed in chapter 4, managing the rivers' fluctuating water levels was the major component of the water management system adopted in the Umma Province during the Ur III Period.

2.1.2 Climate

The climate of the alluvial plain belongs to the semi-arid zone and is characterized by very hot and dry summer months and mild and rainy winter months. The annual precipitation rate most years is less than 100 mm, and rainfall is unevenly distributed throughout the year (see table 2.2). Most of the rain falls in the winter months, between December and February, while the summer months, between May and October, are almost completely dry. While winter rains benefit winter crops, they are insufficient to allow for rain-fed agriculture. The cultivation of winter and especially summer crops has always depended on the artificial allocation of water. This being said, rain is very important at the beginning of the agricultural season (Oct/Nov) to soften the hard-backed topsoil to allow for plowing. The amount of rain received during the winter months also determines the overall soil moisture and the health of the vegetation cover used for animal fodder (Adams 1981: 12, Charles 1988: 2–3; Pournelle 2003: 74). Precipitation rates vary greatly from year to year due to shifts of the Indian Monsoon, which is shifted by variation in the air pressure above the Asian landmass (Pournelle 2003: 73–74). Therefore, the average annual precipitation rates in the years 1953–1957 ranged from 93 to 277 mm (Charles 1988: Table 1).

Table 2.2

Monthly Precipitation and Temperature in Nasiriyah

Month	**Precipitation in mm**[15]	**Temperature in Celcius**[16]		
		Ave	**Max**	**Min**
Sept	tr.	31.4	48.9	13.9
Oct	0.5	26.6	36.7	7.8
Nov	22.4	19.7	26.7	3.9
Dec	27.8	13.2	26.6	-2.2
Jan	17.9	11.2	26.7	-7.2
Feb	9.4	13.4	31.1	-2.2
Mar	23.0	17.4	33.9	0.5
Apr	12.1	23.5	42.8	6.1
May	6.6	29.7	45	12.2
Jun	tr.	32.5	47.8	18.3
Jul	0.0	33.5	48.3	20.6
Aug	0.0	36.8	48.3	16.1

Temperatures in southern Iraq can show great variation between winter and summer (see Table 2.2). In the summer, the temperature can go up to 50°C, but it rarely drops below 0°C in the winter. Frost rarely occurs in southern Iraq (Adams 1981: 11–12; Food and Agriculture Organization 1997: 103; Nützel 2004: 5). The evaporation rate during the summer months doubles

[15] Monthly mean precipitation in mm at Nasiriyah 1940-1956. Source: Government of Iraq, M. o. C. a. w. (1950). Metrological Service. Climatological Means for Iraq. Publication No. 9. Baghdad, http://docs.lib.noaa.gov/rescue/data_rescue_iraq.html).

[16] Monthly temperature in Celcius in Nasiriyah, 1940-1947. Source: see fn above.

with every 10°C increase in temperature, and evapotranspiration[17] rates reach 10 mm per day during the months of July and August in comparison to the monthly rates of 45–160 mm between November and April. The water demand of plants quadruples during the summer months. For this reason, crop cultivation in southern Iraq has always focused heavily on the winter crops, mainly wheat and barley (Charles 1988: 4–5).

2.2 Paleoenvironment

Reconstructions of the paleoenvironment in southern Mesopotamia are mainly based on studies of the diachronic development of the water regime of the Euphrates and Tigris (Adams 1965, 1981; Gasche and Tanret 1998; Gibson 1972; Hritz 2005; Pournelle 2003; Wilkinson and Tucker 1995; Wright 1981). Proxy data for paleoclimatic conditions are for the most part lacking, and reconstructions for southern Mesopotamia so far have had to rely mainly on data from Anatolia (Turkey), Oman, and the Levant (Israel and Palestine) (Pollock 1999: 36).

2.2.1 Paleoclimate

Paleoclimatic data from Lake Van (Turkey) suggest that the conditions between the seventh and second millennia B.C. were more humid than those of today (Lemcke and Sturm 1997). The humid period reached its peak between the middle of the sixth and fourth millennia B.C., with a continuous trend towards an arid and semi-arid climate from then on. These climate trends are partially confirmed by oxygen isotope results from Soreq-cave, close to Jerusalem (Israel). They also indicate the beginning of a dry period around the end of the third millennium B.C. and an abrupt change to arid climate conditions in 2150 B.C., which coincides with the Ur III period (2112–2004 B.C.). The data further indicate that the four-hundred-year long dry period was characterized by great fluctuations (Bar-Matthews 1997, 1998, 1999; Goodfriend 1990, 1991). Even though the paleoclimatic data from Turkey and Israel are impacted by local climate variation, the general trends suggest that paleoclimatic conditions around the third millennium B.C. might have been slightly more humid than today, with slightly higher and less seasonal precipitation rates, resulting in milder summers and moister winters as well as slightly higher water volumes in the river (Nützel 2004: 145; Pournelle 2003: 80–81; Wilkinson 2003: 21–22). There is, however,

[17] Evapotranspiration is the process by which plants draw water from the soil and dispense it to the atmosphere through photosynthesis and turgidity and the byproducts of respiration. This is also the process by which plants retain most of their water demand.

no indication that rain-fed agriculture was possible in the third millennium B.C. in the southern alluvial plain. As will be shown in chapter 5, textual data suggest that possible higher precipitation rates might have cut down on the amount of irrigation that had to be applied to the crops.

Even though the available proxy data do not allow for a detailed description of the paleoclimatic conditions of southern Mesopotamia, they are important for understanding the evolution of the Euphrates and Tigris rivers. In particular, the available proxy data of regional rainfall patterns from Lake Van, located in the catchment area of the Euphrates and Tigris in the Anatolian Uplands, are indicative of variations in the water volumes of the rivers. According to Cole and Gasche (1998), the effect of a period of lower precipitation rates between 3000 and 1500 B.C. on the water regime was twofold. First, lower water volumes in the river led to the desiccation of many major and minor river branches and the constriction of the river's main channel. Second, a sudden influx in water (Cole and Gasche 1998: 10–11) must have resulted in disastrous floods, as the constricted river channel could not further contain large amounts of water. The archaeological findings of major flood dike structures at ancient Sippar Amnanum (Tell ed-Der), Sippar (Abu Habbah), Nippur, and possibly Uruk in the first half of the second millennium B.C. are indicative of massive floods during that period (Cole and Gasche 1998: 7–11; Heyvaert and Baeteman 2008; Paepe, Gasche and Meyer 1978: 1–35).

2.2.2 Changing Water Regime of Euphrates and Tigris

Changes in a river's water regime can be observed both spatially and diachronically. These changes are due to the river's effort to keep variables such as water volume, sediment load, cross-section of channels, and composition of the riverbed as well as flow velocity and slope in balance. The configuration of a river will change from one type to another (single channel, braided, meandering, etc.) along its course traveling through various terrains and landscapes. The configuration of rivers will also change locally through time in response to geomorphological processes related to climate change, fluctuation in the sea level, tectonics, and environmental changes in the catchment area (Buringh 1960: 143–146; Verhoeven 1998: 188–191). Wilkinson (2003: 77) and Verhoeven (1998) define two key features of river transformation in the alluvial plain of southern Mesopotamia: avulsion and lateral migration. *Avulsion* describes a process by which the deposition of sediments in the riverbed reaches a threshold and causes a breach at a weak point in the river's levee, leading to the formation of a floodplain splay, a fan-like array of smaller water channels (see fig. 2.3). Avulsion can result in the formation of secondary river channels and/or a shift of the entire course into a new channel (Hritz 2005: 14–16, 47–58; Louis 1979: 232, 236; Pournelle 2003: 96; Verhoeven 1998: 171, 173, 209; Wilkinson 2003: 80–88).

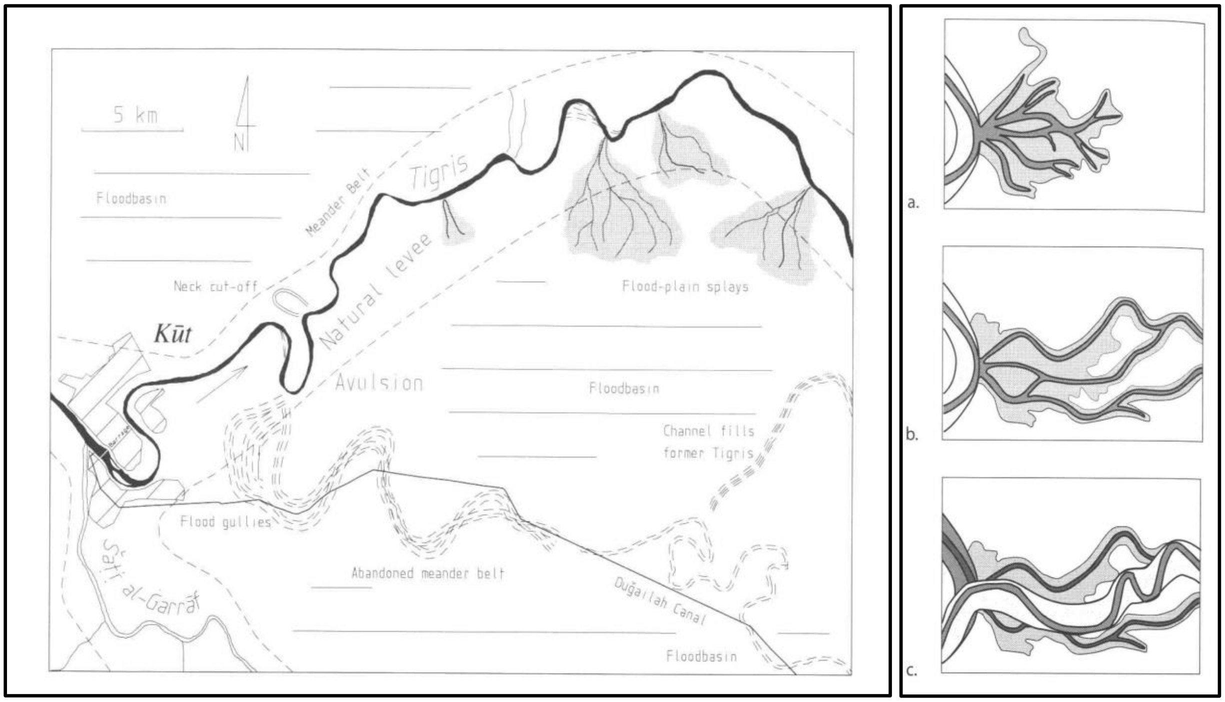


Figure 2.3 Channel avulsion (Verhoeven 1998: fig. 2).

The lateral migration of a river channel is restricted to meandering rivers. Meanders form through the oscillating movement of the river's main current line, which represents the middle, fast-moving portion of a river's water flow. Irregularities in the river bed will deflect the river's main current line, causing it to erode one side of the river bank while depositing sediment on the other, forming sand and gravel banks. The sand and gravel banks force a river to migrate laterally, eventually resulting in a shift of the main course of the river as well as wavelike sedimentation of the flood plain (Louise and Fischer 1979: 227–231; Marcinek 1996: 176, 225; Verhoeven 1998: 192–195, 226–227; fig. 2.4).

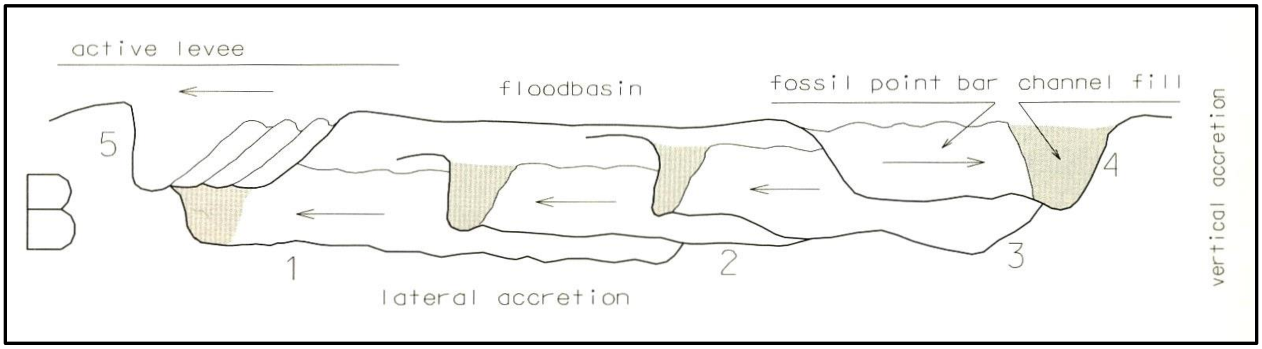


Figure 2.4 Lateral migration of meandering rivers (Verhoeven 1998: 226, fig. 16)

2.2.3 The Study of Changes in the Rivers

The early reconstructions of the major shifts of the Euphrates and Tigris were based on the analysis of the location of settlement and settlement patterns. Sedentary life in a semi-arid environment such as the southern alluvial plain since the fourth millennium B.C. was only possible with access to sufficient water. The settlement distribution in the central alluvial plain was characterized by a noticeable alignment of sites along major water channels (Adams 1981: 27–28).[18] A shift in the major river channels would have ultimately resulted in a shift in the location of settlement as well. Mapping the shifts in settlement location through time formed the basis of the early reconstructions of the development of the Euphrates–Tigris configuration. Settlement surveys were conducted in the alluvial plain from the 1950s onwards, first by Thorkild Jacobson (1960, 1969) in the Umma, Lagaš, and Ur area, followed by Adams (1965, 1972, 1981), who surveyed one-third of the entire alluvial plain over a period of 30 years (Hritz 2005: 2) and recoded 2,796 archaeological sites in the Diyala region, the central alluvial plain and the Uruk-Warka area. Other small and more intense surveys were carried out in the area around ancient Kish by MacGuire Gibson (1972), in the Ur-Eridu basin by Henry T. Wright (1981), and in the Abu Salabikh and Maškan -Šapir area by Tony Wilkinson (1990, 2004). More recently, Amir Hamdani (2008) and his team conducted another survey from 2003 to 2009 in southern Iraq as part of a large-scale heritage protection effort. Hamdani and his team conducted a survey in the Umma/Lagash area, the area at the Shatt al-Gharraf, and southward to the central marshes.

[18] According to Adams (1981: 27–28), “Where tells fall into a linear pattern, as they generally do, a kind of least effort principle allows us to hypothesize that the line is approximately that taken by the watercourse serving those settlements during their flornit. With the addition of air photographs, the individual watercourses, and even superimposed sequences of watercourses dating back to fairly remote periods, can often be seen.”

Based on their research, Adams (1965, 1981) and Adams and Nissen (1972) could show that the Euphrates and Tigris were once interconnected near ancient Sippar and ran parallel within a narrow corridor from northwest to southeast at the center of the central alluvial plain and migrated gradually to the west and east, respectively. According to Adams (1981: 17–19), the gradual movement of the Euphrates to the west and the Tigris to the east was characterized by two major shifts. The first occurred in the fourth millennium B.C., causing the joint course of the rivers to split while remaining interconnected by joint channels north of the ancient city of Nippur (Adams 1981: 17). The course of the ancient Tigris could not be determined with certainty at that time, and Adams suggested a course east of the modern Tigris or a course more or less in its modern position. The second shift occurred in the second millennium B.C., as the bulk of the Euphrates water moved west while the lower branches turned south instead of southeast. This shift, according to Adams (1981: 19), was accompanied by a considerable decline of the rivers' water flow, causing many secondary channels to gradually silt and eventually dry up. Aggradation of the central alluvial plain due to irrigation (so Adams 1981: 20) continuously forced the Euphrates further to the west, and finally into its modern location by the Neo-Babylonian Period (626–539 B.C.).

2.2.4 Irrigation in the Alluvial Plain

The major shifts of the Twin Rivers, according to Adams (1974, 1981), resulted in three major configurations of irrigation management in the alluvial plain. The beginning of irrigation agriculture is thought to date to the Ubaid Period (ca. 6500–4000 v. Chr.), when many major and minor channels of a more braided river system of the Euphrates and Tigris were spread all over the central alluvial plain.[19] These minor channels could be easily controlled without major water control devices and allowed for a fairly even settlement distribution across the plain (Adams

[19] Based on the evidence of a higher settlement density in the Ur-Eridu region in the Ubaid Period (ca. 6500–4000 B.C.), Adams (1974: 2) argues that the beginning of irrigation agriculture was located in the very south. Nützel (2004: 107–110) and Wilkinson (2003: 87), however, argue that the south was more attractive for permanent settlement, since it allowed for the exploitation of different ecological niches consisting of irrigable land, marshes, and the estuary zone of the coast. They further argue that the initial cultivation of crops in the very south could have been based on tidal irrigation that was less labor intensive. Tidal irrigation is practiced along channels in a river's delta in an estuary zone. The water level in the river fluctuates according to the tidal movement of the sea and charges and drains irrigation canals along the river's bank automatically. This kind of irrigation is mainly used for the irrigation of the great date plant plantation alongside the Shatt al-Arab river in the South of Iraq. Low tide in particular has a drainage effect on the agricultural soil that prevents salinization and is a very productive form of irrigation (Adams 1955: 6–7; Wirth 1962: 148–150).

1981: 59–60). The irrigation methods consisted mainly of simply breaching the levees of minor channels to irrigate fields adjacent to these watercourses (Adams 1981: 59; 1974: 2). Adams further argues that this form of simple and locally managed irrigation was practiced until the late third to early second millennium B.C. (Adams 1981: 158–159, 164).

By the Early Dynastic Period (2900–2350 B.C.), the more even distribution of sites across the plain was replaced by a stricter alignment of sites along two major Euphrates branches running parallel to each other in a roughly northwest-to-southeast direction. This trend seems to have continued in the following Akkad Period (2350–2120 B.C.) (Adams 1981: 160–164; Nissen 1975: 20). Alongside its westward movement, the Euphrates adopted a configuration that consisted of a few major branches instead of a web of smaller interconnected minor channels, which is characteristic of a braided river pattern. According to Adams (1981: 19, 165–170), these changes led to a second configuration of irrigation management that entailed more construction of artificial canals in order to compensate for the loss of many smaller natural bifurcations. Adams further argues that this this form of irrigation management became increasingly dependent on state investments beginning in the Old Babylonian Period (2017–1595 B.C.). This trend culminated in the construction of the heavily state-financed irrigation systems of the Sassanian Period (224 B.C. – 642 A.D.), which consisted of a latticework of artificial canals transecting the entire alluvial plain. The Nahrawan system, for example, located southeast of Baghdad allowed for the irrigation of an 8000 km^2 area and was fed by a major primary canal of 300 km in length that drew water from the Tigris (Adams 1981: 246).

2.2.5 Evaluation of Adams's models

Due to political circumstances, the alluvial plain has not been resurveyed, except for the work that was carried out by Amir Hamdani (2008) and his team. However, the availability of remote sensing data at continuously higher resolution (CORONA, SPOT, Digital Globe, etc.) enabled a remote reanalysis of the alluvial plain that has allowed for corrections to and refinements of Adams's earlier reconstructions (Gasche and Tanret 1998; Hritz 2005; Pournelle 2003; Stone 2004; Verhoeven 1998; Wilkinson 2003). While Adams's (1981) approach largely used site alignments as the guiding principle for the reconstruction of ancient river channels, the new approach puts a much greater emphasis on mapping relict landscape features of the former

Euphrates and Tigris river (Hritz 2005: 10). The “bird’s eye” perspective provided by satellite imagery improves the scope for detecting features such as irrigation networks and road systems (Alizadeh and Ur 2007; Hritz 2010; Ur 2003, 2005). In addition, Digital Elevation Models (DEM) based on SRTM data[20] allowed for detecting fossil levee systems of former Euphrates and Tigris channels that cannot be detected by the naked eye (Hritz 2005: 78). Dating these landscape features by means of adjacent archaeological sites enables a much more nuanced understanding of the paleoenvironment of the alluvial plain (Gasche and Cole 1998; Hritz 2005; Pournelle 2003; Verhoeven 1998; Wilkinson 2003).

The approach described above was pioneered by the Ghent team under the direction of Herman Gasche (Gasche and Tanret 1998). By mapping fossil river levees in the Sippar area dating to the second and first millennium B.C., Gasche and Cole (1998: 5–7, 14) were able to show that earlier reconstructions of river channels could not be sustained, as they run across major levee systems. In addition, the notion of a considerable increase in artificial canals and the desiccation of most of the minor natural river branches in the second millennium B.C. suggested by Adams (1981: 18) could not be confirmed. Instead, recent geomorphological research shows that the Euphrates and Tigris maintained an anastomosing river pattern until the end of the tenth century B.C. in the central alluvial plain (Verhoeven 1998: 160, 182–183). Due to a higher sea level in the third and second millennia, the zone in which Euphrates and Tigris adopt an anastomosing river pattern was located further to the north in the area of Baghdad (Verhoeven 1998: 160).[21] Their research further showed that many of the identified artificial or man-made

[20] The Shuttle Radar Topographic Mission (SRTM), directed by the US National Geospatial-Intelligence Agency (NGA) and National Aeronautics and Space Administration (NASA), collected elevation data on a near-global scale in an 11-day mission in February 2000. These data are accessible through government-run websites (see http://www2.jpl.nasa.gov/srtm/, accessed 8 August 2013).

[21] Global climate data indicate considerable changes in the sea level between the sixth and first millennia B.C., and as a result the migration of the coastline of the Persian Gulf further inland. The geomorphological development of the coastline is further impacted by tectonic shifts as well as the local climate (Sanlaville 1989: 5). Geomorphological investigations have been carried out by Sanlaville (1989) in the areas of Amara, Zubair, Shapur, and Fao, while Aqrawi’s (1997, 2001) investigations focused on the former marsh area triangle between Basra, Nasiriya, and Qurna. Pournelle (2003: 117–118) expanded this research by including multispectral MODIS satellite imagery to map the signature of ancient beach ridges using the drill location of both scholars in addition to archaeological evidence of an ancient beach ridge at the Ubaid site Falaika in Kuwait as ground checks for her image interpretation. The results of her research suggest that the maximum northwards migration of the gulf coastline was reached in the fourth millennium B.C., covering the entire former marsh area triangle between Amara/Nasiriya in the east and Qurna in the west. This suggests that the ancient cities of Uruk and Ur were most likely located directly at the sea (see also Sanlaville 1989: 19). Pournelle (2003: 177, 195) argues that due to high sea-levels in the by the fourth millennium B.C., the zone of sweet and brackish seasonal and permanent marshlands

canals of the Neo-Babylonian Period (626–539 B.C.) ran along levees of former Euphrates channels (Cole and Gasche 1998: 32–35).

This reuse or revitalization of abandoned former riverbeds for irrigation purposes by means of punctual modifications has by now been widely recognized. This strategy was even employed in the large-scale irrigation projects of the Sassanian Period (Hritz 2005: 174; Pournelle 2003: 161–164, fig. 59–60; Wilkinson 2003: 89). Scholars have further pointed out that rather than being hindered by shifting watercourses, humans might have taken considerable advantage of natural processes of the fluvial dynamics of the Euphrates and Tigris (Hritz 2005: 15–17; Wilkinson 2003: 89). Hritz argues (2005: 15–17, see also Wilkinson 2003: 88–89) that the punctual modification of river avulsions discussed above might have allowed for the expansion of the irrigated and settled area across the alluvial plain by maintaining flow in two or more channels. This finding considerably alters our understanding of the human–environment interaction in the alluvial plain, particularly with respect to the social feedback loops of labor input and labor management in the construction and maintenance of large irrigation devices (Wittfogel 1957: 18, 25–29, 50–54).

2.3 Grain Cultivation Calendar

Despite this considerable progress in the study of irrigation in Mesopotamia, much of the irrigation technology remains unclear. This is particularly true of the type of water control facilities used to control the water flow within the irrigation systems and those used to manage the river and major watercourses. While the amount of information provided by Ur III texts on watercourse management is exceptional, these data have so far not been systematically studied. So far, the study of Sumerian irrigation and water management has consisted of single case studies based on small sample sets due to limited access to the textual material prior to the creation of text databases such as the CDLI and BDTNS (see Bulletin of Sumerian Agriculture I–V 1988–1990 and Civil 1994). As a result, much confusion surrounds the translation of terms referring to tasks or devices related to the management of watercourses for irrigation, flood control, and navigation. Not being

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was located much further north. The coastline retracted around 3300 B.C., first changing into a coastal marshland and later into sweet water lakes. The deposition of maritime sediment stops in the first millennium B.C., which is also the time of the birth of the current Shatt al-Arab, which is formed by the confluence between the Euphrates and Tigris and follows an ancient course of the Tigris. The current location of the coastline was established by 1050 B.C. and has changed very little since (Hritz and Pournelle in press; Pournelle 2003: 123–129, 266, fig. 9).

able to identify the tasks and devices recorded in the texts limited the ability to analyze the social organization of watercourse management in relation to state versus localized control. The grain cultivation calendar provides a framework with which the texts can be analyzed. The purpose of this calendar is to describe the plant production cycles as determined by area-specific environmental conditions (climate, water regime, topography) and human productive efforts (Hunt and Ingram 2014). The calendar provides the timeline according to which certain tasks needed to be carried out to manipulate certain variables of the environment (e.g., the water source) for the sake of irrigating and cultivating grain successfully. As noted by Hunt and Ingram (2014: 254): "One of the benefits of such a calendar is that the rhythms of human labor in the various tasks are explicitly anchored in a solar time frame. Labor bottlenecks are thereby made fairly obvious."

2.3.1 Focus on Grain

Despite the diversity of cultivated crops[22] in antiquity, there is sufficient evidence that agricultural production—much like today—was heavily focused on winter grains (barley and wheat). Due to Iraq's environmental and climatic conditions, laid out above, summer crops such as millet, pulses (lentils, beans, peas, etc.), fruits, and vegetables have never played more than a minor role in Iraqi agricultural production. In the year 1952/53, for example, 88% of the total agricultural area was cultivated with winter grains, while only 7% was cultivated with summer crops (Wirth 1962: 47–48). There is sufficient evidence to conclude that the same ratio holds for ancient times. As shown by Jacobsen (1982: 15–17), barley became by far the predominant field crop in southern Mesopotamia with the beginning of the Ur III period (2112–2004 B.C.), and remained the most important crop through history. The predominance of barley is also well attested in the administrative record TuT 5 from the neighboring Girsu/Lagaš province, which records a survey of the cultivated agricultural land, or so-called "domain land" (gan$_2$-gu$_4$), in the forty-seventh regnal year of king Šulgi (Maekawa 1985: 97, 101). According to this text, 23,744

[22] The archaeobotanical record and information derived from texts indicate that cultivated crops included different types of oil plants (e.g., sesame, linseed, flax, olive, and almond) (Renfrew 1985a, 1987a; Waetzoldt 1985) and various pulses (e.g., lentils, peas, vetchlings, chickpeas, horse beans, and bitter vetch) (Renfrew 1985b), as well as vegetables (e.g., onions, garlic, various members of the cucurbitaceous family, and legumes) and fruit trees (e.g., apple, pistachio, hackberry, prosopis, date) (Gelb 1965; Maekawa 1985; Postgate 1987; Renfrew 1987a; Waetzoldt 1987b). There is even evidence of the cultivation of hardwood trees that do not grow naturally in southern Mesopotamia (Steinkeller 2011).

ha (97.8%) out of a total of 24,266 ha (3,744 bur3 14 ¼ iku) were cultivated with barley, while emmer accounted only for 415 ha (1.7%) and wheat 37 ha (0.15%). A total of 71 ha were reserved for plants designated by the umbrella term mun-gazi, which according to Maekawa (1985: 99–101) refers to large pulses (gu_2-gal [-gal] = chick-peas) and small pulses (gu_2-tur (-tur) = "lentils (or small beans)") and possibly spices such as coriander (še-lu_2), as well as onions and garlic (sum-silkil, sum-gaz). Given the fact that the majority of land is cultivated with grain, most of the irrigation works documented in these ancient texts do concern water control for grain cultivation. As will be shown in chapter 4, this assumption can be confirmed with empirical data. Since the climate at the end of the third millennium B.C. was very similar to modern conditions, the sequence in which agricultural and irrigation tasks were carried out must have very closely followed the timeline established by the grain cultivation calendar based on modern data. It therefore represents a suitable framework for analyzing the relevant data on the past.

The predominance of barley in antiquity is frequently explained in the literature as a result of increasing salinization of the soil due to irrigation (Helbaek 1960: 195; Jacobsen 1982, Jacobsen and Adams 1958). Indeed, barley is more tolerant of alkaline soils than wheat (Baldridge 1985: 468; Poehlman 1985: 2–3; Smith 1995: 100–101). However, whether or not the switch from mainly emmer wheat to barley at the beginning of the Akkad Period (2350–2120 B.C.) (Charles 1984; Helbaek 1960: 195; Jacobsen 1982: 15–17; Poyck 1962: 38–46; Renfrew 1984: 33–34; Wirth 1962: 45–47) can be attributed to soil deterioration due to salinization has been questioned by Powell (1985). Other factors might have played an equally or even more important role in bringing this switch about. According to Helbaek (1959: 370), barley has a gene complex that allows for successful adaptation to a wider range of environments, it is more productive, and its yields are much less susceptible to seasonal variation. Barley is also considered a drought-resistant crop, as it requires less water than other cereals due to the fact that its transpiration rate is the lowest of all the small grain crops. Two-thirds of the world's production of barley is in semi-arid regions, where it is usually grown during the winter, when temperatures are cool and transpiration is low (Newton 2011: 142; Smith 1995: 177). In addition, barley is less prone to be damaged by the Asian shield bug (*Eurygaster integriceps Put*), as it reaches maturity earlier than wheat (Wirth 1962: 46). It is possible that barley was favored in Mesopotamia for being a more robust crop due to the qualities outlined above. Certainly the importance of beer in the Mesopotamian diet might have been an additional reason for favoring the cultivation of barley over wheat (Ellison 1981: 42; Damerov 2012).

2.3.2 The Sources Used for the Grain Cultivation Calendar

With a few exceptions (see Fernea 1970; Poyck 1962, Wirth 1962), ethnographic data on traditional irrigation and cultivation methods (prior to mechanization) in Iraq is lacking. In recent years, more traditional hydraulic devices made of less durable organic materials either were replaced by concrete and metal structures or entirely went out of use as a result of the use of water pumps[23] (Adams 1955: 11). Travel accounts do make occasional references to irrigation practices, but they are rare and it is for the most part a matter of luck to stumble across them (Sachau 1900). More informative are reports of the British Admiralty (Chesney 1850; Great Britain 1944), which do provide some information on traditional means of irrigation and the construction design of certain water control devices. The collection of letters by the British officer James Saumarez Mann (1921) is particularly informative. Mann was put in charge of the agricultural development of the district Eastern Shamiyah along the Euphrates near Kifl and Shinafiyah in the Diwaniyah District from August 1919 to July 1920, when he was killed during tribal upheaval against the British Occupation. Despite the fact that the major crop cultivated in the area was rice[24] (sown in March/May and harvested in November), his weekly, and at times daily, reports on his supervision of the construction of irrigation and flood control devices provides very detailed insight into watercourse management. As I will show later, there are remarkable similarities between the way these devices were constructed in the early twentieth century and what is documented in ancient texts.

Further, detailed information on the construction design of traditional water control devices has been provided by Rost and Hamdani (2011). In winter 2012 I was able to gather more ethnoarchaeological information on traditional irrigation and cultivation methods in the Nasiriyah area of Diqar Province in cooperation with my colleague Amir Hamdani. I was able to

[23] Water pumps were introduced in 1919 by the British, and by 1955 half of the irrigation in Iraq was done by means of 5,500 pumps (Adams 1955: 11).

[24] There are early and late rice-growing seasons (Poyck 1962: 42, table 4.5; Mann 1921: 237). The early rice is sown as early as March, while rice grown in fields that have been previously cultivated with winter crops is sown between mid–May and the beginning (Poyck 1962: 42) or end of July (Mann 1921: 266). Rice is harvested by November (Rost and Hamdani 2011: 207).

visit part of an operating irrigation system and have conversations with one large-scale landowner, a farmer and the head of the Nasiriyah Farmers Union named Abbu Montaz. I have refrained from making use of the so-called "Book of Nabatean Agriculture," since the agricultural information in it is unreliable.[25]

2.3.3 The Annual Timeline in 20th Century A.D.

The annual timeline presented below is a synthesis of information gleaned from the sources described above. A schematic outline of the calendar is provided in fig. 2.5 and represents an ideal outline of when tasks take place. As will be discussed below, the timeline can shift 1–3 months from year to year due to intra-annual variations. Barley and wheat are grown as winter crops in southern Iraq to take advantage of the cooler and moister winter months. Barley is usually sown by mid-October, while wheat usually a month later, by mid-November, and harvested in March/April (barley) and May (wheat). The preparation of fields, irrigation canals, and water control devices has to be accomplished prior to the sowing of the crops, and the agricultural cycle begins usually by August/September. An early sowing date close to mid-October is preferred, as crops that mature late are more prone to being infected with diseases (Adams 1965: 16, Table 5; Charles 1988: 2). The sowing of barley and wheat can be delayed as late as December in exceptionally dry years (Adams 1965: 16, Table 5). Farmers might have to wait for cooler and moister weather conditions before plowing the hard and dry-backed soil is possible, which can delay the beginning of the cultivation cycle by as much as 1–3 months. The timeline of agricultural/irrigation tasks is only a rough guideline, and shifts of 1–3 months need to be taken in consideration.

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[25] The *Book of Nabatean Agriculture* was written by Ibn Wahshiyah in the sixth century A.D. (Samarra'i 1972: 62–64). The book consists of practical agricultural advice in the form of an agricultural manual and a description of late antique paganism in rural Iraq. As has recently be shown by Hämeen-Anttila (2006), much of the agronomic information in that manuscript is based on the late antique Greek and Latin tradition of agronomic literature and can not be taken at face value. The dependence on Greek sources was intentionally obscured, and the manuscript was given a much earlier date in order to make it look like an authentic Mesopotamian document, motivated by the desire to establish a Mesopotamian national identity in Iraq in the aftermath of the Islamic Conquest in the sixth century A.D. The "fraud" has led scholars, especially specialists in Near Eastern Studies (Gutschmid 1861; Nöldeke 1876), to dismiss the document altogether, particularly as it became apparent that it was not based on ancient Mesopotamian texts. However, as argued by Hämeen-Anttila (2006: 17–20, 29), the detailed information about very specific forms of paganism as well as agricultural practices and botanical facts could not have been known to the Greek authors of late antique agronomic literature. He argues that this information rooted in the personal observations and knowledge of Ibn Wahshiyah. Unfortunately, Hämeen-Anttila's (2006) study did not include an investigation into the validity of the agronomic information. The document will only become useful for agronomic reconstruction once the Iraq-specific information can be separated from the material deriving from Greek and Latin sources.

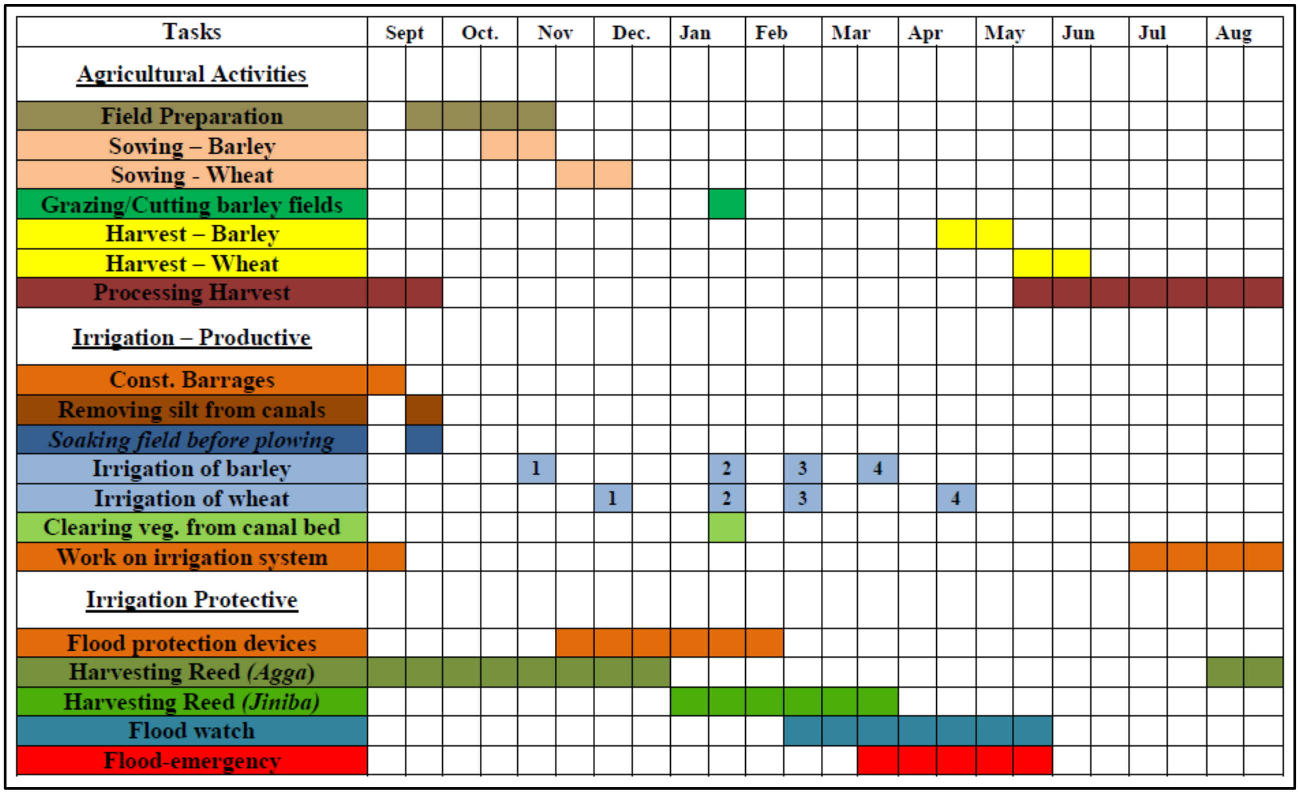

Figure 2.5 Ideal timeline for irrigation and agricultural tasks within the solar year

2.3.3.1 Construction of Barrages to Raise Water Level in the River (September):

Water levels in the river are lowest at the beginning of the agricultural season, in September/October (see Table 2.1). Therefore, water levels in the river need to be raised in order to force water into the inlet of primary canals. Prior to the widespread use of water pumps, Iraqi farmers constructed elaborated barrages consisting mainly of reeds, brushwood, and earth. The most detailed description of these barrages is given by James Saumarez Mann (1921). His letters indicate that barrages were built within two to three weeks before rice cultivation season started in March or May (Mann 1921: 235, 279). His (Mann 1921: 279) letter from June 5, 1920 provides a very detailed description of the construction design of these barrages: “As the water fall in the river, which is from now onward till it reaches its lowest in October or thereabouts is a steady process, my tribes have to put dams to keep up the levels; and we are just going to start work on them. They are very wonderful things, made according to the wisdom of time immemorial, of reed and earth only; a gap of only a few yards [3–4m] in the middle to let the water through, and when you reflect that the river is about the width of the Thames at Kingston [approx. 60 m][26] and has a depth of 10–12 feet [3–4 m] a stream of 5–6 miles an hour [2.2–2.7m/s], you will see that to construct such a dam with absolutely no appliances whatever takes a bit of doing. In each of the larger tribes there are one or two families who have the knowledge of the art handed down from father to son, and they take charge of the operation (Mann 1921: 279, fn 1).” To his father, he writes on June 26 that three such dams were to be constructed. “The idea is really to plait a rope of reeds twenty to thirty feet broad [6.1–9.2 m] and as deep as the river may require, and then load it down with earth until it becomes stable. Anything up to 100,000 bundles of reeds may be needed, and every single bundle passes through the hands of the expert, who lays it in position. His skill is transmitted from father to son, and is, I suppose, as old as Babylon.”

As the images (fig. 2.6 a–c) show, these barrages were very effective and could even block the entire Euphrates River, as was done in the course of the construction of the Hindiyah barrage by the Ottoman Empire (Great Britain Admiralty 1944, see fig, 2.6 a-c). As can be seen in fig. 2.6 b, this barrage consisted of gigantic reed mat rolls, close to 30 m long and 2.5 m high, which were weighed down with mud (Great Britain Admiralty 1944: 436). fig. 2.6 b and c also depicts the huge amounts of construction materials piled up all along the bank of the Euphrates as well as the large amount of human labor that was required. Even though this barrage might have been larger than most, reed-earth-brushwood barrages were still widely in use during the 1940s before the British Mandate government gradually replaced them with more durable and permanent structures made of metal and concrete. The Diyala Weir, built in 1927–1928, for example, replaced a temporary barrage made of brushwood and earth that would force water into six main canals (Great Britain Admiralty 1944: 439). The Euphrates was tapped in a similar fashion from Nasiriyah eastwards to the Hammar Lake, as was the lower Tigris below Kut al Amarra. These barrages would frequently be washed away during the flood season and had to be rebuilt every year (Great Britain Admiralty 1944: 439; see also Mann 1921: 235 above).

[26] The width of the Thames by Kingston is based on Google Earth, Oct. 5, 2012.

The barrages used to raise water levels differed depending on the nature of the watercourses they controlled. According to Fernea (1970: 33), raising the water level in the Daghara canal[27] was accomplished by means of temporary barrages that were dismantled once water withdrawals had been accomplished. As Fernea did not observe these barrages himself, he suggests (1970: 199, n. 21) that the so-called *badkha*, huge rolls made of reed mats and brushwood described by Ionides (1937: 71), might have been used in the construction of these temporary barrages. As grain has to be irrigated from four to ten times per season, these dams must have been constructed differently from the ones described by Mann (1920) to allow for frequent removal and reconstruction. According to Abu Matoz (interview Dec. 29, 2011), in the area around Nasiriyah tamarisk trees were mainly used for the construction of more temporary barrages, which could be removed easily and reused.

Where the river's water level is close to the canal intake, as is the case in the very south of Iraq, no barrages are needed. According to informant Abu Montaz (interview Jan. 16' 2012), withdrawal in such an instance is accomplished by simply breaching and later closing the riverbank (see also Adams 1965: 8). Fernea (1970: 159) describes the same method. In order to protect the irrigation system during the flood, the inlets of primary canals are sealed with so-called "head-dams," as described by Rost and Hamdani (2011: 213–214). These head-dams were placed across the entire width of the canal inlet at the intersection between river and primary canal. Pipes placed at the bottom of the dam allow for regulation of the amounts entering the system. This type of head-dam also consists of a mixture of reed and earth but also contains palm tree trunks, palm leaves, and other organic materials.

[27] The Daghara canal is 77 km long with an average discharge of 22 cu/sec at high rotation (now determined by a regulator). It was once a natural bifurcation of the Euphrates River but has since been canalized (Fernea 1970: 164).

Figure 2.6 a Reed dam to block the Euphrates River, 1909 (Great Britain Admiralty 1944: 436)

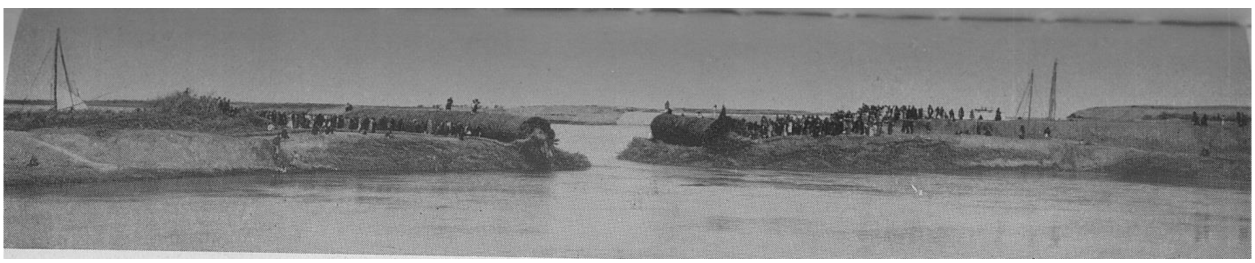

Figure 2.6 b

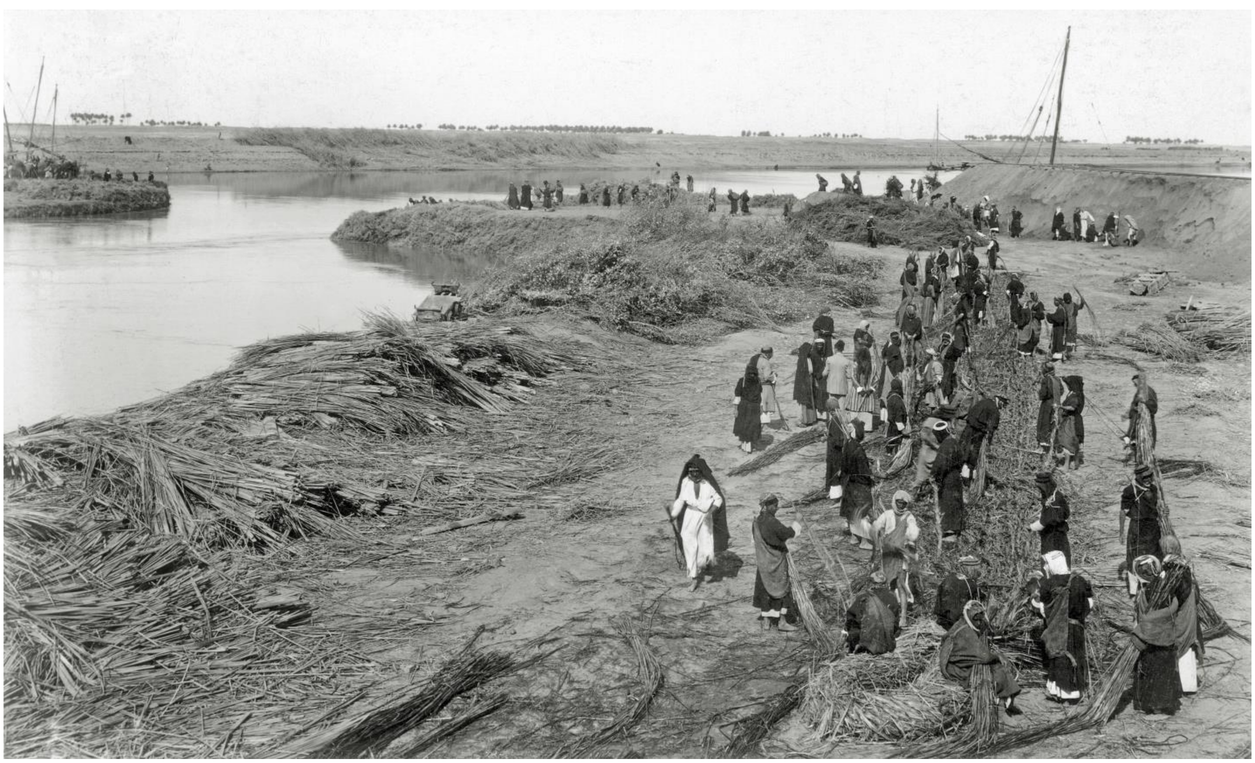

Figure 2.6 c © Royal Geographic Society (IMB)

2.3.3.2 Cleaning Irrigation Canals (Middle to End of September):

Before the canal can be charged with water, sediment that has accumulated in the previous season needs to be removed to guarantee adequate water flow velocity. Canals in the recent past were simple earthen constructions whose embankments were usually reinforced. During canal maintenance, accumulated sediment would be piled up on either side of the canal and compressed to form an embankment. Once the embankment became too high and removal of sediment too cumbersome, the canal would be abandoned and a new one built parallel to the preexisting one (see also Fernea 1970: 120–22; Koldewey 1990: 19–21). Sediment accumulates in canals unevenly due to the frequent changes in water velocity, especially at offtakes. Fernea (1970: 132, 159–162) observed that within the 1.6 km long and 1–2 m wide secondary canal in the Daghara area, the silt that accumulated within a year amounted to 46 cm at the head of the canal but only to 15–18 cm at the tail end (see also Adams 1965: 8).

There are many different ways that the canal cleaning can be accomplished. In Iraq, as observed by Fernea (1970: 132–133) in the Daghara region, the cleaning of the primary canal was done by the state with machinery and employed workers. The cleaning and upkeep of the secondary and subsequent smaller canals was the responsibility of the water users consisting of various tribes of the El Aqra confederation. The secondary canals (Arab. *bada*) are shared usually by a single tribe and are overseen by the tribal leader (Arab. *sheikh*) and his family. The cleaning of secondary canals is done cooperatively and on a "voluntary" basis. When the cleaning has to be done, the tribal leader (Arab. *sheikh*) will call out for help (Arab. *awna* or *musa'ada*), and his representative (Arab. *wakil*) will ride around and announce to the tribal members the day and time when the cleaning will be taking place. Once the members of different families arrive, they are assigned a certain portion of the canal, measured out with a shovel. One workman is expected to be able to dredge a 4.6 m long section of a canal that is close to 1 m wide and 0.5 m deep (Fernea 1970: 130).

Usually tribal members will help out for one or two days, during which they are supplied with food. Compliance is usually enforced indirectly, by the sheikh's granting or withdrawing support in negotiating the concerns of tribal members with government authorities (Fernea 1970: 129–131). Tertiary canals (Arab. *naharan*), on the other hand, are shared by members of family groups (Arab. *shabba*), and their construction and upkeep is organized and enforced informally by the family groups. The cleaning of the secondary and tertiary canals was done twice a year, once before the winter growing season in October and once before the summer growing season in April (Fernea 1970: 125). The latter was done mainly for rice cultivation and would not have been applicable in the past. Farmers would spend a maximum of full seven or eight work days on canal cleaning in one season, but would spread the workload over a twenty-day period working only a few hours each day (Fernea 1970: 132).

2.3.3.3 Initial Irrigation before Plowing (Middle to End of September, Optional):

Prior to the plowing of fields, a first irrigation might be needed to soften the soil if it was baked and dried up to a depth of 2–3m over the summer and was too hard to be plowed. This can, however, only be done to well-drained soil.

2.3.3.4 Field Preparation for Barley: Plowing (Beginning to Middle of October):

Field preparation for winter crops starts no earlier than the beginning to middle of October and continues until mid-December (Adams 1965: 16, Charles 1988: 2, Fernea 1970: 40, Poyck 1962: 45). Until the widespread mechanization of agriculture in Iraq from the 1970s onwards, fields were plowed using a straight-tipped, shallow, animal-drawn draft plow, which would only loosen the topsoil to a depth of 5–12 cm and did not turn over clods (Adams 1965: 16, Abu Motaz Interview Dec. 29th 2011, Fernea 1970: 40, Poyck 1962: 45, Wirth 1962: 101). This tilling practice is best suited to the fine soils of the alluvial plain, since greater disturbance of the soil structure would lead to greater aeolian erosion (Fernea 1970: 200, Note 2).

2.3.3.5 Construction of Field Bunds (Beginning to Middle of October):

After the plowing of the agricultural land was completed, fields were laid out by constructing low walls of earth, creating shallow rectangular plots (Arab. *lowh*) that allowed for regulating the water flow within the field. These field bunds were constructed each season by means of simple spades (Fernea 1970: 40; Poyck 1962: 45; Smith et al. 1957: 2, 4). Wirth (1962: 95) observed on an agricultural estate south of Baghdad that field bunds enclosed an area of 400 x 100 m, which was further divided by means of lower earthen dames into areas of 50 x 25 m.

The height of the field bunds is proportional to the amount of water applied to the soil (Pemberton et al. 1988: 215).

2.3.3.6 Drawing Irrigation Furrows (Beginning to Middle of October):

Furrows are usually drawn with the plow. It is not clear from the available literature how widespread furrow irrigation was in traditional grain cultivation of southern Iraq. Fernea (1970: 40, 158–160) describes irrigation methods with and without irrigation furrows. The simpler irrigation method consisted of breaching the river bank and passing water from one field to the next by opening and closing the field bunds. The drawback of this method is that fields closest to the water source will salinize very quickly, as they tend to be over-irrigated due to the fact that water needs to be passed through them each time outlying fields are irrigated. The more complex irrigation method described by Fernea (1970: 122, Map 7) makes use of both canals and irrigation furrows. In Poyck's (1962: 46) description of irrigation in the Hilla-Diwaniyah area, irrigation furrows are only used for the cultivation of vegetables, due to their greater moisture sensitivity. Water is applied only to the rooting zone, while the furrow ridges on which the vegetables are grown remain relatively dry. Wirth (1962), on the other hand, does not mention furrow irrigation in relation to grain cultivation at all.

2.3.3.7 Sowing Barley (Mid-October to Mid-December):

Sowing of barley starts as early as mid-October and continues until mid-December, depending on weather conditions (Charles 1988: 2; Fernea 1970: 40, Mann 1921: 181, Poyck 1962: 45, Wirth 1962: 47), and according to Adams (1965: 16, Table 5) may even continue as late as December in exceptionally dry years. As observed by Ferneas (1970: 40) in the Daghara area, barley and wheat seeds are broadcast onto the freshly ploughed fields without further furrowing or harrowing. Sowing rates depend on whether the soil is considered weak or strong and vary from 15 to 50 kg per *meshara* (= 0.24 ha).

2.3.3.8 Sowing Wheat (Mid-November to Beginning of January):

Wheat is planted in separate fields almost a month later than barley and the timing of when it is broadcast depends on annual and local weather conditions. It can be delayed in exceptionally dry years until the beginning of January (see 2.1.2, Abu Matoz Interview Dec. 29, 2011; Adams 1965: 16, Table 5; Poyck 1962: 45).

2.3.3.9 Removing Silt from Tertiary Canals (Before Irrigating a Field):

When water is allocated, tertiary canals are cleaned if necessary. On my visit in Iraq on January 8, 2011, I observed a single farmer with a shovel doing this kind of work alone (see fig. 2.7). He cleared the tertiary canal adjacent to his fields, as he was scheduled to receive his share of irrigation water a few days after. The amount of time the farmers interviewed by Fernea (1970: 132) spent cleaning the minor irrigation canals did not exceed seven to eight days a season.

Figure 2.7 Farmer removing silt from a minor canal in Nasiriyah area, Jan. 2012

2.3.3.10 First Through Fourth Irrigations of Winter Grains (Mid-October to Mid-April)

Winter grains require an average of four to five irrigations and up to ten in exceptionally dry years.[28] The first irrigation is applied right after barley (and wheat) has been sown. After the first irrigation, the second irrigation is not applied until the end of January, as winter precipitation covers part of the crops' water demand. The third irrigation is applied a month later, by the end of February, and the fourth and last irrigation is applied two to four weeks before harvest to leave enough time for the soil to dry out sufficiently (Charles 1984: 3). An additional irrigation is applied to barley fields if they are allowed to be grazed by sheep and goats at the end of January (see below). The fields are filled with water up to a depth of 5–10 cm (Poyck 1962: 45) or 20 cm (Wirth 1962: 101).

The allocation of water to the field requires the operation of water control structures in the canals. According to Rost and Hamdani (2011: 215), and as observed by me on January 8, 2012 (see fig. 2.8), moving water within the irrigation systems is frequently accomplished by lateral earth dams (approx. 0.5 m wide and 0.3 m high) that run across the entire width of the canal. The water flow is temporarily dammed to divert water into lower order canals or fields. Once the diversion of water or the irrigation of that field is accomplished only a small section of the dam is removed (red box) to let water pass to downstream users. Therefore, works related to water

[28] Note that this does not include the initial irrigation applied to soften the soil for plowing. The frequency and the numbers of irrigations applied to barley (and wheat) in one season vary greatly within the literature. According to Poyck (1962: 45) and Fernea (1970: 41), barley is irrigated 4–8 times (once a month or every three weeks) during the growing cycle. Poyck (1962: 45, see also Wirth 1962: 101) states that wheat is usually irrigated more lightly but more frequently. According to Wirth (1962: 101), winter grains are irrigated five or six times: the first irrigation is applied right after planting, the second approximately 25 days later (for barley, the beginning to middle of November), the third 15 days later (end of November), and the forth 10 days after the third irrigation (mid-December). The last irrigation is applied when the grain starts to become yellow. Wirth (1962: 101) does note, however, that more extensive forms of irrigation agriculture would only irrigate three to four times. Abu Montaz (Interview Dec. 29, 2012) stated that in the area of Nasiriyah winter grains are only irrigated three times: right after planting, once in February, and a third time before March 21 or after April 1. Abu Montaz was very specific about the last irrigation having to take place either before Marsh 21 or after April 1. I was not able to fully ascertain the reasoning behind this; the only explanation I could obtain was that the period of ten days between March 21 and April 1 was a critical stage for the crop and that applying water would harm the crop. This rule could relate either to local weather conditions or to a period of moisture sensitivity of the crop, or it may be based on cultural practices. Abu Montaz (interview Dec. 26 and 29, 2012) further informed me that if they receive sufficient precipitation over the winter months, the second irrigation in February is skipped. Note, however, that the agricultural production in the area suffers from severe water shortages and most of the cultivated barley is of low quality and is used as fodder for animals. In 2003, five million dunum (1 dunum = 2.5 ha) of land were under cultivation in Diqar Province (Nasiriyah is the provincial capital of Diqar Province), but due to increasing water shortages as a result of large-scale storage dam construction, particularly in Turkey, the amount of irrigated land was reduced to one million and a half (Abu Montaz, Interview 26 Dec. 2012).

allocation at the field level can usually be done by one farmer singlehandedly. Once the field is irrigated, a small section of the mud dam is removed to let water pass to the next field inlet further downstream.

Harvested grain fields are sometimes irrigated once or twice right after the harvest for pasture. The farmer makes use of the already existing moisture in the soil and the weeds already present among the stubble. Fallow fields are irrigated as well but much less frequently, since a large amount of water is needed to inundate fields that have been drying up for a year or two. Irrigating fallow fields is more of a flood emergency measure, as will be discussed below (Poyck 1962: 52).

Figure 2.8 Control dam to regulate the water flow within a canal

2.3.3.11 Grazing/Cutting Barley Fields, Plus Irrigation (Middle to End of January):

Cutting or grazing barley is still a common practice in Iraq, since it is beneficial for both livestock and crops: the young sprouts provide good fodder for animals and also help to prevent lodging,[29] the collapse of the cereal stem when it cannot support its own weight (Abu Matoz, Interview Dec. 29, 2012, Poyck 1962: 51–52). Moreover, the grazing stimulates the barley shoots to increase growth and animal droppings fertilize the field. According to Poyck (1962: 52), barley is grazed as early as 45–60 days after sowing, but only if the plant growth is great. In that case, landowners would allow for a grazing period of 10–20 days for sheep and goats as well as for cows and horses. Barley that is cut rather than grazed is 90–120 days old and the leaves are only halved. Certain barley fields are planted only to be grazed by animals when the barley is 100–120 days old and are grazed completely, with no harvest following. The grazing of fields usually requires an additional irrigation.

2.3.3.12 Drainage and the Risk of Salinization

Drainage is crucial in irrigation agriculture to prevent salinization and maintain soil fertility. According to Buringh (1960: 83) the principle process in the soils of lower Mesopotamia is salinization and as a result most soils are saline. As the salt content in the soil increases so does the osmotic pressure which makes it progressively more difficult for plants to extract water from the soil. The process of salinization is the result of arid climate conditions of Iraq coupled with insufficient rainfall. Plant growth hence either depends on irrigation or on deep rooted plants drawing water from the ground water. Even though the salt concentration in Euphrates and Tigris is low (200–400ppm) when river water is applied to fields, sodium ions become dominant in the soil solution as the water evaporates. The rainfall is insufficient to leach out the salt fully and without additional measures irrigated land in southern Iraq becomes saline in the course of 7–25 years (Webster 1921, cited in Buringh 1960: 84). This is particularly true for soils with poor drainage. Soils in southern Iraq generally consist predominantly of finely textured silt and clay loam, while coarser sandy loams are almost exclusively restricted to river beds and levees. Areas where the permeability of soil is low are more prone to salinization (Jacobsen 1982: 5–7, Chaudhri et al. 1971: 321).[30]

[29] Department for Environment, Food and Rural Affairs, Glossary of the crop http://adlib.everysite.co.uk/adlib/defra/content.aspx?id=000HK277ZW.0A6CM6YK9603VEM, accessed Sept. 27, 2012)

[30] Six soil surveys have been conducted in the 1950s to assess the soil conditions in Iraq. A total area of 10,320km^2 was surveyed in different locations of north and south Iraq. For the three locations south of Baghdad (Gharraf , Dujailah and Naharwan region) over 80% of the soils had a salt content greater than 8 dS/m which is considered highly saline, while over 60% had a salt content greater than 16 dS/m which is considered severely saline. While barley can still be cultivated under highly saline conditions satisfactorily, no crop will grow on severely saline

An additional problem is the ground water which can be very saline and located close to the surface, in particular in the most southern part of the alluvial plain. Some of the very deep layers of the Mesopotamian plain are either of marine origin or former floodplains of Tigris and Euphrates, both of which contain a lot of salt. As groundwater passes through these layers its salt content increases. In areas closer to the Persian Gulf, the groundwater is in contact with the sea adding to its salt content. Irrigation, but also flood waters will temporarily raise the groundwater table up to 1–3 m below the surface, particularly in the vicinity of irrigation canals, as simple earthen canals without lining will lose 20% of their carrying capacity to seepage. While the water table will retreat naturally during the hot summer months, the temporary rise can cause severe problems for crop cultivation. The more immediate problem is water logging, causing crops to "drown" due to insufficient soil air in the root zone, from which dry foot crops draw the needed oxygen. The other more severe and long-term problem is salinization of the soil, which renders entire tracks of land unfit for cultivation for extended periods of time. When the salt content reaches 0.5–1%, important nutrients are destroyed that are needed for the plant's growth. The rise of the groundwater table to less than 1 m below the surface, can trigger the "capillary effect," a process by which salty minerals contained in the groundwater are transported into the rooting zone and onto the surface by means of evaporation of irrigation water on the surface (Achtnich 1980: 199; Adams 1981: 3–5; Hunt 1987: 1–2; Nützel 2004: 26–27; Tanji and Kielen 2002: 2–4).

Effective drainage controls the rise of the ground water table, and the risk of salinization (Buringh 1960: 105). The simplest method of drainage is by means of open surface drainage canals, which are deeper than irrigation canals. They collect excess water and either transport it back into the river, into primary or secondary canals, or into depressions. In southern Iraq, drainage is accomplished in two ways: either by means of drainage canals at the lower ends of the levee slope or by means of the natural gravitation by which excess water tends to drain into the nearby depression (Charles 1988: 30–31; Nützel 2004: 26–27). According to Hamdani (p.c. March 2014), artificial depressions called *doub* are constructed when the local topography does

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ground. The findings were slightly better for the three surveyed areas north of Baghdad, where 35–50% of the soil had a salt content over 8 dS/m and 15–25% over 16 dS/m (Christen and Saliem 2012: 10–16). Based on these findings it was estimated that prior to the land reclamation projects (1952 onwards) 20%–30% of the available agricultural land had gone out of use due to salinization (Buringh 1960: 83; Powers 1954; Wirth 1962: 97).

not enable drainage. These *doub* form artificial ponds whose waters are contained by low earthen dikes to prevent unwanted encroachment of water into the agricultural area.

Salinization is further combated by regularly fallowing the fields to allow for the water table to sink naturally and restore soil fertility. According to Poyck (1962: 18, 38–39), usually only half of the arable land is cultivated while the other half is left fallow. Further methods to combat salinization are “leaching,” in which the soil is heavily inundated with up to 15–30 cm of water above surface in order to flush out the harmful salt minerals. This method, however, requires sufficient drainage to be successful. The leaching of soil with a medium drainage capacity will take up to 3–4 months, while the leaching of poorly drained soil can take up to 12–24 months (Charles 1988: 32–33). Leaching is a labor-intensive process, and it is not clear if it was practiced in the past. Another method is the cultivation of water-absorbing plants such as *Prosopis* and *Alhagi*, which can reduce the groundwater table by 4–5 m within one cultivation cycle (Charles 1988: 30–31; Nützel 2004: 26–27).

It is unclear how widespread the problem of salinization was in antiquity. According to Buringh (1960: 45) irrigation was primarily done on well-drained soil along the levees, which would have been much less prone to salinization due to better drainage and a low ground water table. The large scale process of salinization only started with the widespread construction of irrigation canals in areas that lacked natural drainage. However, as has been pointed out by Jacobsen (1982: 8–9) the problem of salinization must have been present and understood very early on. The term ki-mun “saline ground” was in use to classify the fertility of soils from 2500 B.C. onwards. In addition, surveys of agricultural ground regularly delineate parcels as saline ground that remained uncultivated due to salinization. However, as shown in chapter 5, there is evidence that the benefit of drainage was known and practiced already in the Ur III period.

2.3.3.13 Clearing Vegetation from Canals (End of January):

Vegetative growth in canals can slow down the water flow and in turn increase the deposition of sediment (Achtnich 1980: 270). Increasing daylight and rising temperatures in early spring provide ideal conditions for the growth of water plants, which are removed in January/February (Interview with farmer from Nasiriyah Jan. 6, 2012). Clearing the canal from vegetation is called *hasher*, and a group of farmers gets together to do the work cooperatively. In Arabic, removing unwanted vegetation from the canal is called *tandif* (cleaning), while removing accumulated sediment is referred to by the verb *gaffer* (digging).

2.3.3.14 Flood Protection Works (End of November to February):

After sowing, tasks related to irrigation are the only work left to do in the fields. From the end of November until the harvest, farmers can put their attention to other tasks. Most of the freed up labor is needed to repair or construct flood protection devices which must be in place at the onset of the flood in March/April. Flood control in southern Iraq is particularly important, as the flooding of the Euphrates and Tigris coincides with the harvest of winter grains in March/April and May. There are various ways of reducing the risk of devastating flood damage, including building up the banks to prevent the river from overtopping its levees (Fernea 1970: 158–159), strengthening weak points in river banks such as old breaches (Mann 1921: 170–171, 181), and/or surrounding settlements and fields by a dyke (Mann 1921: 186–187, 207–208).

Flood Banks

The timing of these various flood protection measures is based on the letters written by Mann (1921: 170 [Letter of November 18th 1919], 181 [Letter of December 11th 1919], 229 [Letter of March 6th 1920], 252 [Letter of April 30th 1920]). The flood protection works need to be in place before the onset of the flood at the end of February for the Euphrates area. Most of flood protection work described by Mann (1921) consists of the construction of flood dikes (Arabic *sedd*) made of earth and reed, designed to build up and strengthen the embankment of the Euphrates river, particularly at points of former breaches. He describes the construction of a flood bank at the so-called Ibn Hayyan breach in greater detail, with the dimensions of 120 m in length, 15 m in width and 3 m in height (Mann 1921: 170–171, 181). Even though Mann does not specify how long the construction of the actual flood dike took, the planning of the work project (e.g., work assignment, collecting construction materials, labor recruitment) took about a month.

Mann wrote (1921: 170–171 [Letter from November 18th 1919]): “I was busy all the time at Abu Shora on land protection works, and you would have been amused to see me conducting two mejlisses or conferences. The first, on Sunday, related to what is called a sedd, or flood bank built to stop up an old breach in the river bank: if this is not done the flood water comes over the bank and pours down over the cultivated land, blocking irrigation channels with silt, spoiling the tilth, etc. So we summoned everyone whose lands would be flooded if this 'sedd' were to break. I took them to the spot in the launch, we decided on what we wanted, and I took them back to Abu Shora, where I announced my view as to a fair distribution of labour. The work is the construction of a bank of earth and reeds, 120 metres by 15 by 3, and I divided it thus: A 40 metres, B 35, C and D 10 each, E, F, G, H, I, and J 25 meters between them. So you see I had a pretty invidious task; for I had not accurate means of judging their relative resources, and any frank discussion is impossible, owing to their tribal feuds. Still, of course, they accepted, as they had to. But co-operation, which is an essential preliminary to self-determination, can't be seen in Iraq these thirty years, I fancy." Planning the work usually consists of a meeting in the *mudhif* (public meeting house made of reed financed and run by a tribal leader (Arab. *sheikh*) (see for detail Rost and Hamdani 2011: 211–212).

It is not clear when the work on the flood bank for the Ibn Hayyan breach was started, but Mann (1921: 181) inspected the work in progress on December 11, 1919, almost a month after the planning and work assignment had been finalized (Mann 1921: 171, November 18, 1919). Upon his visit, approximately four hundred to five hundred people belonging to five different tribes were at work at the same time. Assuming that that one workman could construct 2.25 m^3 per day (based on the work norms documented in Ur III texts), the construction of a flood bank of 120 x 15 x 3 m with a volume of 10,800 m^3 should not take longer than 10–12 days with a workforce of four hundred to five hundred men. Mann (1921: 181) further noted that upon his arrival the workmen performed the war dance called *hosa*, which was also observed by Fernea (1970: 131–132) during the cooperative effort by tribesmen of the El-Shabana tribe to clean one of the major canals. Mann further discusses planning for the construction of another flood bank on top of the ruins of a previous one (Mann 1921: 170–171 [Letter from November 18th 1919]): "The second conference, on Monday, was simpler; the question being simply one of building a new earth bank on the ruins of the old one, and only digging is necessary, no reeds, etc., the cutting and carrying of which cost money."

Raising River Levees

The other form of protection work observed by Fernea (1970: 158–159) in the Daghara region consists of the local farmers' gradually building up the riverbank year by year in order to protect their homes and the agricultural land. With higher riverbanks, the water level of the river will gradually rise as the river builds up its bed by depositing its sediment load. There is a threshold in height that can be sustained. Containing the water within the riverbed also prolongs the period of water availability, making it available sooner, at the onset of the flood, and later, after the peak has already passed (Fernea 1970: 159).

Surrounding Settlements and Agricultural Fields with a Dike

The construction of a dike around settlements and date orchards is described by Mann as part of a lager flood protection scheme of the town Ghamash, south of Abu Sukhair (Mann 1921: 186–187 [Letter from December 22; planning meeting was held on December 23, 1919, with sixty to seventy people, mainly sheikhs of various tribes]). The town was a great tribal center, with a lot of commerce and a marketplace for many nomadic tribes that would come to Ghamas from as far as 40–50 miles away. Malaria seems to have been a serious problem in the town due to its topographic location, being almost level with the elevation of the river. The local inhabitants lived at the time mainly in reed huts built on constructed platforms of earth and reed mats. The pits from which they took the earth filled with water during the flood season and formed ponds of standing water that become breeding grounds for mosquitos.

Mann's (1921: 181) flood protection scheme included **a)** raising the overall ground level by 2 feet (0.6 m), **b)** filling in the standing pools of water, **c)** raising street levels, **d)** strengthening the front of the river, including constructing four sets of steps down to the water, and **e)** the construction of *a great flood bank* 1.5 miles (2.4 km) long that surrounded the entire town, including the date orchards (Mann 1921: 196–197, 207). The entire project called for 15,000 rice-straw bundles provided by three rice-growing tribes; 100,000 bundles of reed provided by a dozen reed owners; 100 donkeys for three weeks to transport an estimated 40,000 donkey-loads of earth from a site half a mile away, provided by two desert tribes; and about 200 workmen for three weeks, recruited and provided by the townspeople to attend to the donkeys, dig the earth, load and unload it at the work site, and fetch the reed bundles from the riverbank. A large landowner filled up some area at his own expense in return for retaining tenant's rights to the land (Mann 1921: 186, 196–197). The first stage of the flood protection scheme, entailing the filling up of the ponds of standing water, was completed on January 20, 1920, a month after the initial planning meeting. There is no further information on how long it took to complete the other stages. However, in a letter dating to February 1, 1920 (Mann 1921: 207–208), all the projects of the scheme had been completed. The entire project was done within one month and one week, which seems short for the amount of work accomplished.

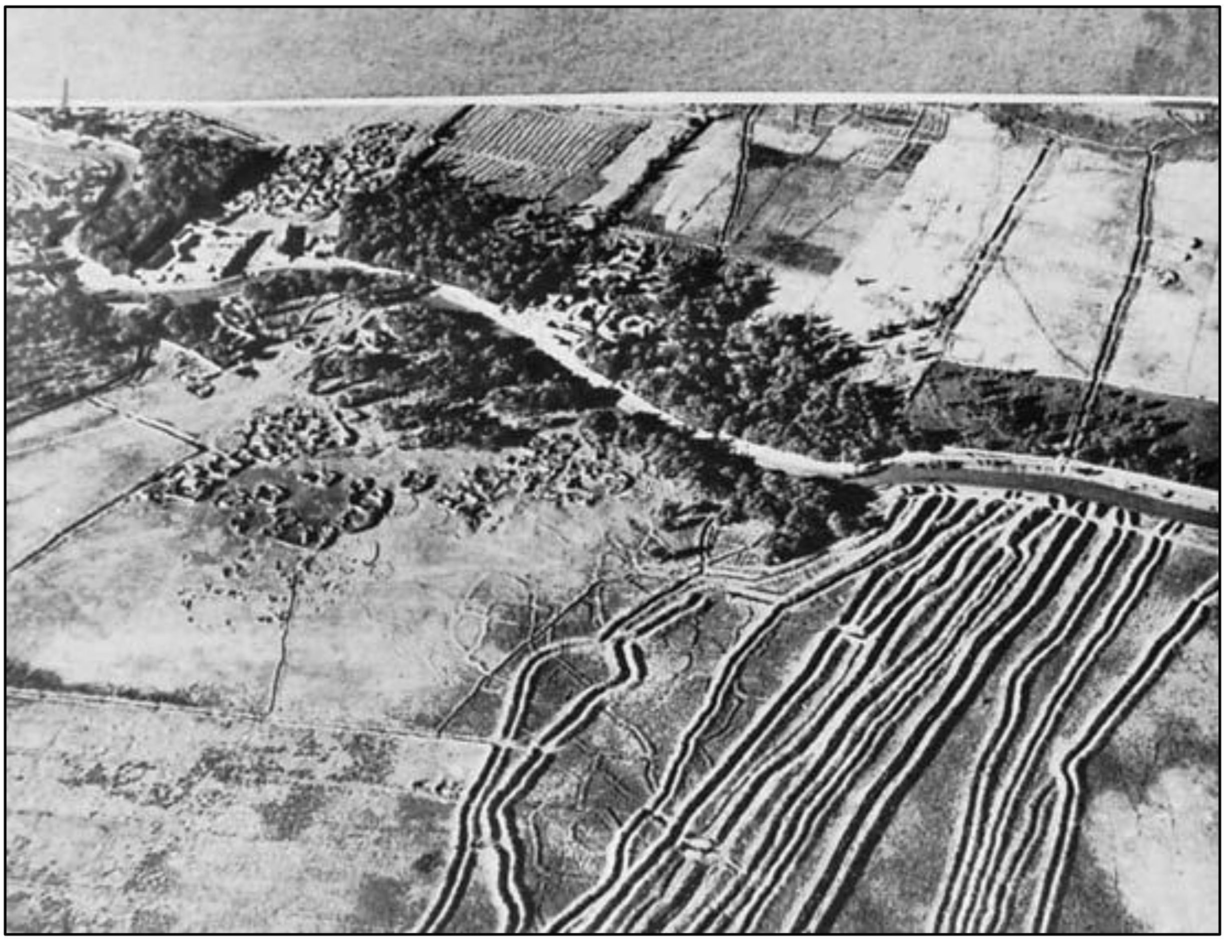


Figure 2.9 Inundation canals near Euphrates River, Iraq (Encyclopædia Britannica Online)

Inundation Canals

Another quite effective flood-control measure is the construction of so-called inundation canals, as can be seen in fig. 23. These shallow canals are designed to fill up with water once the river level rises to a specific threshold and allow for transporting excess water away from the settlements and agricultural areas to depressions and wetlands.

2.3.3.15 Flood Watch (Mid-February to End of May)

Another preventive measure is appointing a flood watch along critical points, for example, at the above-described head dam at the inlet of the primary canal. The water pressure increases as the water rises during the flood season and can result in a dam failure. Guarding the head dam from potential breaches has to be done for the entire risk period from mid-February to the end of May. The 3⅓-month long watch is usually divided among the members of the different farming families (Rost and Hamdani 2011: 213–214).

2.3.3.16 Flood Emergency Measures (March to May):

Even though flood protection devices minimize the risk of flooding, they cannot eliminate it entirely, especially when water levels are higher than expected. Therefore, when the river threatens to overtop its banks or causes dams to be breached, an immediate response is needed. One emergency measure is to deliberately breach the riverbank further upstream to decrease the amount of water arriving further downstream (Cole und Gasche 1998: 12–13; Hunt 1988b: 193). Another way of reducing water volume is flooding fallow fields, also called haphazard irrigation (Poyck 1962: 52). The advantage of this method is that the moisture level in the soil encourages vegetative growth, providing pasture for animals at the beginning of the summer. In the event of a dam failure, anything and everything that is in reach will be employed to close the breach as quickly as possible, even if it means dismantling nearby reed houses.

2.3.3.17 Repair of Breaches

Mann (1921: 252–253 [Letter of April 30th 1920]) describes the measures that are taken when a breach in the river bank occurs as follows: "The river is very high indeed; one bad breach has already occurred and is now being closed (I hope) […] When breaches occur one has to collect reeds and straw from whoever is nearest, and if necessary to pull down the reed houses in the neighbourhood, in order to make a sort of mattress for the earth..."

Ionides (1937: 71) describes similar measures to close the breach in the banks of the Euphrates just north of Samawah: "The breach was closed by an interesting method which has been used for centuries in the lower Euphrates area. Huge mats of brushwood and reeds are rolled round a central rope made of date palm fronds, to form a sausage-like mass called a ‘badkha’. The central rope may be as large as 40 centimeters in diameter and the finished badkha 3 or 4 meters in diameter and 40 meters long. A deep trench is now dug along the bank of the river near the breach and a heavy rope, sometimes as much as 60 centimeters in diameter, is buried in it as an anchor. To the free end of this is attached an end of the core rope of the badkha whose other extremity is held by a smaller rope. The badkha, now lying along the bank parallel to the line of flow of the water through the breach, is rolled into the water, partially closing off the opening and itself restrained from being swept downstream by the anchored rope, while the smaller rope at the other end keeps its tail in the shore. If the water is deep enough it floats, and is covered with tree branches resting on the shore and on the badka itself. On top of these branches, camel thorn and earth are piled up until the badkha sinks to the bottom, when a second one is rolled in on top of it. This process is continued from both banks until the breach is entirely closed.” This quote also shows that the construction methods and design of barrages for diverting water are very similar to those of barrages used for closing off breaches (see fig. 2.6 a-c).

The *badkha* described by Rost and Hamdani (2011: 214) could also contain palm tree trunks at its center. The *badkha* is lifted and transported using large sticks that are placed underneath it and allow it to be lifted. Rost and Hamdani (2011: 214) observe that there is a strong obligation for all members of the community to participate in emergency flood protection, and social sanctions for nonperformance can go as far as forfeiting property rights to agricultural land.

2.3.3.18 Reed Harvest (August to December / January to March)

In the absence of hardwood and stone, reed is next to mud the major construction material used in southern Iraq. Massive amounts are needed for the construction of irrigation and flood protection devices. Harvesting and processing reeds is an important aspect of irrigation and flood management. Until recently, this was done mainly by the inhabitants of the large wetlands, and reeds formed the major trade good between marsh dwellers and the farming population. The harvest of reed for construction purposes takes place between the end of August and the end of March.

Reed starts growing in January/December and fully matures a year later, with an average height of 6 m and a diameter of 9–10 cm (Salim 1962: 104). The marsh dwellers of Iraq distinguish between different growth stages of reed. The youngest reed of the growth stage that falls between January and April, consisting of soft green rushes, is called *ḥashīsh* (grass); reed of the growth stage April to September is called *angir*. Reeds of these two early growing stages are used for fodder. Reed that is 8–11 months old is called *agga*. It is stout and tall but still green and soft and is cut to be used in the mat-weaving industry. The fully matured reed (12 months old) is called *jiniba* and is thick, dry, and yellow. It is also suitable for the reed mat–weaving industry but more importantly for various construction purposes (Mann's 1921: 182, letter from December 13, 1919). Reed can live for another 2–3 years but gets increasingly brittle. Old reed is called *rubakh* and is used as fuel and usually cut after 18 months. Reed cutting is usually done with a wooden-handled, toothed sickle, and people work in pairs to harvest it, one cutting and the other measuring, tying, and loading. One canoe load consisting of fifteen bundles takes about four hours, not including traveling time. The harvest stretches from August to December for *agga*-reed and January to March for *jiniba*-reed (Salim 1962: 104–105). Reed also grows along the river as well as major canals. Mann (1921: 186) notes that one hundred thousand reed bundles were cut along the riverbank alone.

2.3.3.19 Harvest of Winter Grain (End of April to Mid-June).

Labor demands are highest in the months of April/May, as the flood and harvest coincide. The harvest of grain has to be accomplished fairly quickly before the crop becomes too dry, resulting in seeds falling out of the ear. According to Poyck (1962: 45), the harvest of barley takes place from March/April to the end of May (Adams 1965: 16, Table 5, Wirth 1962: 101). Before the widespread mechanization of agriculture in Iraq, grain was cut with hand sickles and piled up in sheaves to dry for 1–2 weeks before the grain could be threshed and winnowed. Cutting grain manually required large amounts of labor, although the authors do not provide quantitative data on this (Fernea 1970: 42, Poyck 1962: 45, Wirth 1962: 101, 107). High water levels might require flood emergency works, which puts an additional strain on the preexisting labor bottleneck. As observed by Salim (1962: 16, 96–97), the most important seasonal labor migration happened during the harvest of winter grains. Inhabitants of the village ech-Chibayish, located south of Nasiriyah at the edge of the great marshland of Hori l-Hammar, sought temporary employment along the large irrigated areas along the al-Gharraf river.

2.3.3.20 Processing of Harvest (May to September):

Processing the harvest entails threshing, winnowing, and storing the grain crops as well as processing the straw. Processing the harvest could last all summer, from July to the beginning of October, as much of it was done manually by means of draught animals (Great Britain Admiralty 1944: 451). According to a study done by the Government of Iraq – Development board (cited in Adams 1965: 14–15, Table 4), the harvesting and threshing time is more labor-intensive than the sowing time.

According to Samarra'i (1972: 62–64), the threshing floor should be laid out on land that is hard, flat, and elevated and at a certain distance from orchards, vegetable fields, and residences. The reason for the latter is not clear, and there is no other information in the agronomic literature indicating where threshing floors were located. Grains were traditionally threshed using either a threshing sledge drawn by an animal (ox, cow, donkey, or horse) (Arab. *hulw* in southern Iraq and Arab. *jarjar* in northern Iraq), or by simply driving an animal over the grain to trample it (Fernea 1970: 42; Great Britain Admiralty 1944: 450–452; Poyck 1962: 45, Wirth 1962: 102). Winnowing is done using five-pronged pitchforks, and the straw needs to be cast repeatedly until the chaff is blown clear by the wind (Fernea 1970: 42; Great Britain Admiralty 1944: 451; Poyck 1962: 45). According to Poyck (1962: 45), straw is ensilaged in pits. According to Wirth (1962: 102), the grain is cut just below the ear, leaving most of the straw on the field to be plowed to provide some fertilizer. Grinding grain was done in the 1940s by animal-driven stone mills in southern Iraq and by water mills in northern Iraq (Great Britain Admiralty 1944: 451–452). There is no information in the available literature on how grain was traditionally stored in Iraq. However, according to the farmer from Nasiriyah (interview of Jan. 6, 2012), grain silos consisted of a latticework of reed mats, which were placed around a round surface of hard trampled clay. The top was closed by reed mats as well, and the entire structure was cased with clay for anaerobic storage. Grain was apparently retrieved by breaking the construction at the bottom and enclosing it again with clay.

2.3.3.21 Construction Works on Irrigation System:

The agricultural offseason is the time when construction projects on the irrigation system take place. The extension or construction of new canals or a head dam will fall between mid-June and the beginning of September. Construction projects are carried out in the manner described above. The planning and the division of labor is discussed and decided in the *mudhif* among those farmers who directly benefit from the construction of a dam or canal. As noted by Rost and Hamdani (2011: 213), this is usually a cooperative effort where even the provisioning of the laborers with food is shared among the participating families. Canal cleaning has a ritualistic character, and the completion of a project is usually celebrated with a feast or even a ceremony, though the latter is most likely done only for larger projects. There is no direct account of how the construction and maintenance of larger primary canals was organized on a more regional level prior to mechanization and state management. Fernea (1970: 120, 164) notes that the construction of a 25 km-long Hurriyah canal by the El-Shabana tribe was accomplished over years in piecemeal fashion. This is something to keep in mind in particular when looking at ancient irrigation systems. The archaeological record will always represent the endpoint of such a process.

2.4 Application of the Calendar to the Past

As mentioned above, since the climatic conditions of the end of the third millennium B.C. were similar to those today, the sequence in which agricultural and irrigation tasks were carried out must have very closely followed the timeline presented above. In turn, grain cultivation can function as a valid analogy to aid the analysis of ancient documents. There are however indications that the climate at the end of the 3rd millennium B.C. might have been slightly moister with more and more evenly spread out rain falls. There is however no evidence that suggests the possibility of rain fed agriculture or a totally different cropping pattern. Moreover, the Sumerian description of an agricultural year in form of the so-called “Farmer’s Instructions (FI)” proves that the timelines were very similar – even though there a number of differences in past and present cultivation practices. As Civil (1994: 1) puts it: the “Farmer’s Instructions describes, in chronological order, the proper way to cultivate cereal crops, specifically barley...”

The agricultural season in ancient Sumer began with **(1)** inspecting canals and dikes before the **(2)** fields are flooded (i.e., softening the soil before plowing) and **(3)** Shoed oxen (gu_4-$suhub_2$) were brought into the field to trample the wet soil, break up the clods and make the soil smoother, called "puddeling" (Maekawa 1984: 80–81; 1990: 128–129).[31] Field preparatory work began according to the FI after the field had "emerged" from the water and entailed **(4)** establishing its borders, **(5)** clearing it of unwanted weeds and shrubs and **(6)** leveling the soil surface with a light hoe. The tracks of old furrows and oxen had to be erased by means of a **(7)** flat hoe and a maul. Afterwards the fields were left to dry up completely before they were **(8)** plowed, **(9)** harrowed and **(10)** "stubborn" clods were broken up by means of a maul. **(11)** Sowing was done by means of a seeder plow whose peg would draw the irrigation furrows. The FI instructs eight furrows to be made per nindan (= 6 m) which translates to a distance of 0.75 m between the individual furrows. Seeds are supposed to be buried 2 fingers (= 3.2 cm) deep and one gin_2 (= 0.3 m^3) of seeds per nindan (= 6 m). After the furrows are drawn, **(12)** earth clods are removed to guarantee free water flow in the furrows. The major difference between the modern and ancient grain cultivation calendar is the absence of irrigation right after sowing (Civil 1994: 88). **(13)** The first irrigation called "water of the first seed" is only applied when the plants "overflow the narrow furrow <u>bottoms</u>". This not only suggests that the first irrigation was applied after the seedlings had already emerged but that they were grown <u>inside</u> the furrow and not alongside its ridge. The required soil moisture was either provided by the initial flooding or rain. As will be discussed in chapter 5, there is no evidence for irrigation right after sowing in Ur III records and the amount of irrigation appears to have been even lower (2–3). The planting of grain in the irrigation furrow might be an additional strategy to obtain sufficient soil moisture for the germination period. According to Brouwer (1988: 3.5) planting in the furrow is preferred if water is scarce. In addition rainfall water would collect within the furrow due to the runoff from the furrow ridges on either side.

The FI further instructs **(14)** three more irrigations – one when "plants form (like) a reed mat, when the "plant is heading" and right before it can be husked. According to Civil (1994: 89) husking describes the growth stage when kernels are fully formed but yet green in early spring,

[31] This method is ethnographically attested with water buffaloes Madagascar particularly in rice cultivation in the lowlands of South Asian countries to compact calcareous soil to increase moisture retention (Maekawa 1990: 128-129).

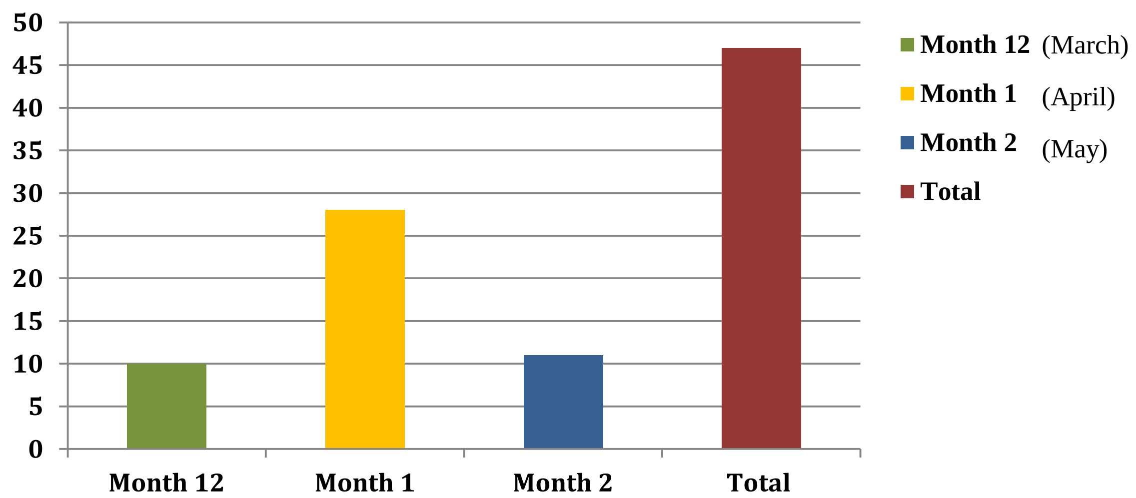
sometimes consumed roasted in limited amounts even in antiquity. The FI goes on to instruct (15) “harvest at the proper time”, which is probably when the ears are sufficiently ripe and dry. The timeline suggested by the FI is very similar to the one described above. While the FI do not discuss the tasks related to irrigation and flood control, they do show that the grain cultivation calendar is a valid analogy for the analysis of the Ur III records.

As approximately 20% of the Ur III administrative texts are dated by month, this calendar should allow us to easily distinguish between tasks and devices related to irrigation, flood control, and navigation. However, this method is only an approximate measure, due to the fact that the month used in Ur III administration consisted of 30 days. The Sumerian calendar was not securely linked to the solar year and therefor the Sumerian months tended to wander. Sumerian bureaucrats were aware of this discrepancy and inserted an intercalary month (iti diri, or thirteenth month) at a frequency which is so far not well understood, as it was done irregularly and varied from city to city (Cohen, 1993: 5; Lehoux 2000: 172–174; Sallaberger 1999b: 233–236; Sharlach 2008: 82). Englund (1988: 123) suggests that an intercalary month was added every 3 years. Texts from Puzriš-Dagan suggest that the intercalary month was inserted after the 11th and 12th months (Schneider 1932: 77–78), while in Umma it was always inserted after the twelfth month.

Since there is no systematic study of the issue of intercalary months, using the month names as documented in ancient texts to identity irrigation versus other tasks might be problematic. In order to test whether the method could be applied, I plotted dated texts that document the reaping of barley (še gur$_{X}$-a [|ŠE.KIN|]). Even though the Sumerian word še and its Akkadian equivalent *še’umand uṭṭatu/uṭṭetu* function as the generic term for “grain,” scholars suggest that in most cases it describes barley. The distinction between barley (še), emmer (ziz$_3$), and wheat (GIG) was based on the frequency in which these terms occur in all historical periods (Powell 1984: 48). Given the known cropping pattern in Iraq, it was argued that since the term še was most frequently attested it ought to be the word for barley, while GIG, being the least frequently attested, was the word for wheat. But as Powell (1984: 49) notes, “it is impossible to ‘prove’ their identification in a rigorously logical way.” Given the predominance of the cultivation of barley, we can assume that the majority of texts reporting on harvesting grain pertain to barley.

The harvest of barley was chosen as a test case since, as discussed above, it needed to be accomplished in a very short period of time. As can be seen from the graph, the distribution of the 47 references, which are spread over a period of 30 years, fall into the expected range. The fact that the majority of references fall on the first month—which is also called "the month of early barley cutting" (iti še-sag/sag$_{11}$-ku$_{5}$)—suggests that the Ur III calendar was frequently enough adjusted to prevent month names from wandering full circle within the solar year. The harvest marks the beginning of the Sumerian year, and month names can be used to establish the timing of tasks documented in the records.[32] The difference in timing between the individual tasks will allow us to identify which are related to irrigation, flood control, and, as discussed in chapter 4, navigation.

Chart 2.10
Monthly distribution of cutting barley (še gur$_{X}$-a [|ŠE.KIN|])



[32] There are other month names that commemorate agricultural events, such as the month of "sowing" (iti šu-numun) or the month of when "barley arrived in the harbor" (iti še kar-ra-gal$_{2}$-la). Determining how well these month names align with when these activities were carried out will be pursued in the future.

Chapter 3

Socio-Political and Economic Organisation of the Ur III State

The Ur III state was founded by king Ur-Namma,[33] who was succeeded by four kings: Šulgi (SH), Amar-Suen (AS), Šu-Sin (SS), and Ibbi-Suen (IS).[34] As has been mentioned in the introduction, the core of the Ur III state covered an area roughly equivalent to modern-day south Iraq and was divided into approximately twenty-one provinces. The periphery of the state extended all the way to Iran in the east and modern day Syria in the north. The formation of the state initially consisted of gaining control over the former city-states of Sumer in the south and the conquest of the Akkadian area to the north during Ur-Namma's and Šulgi's reigns. With military campaigns and political alliances, areas to the east and northeast (periphery) were brought under the control of the house of Ur. During periods of political stability, Ur III kings, in particular Šulgi, Amar-Suen and Šu-Sin, focused on reshaping the internal organization and administration of the Ur III state. The decline of the Ur III state is mainly associated with individual provinces regaining independence and the invasion of Elamite troops (Iran) who captured and carried away the last king of the Third Dynasty of Ur, king Ibbi-Suen (Dahl 2007: 1).

[33] There has been some debate about the reading "Ur-Namma." The more traditional reading is "Ur-Nammu," while more recent studies show that the name should be read "Ur-Namma" (for full discussion see Flückiger-Hawker 1999: 8–9).

[34] For a detailed study of the succession in the royal family at Ur and the ruling family of the Umma province, see Dahl (2007). Dahl (2007: 13–33) argues that Amar-Suen, Šu-Sin, and Ibbi-Suen are in fact brothers and sons of Šulgi. While there is no doubt about Šulgi being the son of Ur-Namma and Amar-Suen the son of Šulgi, a strictly primogenitary succession cannot be conclusively proven for the last three kings of the Third Dynasty of Ur. Dahl (2007) arrives at this conclusion based on the relatively short duration of the rule of Amar-Suen, Šu-Sin, and Ibbi-Suen in comparison to their predecessors. Furthermore, his detailed analysis of the ruling family of Umma showed that for the period documented, fraternal succession based on seniority, by which the governorship passed from father to oldest son, was favored over primogenitary succession (Dahl 2007: 51–69, 131–132). Dahl (2007: 77) suggests that this succession may have been preferred for the ruling families of the provinces in order to prevent one family line from becoming too powerful— particularly since Ur-Lisi as well as Ur-Lamma from Girsu seem to have had political aspirations that posed a threat to royal power (Maekawa 1996). However, a vertical succession from father to son seems to have prevailed in the succession of high, mid-level, and low-level offices in the provincial government of Umma.

3.1 The political organization of the Ur III state

The Ur III period was traditionally viewed as an extreme case of centralized control in Mesopotamian history (Deimel 1931; Diakonoff 1974). As rightly observed by Garfinkle (2013: 154), the extraordinary number of administrative documents has led to the assumption that the central power of the state was absolute. However, with growing knowledge of the Ur III period, the assumption of all-embracing control by the crown has been questioned (Adams 2006; Garfinkle 2008; 2013; Michalowski 2013; Sallaberger 1993; Steinkeller 1996; Widell 2013). Nevertheless, expressed opinions on the degree of political centralization adopted during the Ur III period still diverge widely. This is in part a result of the fact that many of such assessments are made in the absence of conceptual frameworks of political centralization. Garfinkel's (2008), Michalowski's (1987) and Steinkellers (1987a) analyses of the Ur III state within the Weberian paradigm are particularly instructive.

3.1.1 Weber's concept of the bureaucratic and patrimonial state

States exercise and maintain administrative and political control over a given territory by delegating authority to lower order institutions and staff that represent and protect the state's interests at the local level. The delegation of authority can either be done for areas (districts, provinces) or functions or both. How and to what extent authority is delegated determines the degree of political centralization of a state (Hutchcroft 2001). The type of authority exercised and the way it is delegated varies with the form of governance according to Weber (1978). Weber (1978i, ii) distinguishes between two basic ideal types of states: the bureaucratic state and the patrimonial state. The basic differences between these two types are the source of authority exercised by the head of state and the way the state is administered. The bureaucratic state rests upon legal authority, while the authority exercised in a patrimonial state rests on tradition and personal charisma (Weber 1978i: 215). Obedience by the subjects is "owed to the legally established impersonal order" in a bureaucratic state, while it is owed to a person in a patrimonial state. Patrimonial states are by definition not bureaucratic. Bureaucracy as defined by Weber (1978i: 956–1005) is the mechanism by which the state is governed according to the established impersonal order of rational rules (e.g., a constitution) to which even the head of state has to comply. It consists of offices that carry out specialized administrative functions and are hierarchically configured such that subordinate offices are supervised by higher ones. The authority assigned to administrative functionaries is stable but limited to the amount necessary to carry out official duties according to the office's distinct and clearly defined jurisdictions. While patrimonial offices can develop functional divisions in a bureaucratic sense, patrimonial states lack the characteristic distinction between private and public. Offices are viewed as a personal right, bestowed by the ruler on a functionary based not on expertise but on personal trust, anticipated obedience, and loyalty (Weber 1978: 1026).

As these offices become personal property, these "autonomous local patrimonial powers" can become a considerable threat to state power, particularly when combined with economic and military power (Webers 1978i: 1055). Frequently, however, kings or heads of states have to compromise with and rely on local rulers or functionaries, either because there are no alternatives or out of fear of local resistance towards state-appointed administrators. As patrimonial rulers do not fully control the power basis of local rulers or functionaries, the degree of political centralization can be fairly limited. According to Hutchcroft (2001), in a highly centralized state the delegation of authority to local levels is restricted and clearly delimited, and appointed officials are rotated frequently to avoid the formation of local fiefdoms, and put under close supervision. Punitive measures are employed to keep the behavior of state officials in line with the state's interests. On the other end of the continuum are politically decentralized states, which can result from a lack of integration of the various entities within a state structure (Hutchcroft 2001: 29). Within this definition, bureaucratic states as defined by Weber (1978) are an ideal case of a high degree of political centralization while patrimonial states are located at the opposite end of being politically less centralized states due to the existence of multiple locations of power which the state does not fully control.

3.1.2 The degree of political centralization in the Ur III period

The political structure of the Ur III state has many of the characteristics of a patrimonial state. Despite the "explosion in record-keeping," offices were held as "proprietary rights," which remained in the hands of powerful families for generations. Due to the hereditary nature of these offices, there was no clear distinction between private and public, and much of the "business of the state" was conducted at home – a clear characteristic of a patrimonial state (Garfinkel 2008: 57–58). However, when understanding how authority was devolved to the local levels, we see a dual character of the state: implementing a state-appointed administration (royal sector), while at the same time integrating and relying on "local patrimonial powers" in the form of governors who derived from pre-existing elites.

The dual character of the political structure is in part related to how the Ur III state came into being. The political history has been eloquently described by Winter (1987). Her model shows how the three-tiered organization of the city-state was integrated as a self-contained unit into the larger four-tired "triangle," with the Ur III King occupying the apex of the hierarchy.

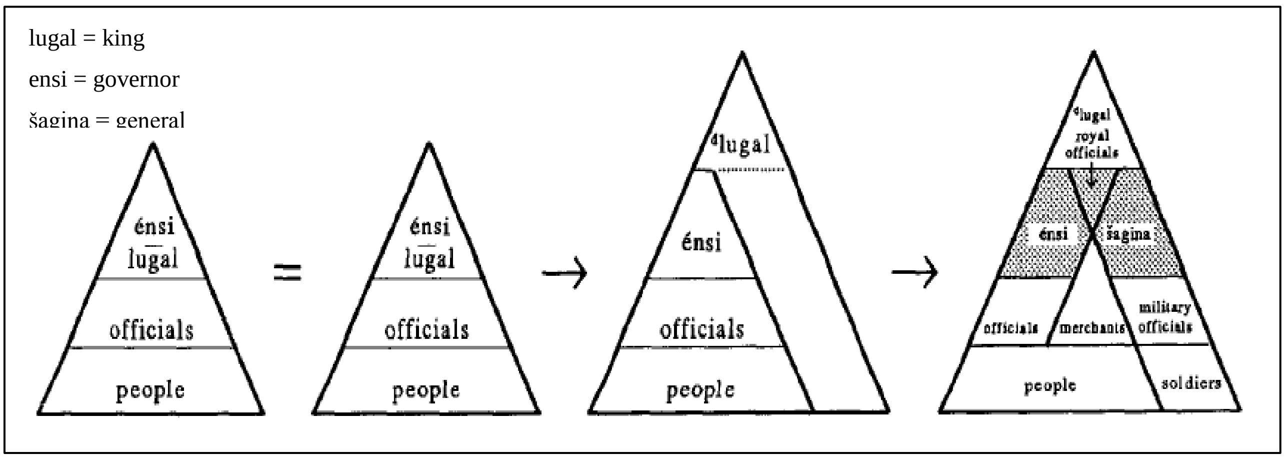


Figure 3.1 "Schematic model of administrative reorganization under [king] Šulgi" (Winter 1987: 76, fig. 1)

Winter (1987: 76–77) rightfully notes that this integration creates a "new column" or a "void" into which military officials (šagina) were inserted at equal status to the governors. Winter's (1987) model equally visualizes the spatial reorganization of southern Mesopotamia under the kings of Ur. As has been discussed in the introduction, the province consisted of the sectors run by governors and a "royal sector." The governor-run sector consisted most likely of land and resources that had previously constituted a given city-state (Steinkeller 2013a: 351). The royal sectors were created by the founding of new settlements of "royal" settlers who were provisioned with land. This wnt along with opening up new agricultural land and the construction of new irrigation systems in particular during Amar-Suens reign (Steinkeller 2013: 358, fn 52, 376, fn 115). The royal sectors were governed very much like the areas in the periphery, by a hierarchy of royally appointed military personnel consisting of "generals" (šagina), "colonels" (nu-banda$_3$), and "officers in charge of sixty men" (ugula geš-da)

(Steinkeller 1987a: 24–25). These military officials were directly responsible to the king, and a number of these generals were also members of the royal family of Ur, both by blood or marriage (Dahl 2007: 10, 19, 21, 27). The spatial as well as the political void was filled with officials and dependents who had much closer ties to the king than to the rulers of the previous city-states. Making important state administrators part of the royal family by marriage is an important characteristic of the patrimonial state, designed to ensure and cement loyalty of an official to the ruler through kinship ties (Weber 1978ii: 1026). An overwhelming majority of these generals bore Akkadian names and it is likely that they had no pre-existing ties with local population as the governors (ensi$_2$) did (Steinkeller 1987a: 21).

As shown by Winter (1987) and also Steinkeller (1977), the dual character of the political structure of the Ur III state is even visible in a new system of cylinder seals. Winter's (1987: 60) study showed that the seal's image in combination with the seal legend was reflective of the official's position in the political and administrative hierarchy. The most common motif was the so-called "royal presentation scene" consisting of a seated figure (king/deity) to whom a clean-shaven individual was presented by an interceding goddess. The seated position, according to Winter (1987: 60), is analogous to the representation of deities, alluding to the deification of the king, which elevated him to a position parallel to that of gods. Royal presentation scenes appear to have been restricted to seals used by royally appointed state officials. Scribes who operated under the jurisdiction of the governors (ensi) used seals that did not make use of the royal presentation scene, nor were the legends dedicated to the king but instead to the governor whom they served (Winter 1987: 66). Therefor, cylinder seals as "functional artifacts" (Winter 1987: 60) were reflective of the dual character of the political order, as discussed above, but at the same time they also communicated the omnipotence of the ruler by placing him in the seated position— a royal and divine prerogative. Moreover, the presentation scenes of seals used by governors and officials of equally high standing were reduced to two individuals, while the interceding goddess was dispensed with. The seal not only communicates the seal owner's social rank but also his proximity to or distance from the king (Winter 1987: 66).

The governors for the most part derived from pre-existing local elites and the power structure of the former city-states were coopted but not replaced by the Ur III state (Garfinkel

2013: 156–157). The governors had administrative staff at their disposal who responded primarily to them and not to the central government. Also, there is little evidence of direct interference of the central government in the day to day operation of the governor-run sector. As will be discussed in chapters 7 and 8, there is minimal evidence of state presence in the management of water courses and agricultural production. However, this should not distract from the fact that the political and economic autonomy of the provincial governors was heavily curtailed by the central government. The royally appointed generals (šagina) whose rank was equal to that of the governor ($ensi_2$) were always perceived as the control mechanism: implemented by the crown to keep these autonomous loci of power in check (Steinkeller 1987a: 21). This was however not the only measure taken by the central government to diminish the potential threat the political ambitions of individual governor's posed to state power.

3.1.3 Governors and the Ur III State

It appears that the central government greatly limited the control governors' exercised over the means of production, first and foremost over agricultural land. As part of king Šulgi's extensive political, administrative and economic reforms, all arable land became de facto state property by which local elites lost the economic basis of their former political power. The distribution of agricultural land appears to have been tightly controlled by the central government, who conducted land surveys and decided how much land would remain under the management of the governor and how much was to be allotted to royal officials and settlers. The state even decided the size of sustenance land assigned to the governors and members of his family.[35] There is even evidence, that land was deducted (zi-ga lugal) from the holdings formerly managed by the governor to be allotted to various royal officials (Steinkeller in press).

Moreover, governors appear to have had even less control over the revenues generated by the provincial economy under their jurisdiction. The governor-run and royal sectors of the various provinces were integrated into the bala taxation system, which had elements of a

[35] The size of the sustenance land assigned to the governor and his family member was quiet substantial. The landholding assigned to Ur-lisi, first governor of Umma amounted to 388.8 ha (Steinkeller 2013a: 358–359). Even the amount allotted to his wife Nin-melam was quiet substantial with 104.22 ha which is fifty-times larger than the size of a sustenance plot of a regular worker (Dahl 2007: 59–60). In additon, govenors and their family members posseded a fair amount of moveable goods, such as servants, domestic and farm animals, orchards, precious objects (metal bowls, silver objects), funiture etc. (see Maekawa 1996b: 113).

redistributive system, in particular for livestock (Sallaberger 1999: 195–196; Sharlach 2003: 20–21; Steinkeller 1987a: 28–30). The primary function of the bala, though, was according to Sharlach (2003: 21) "the forced contribution of the province's wealth to support the central government." Provincial governors were obliged to supply the central government with a quota of goods per year, consisting mainly of barley, livestock, and other goods (e.g., reed, timber, commodities), as well as corvée labor, particularly for "national building projects" (Sharlach 2003: 29; Steinkeller 2013a). In addition to delivering goods and services, individual provinces took turns performing the bala-duty that entailed providing sacrificial offerings to the main temples in the capitals of the Ur III state. Some of the bala deliveries remained in storehouses of the provinces themselves and were withdrawn by the central government directly to sustain royal dependents on site (Sallaberger 1999: 191–196; Steinkeller 1987a: 23–30, 1998: 293–294, 2007: 191–195).

The size of the bala payment for Umma is difficult to estimate due to the lack of summary accounts. However there is evidence from the neighboring Lagaš province, which shows that it was 48% of the entire grain production. It is very likely that Umma had to contribute similar amounts (Sharlach 2003: 30). It is clear that much of the economic wealth did not remain in the provinces and was certainly not at the disposal of the governors to be used for their political ambitions. There are even indications, that after a governor's passing, the state would conduct an audit of his estate, to make sure that he and his relatives did not amass any property that was in excess of what he was entitled to. It has even been suggested that if a governor fell out of favor with the crown, his property (e_2-dul-la)[36] could be confiscated (Dahl 2007: 21; Maekawa (1996b).

3.1.4 Political Centralization and State Building during the Ur III Period

Beyond the control of the provinces, the Ur III kings in general strived for an increase and stability of their control over their territory and subjects, which is most visible in the reforms. The more pragmatic administrative reforms entailed standardization of weights and measurements and introducing the "Reichskalender," designed to synchronize the different calendars of the various provinces of the state. In addition, starting in the thirtieth year of Šulgi's

[36] The property of the governor and members of the gubernatorial family could consist of servants (male and female), date orchards, animal flocks (sheep and goat), draft animals (donkey, oxen), sometimes houses, furniture, precious objects (e.g., metal bowls, silver objects), stored cereal, dates, oils aromatics and so forth (Maekawa 1996b:104ff).

reign, accounting became more detailed as well as more embracive. This involved some language reforms and the introduction of new types of accounting formulae, alongside the formalization of the scribal curriculum. According to Michalowski (1987) these reforms were designed to increase centralized control by restructuring the day-to-day routines and prevailing ideologies (Michalowski 1987). The establishment of scribal schools[37] in Nippur and Ur started by king Šulgi were, according to Michalowski (1987: 52), as much a practical administrative reform as an ideological one. Schools as the "ideological molder of minds" created a whole new stratum of administrators and scribes socialized to the attitudes and convictions of the new political order. A new genre of literature, the royal hymn, became part of the scribal curriculum and according to Michalowski (1987: 52) served as a source of indoctrination in the propaganda of the new charismatic and bureaucratic force of the king.

In sum, the political structure of the Ur III state contained many characteristics of a patrimonial state (e.g. charismatic leadership, hereditary officialdom, reliance on local rulers, etc.). The Ur III state however did also exhibit a high degree of centralization, in particular in the control of flow of revenues. This control was implemented by administrative reforms but more importantly by extensive and standardized record keeping that provided the central government with continuous quantitative data on the provinces' economic potential based on which state revenues could be maximized. There is though no indication, that the central government was heavily involved in the day to day governing of the provinces. When, and to what degree the central government assumed control at the local level is a question that will be addressed in the study of the management of water courses in Umma. As will be shown, this case study provides important insight into how state control was exercised at the local level.

3.2 The Political and Social Organization of the Province Umma

The province of Umma was located at the southeastern corner of the Ur III state and covered an area of about 2000 km^2 (Steinkeller 2007: 188). The province was further subdivided into four geographic districts, Da-Umma, Apisal, Gu'edena, and Mušbiana (see chapter 1, map 1). The

[37] There is no primary evidence, either textual or archaeological, for the existence of scribal schools, as existed, for example, in the Old Babylonian period at Nippur (Robson 2001). Sallaberger (1999: 130) has argued that professional knowledge and training were handed down from father to son, as most offices, such as scribe (dub-sar), became hereditary. However, it is more plausible that scribes did receive some formal training in a state school than to being trained by their fathers whose position they later inherited.

provincial sector under the authority of the governor consisted of state/domain land ($gana_2$-gu_4) and various workshops (e.g., mill houses, weaving establishments) that were run by the governor and his extended family and high officials (Dahl 2007: 110–112; Studevent-Hickman 2006: 8–9). It is the governor-run sector of the Umma province from which the written sources used in the dissertation research derive.

3.2.1 The Governor-run Sector of the Umma Province

The province was named after its major capital, also called Umma. The governorship of the province was held successively by three brothers from the family of Ur-nigar, the chief livestock administrator ($šuš_3$). Ur-Lisi was governor of Umma for about 23 years (SH33–AS08) and succeeded by Akala, who held the governorship for nine years (AS 8–SS 7), then, Dadaga ruled Umma for about seven years (SS07–IS03) (Dahl 2007: 62, 69–71). Members of the ruling family held other important positions in the administration of the Umma province, such as the office of the chief household administrator (šabra e_2), who was in charge of managing the treasury of the governor's household; the office of the chief of the granaries (ka-$guru_7$), who oversaw grain revenues and expenditures; and the office of the chief livestock administrator ($šuš_3$) (Dahl 2007: 85–115; Ouyang 2009: 44–60; Ouyang 2010). Members of the ruling family were also deeply involved in the management of agricultural land and of watercourses. Ur-E'e[38], for example, a brother of the three governors, was in charge of running the agricultural sector of the Apisal district for nearly 33 years (SH33–SS08). He was later succeeded by his son Lu-Haya in the year SS 8/9, whose tenure lasted until the end of the Ur III period (Dahl 2007: 85–104; Vanderroost 2012i: 40–41, fn 136, 184). Both appear very frequently as sealing parties in documents recording work projects related to the management of water courses in Umma.

However, the ruling family did not control all of the important offices in the Umma province, nor did it oversee the entire agricultural operation. The largest agricultural sector located in the Da-Umma district, for example, was managed by members of two prominent families of land surveyors (sa_{12}-du_5); the families of Lugal-kugani and Inim-Šara. Inim-Šara was

[38] Ur-E'e also held the position of chief livestock administrator ($šuš_3$) of the Umma province, a position he inherited from his father, Ur-Nigar, the ancestor of the ruling family at Umma. Ur-E'e never referred to his father Ur-Nigar as the previous chief livestock manager. This practice can also be observed for Lu-Haya, Ur-E'e's son, who succeeded him as chief livestock administrator. The same applies to Šara-izu, the son of ARAD2(mu), the chief of the granary (Dahl 2007: 86).

a royal land surveyor who might have been installed by the crown in Umma to ensure accurate reports on the province's agricultural potential. Lugalemah(e), the son of Lugal-kugani, and Egalesi, the grandson of Inim-Šara, held key administrative positions in the management of the agricultural sector of the Da-Umma district. Furthermore, the office of the provincial archivist (pisan dub-ba) was in the hands of the family of Lugal-ušur, who also managed the agricultural domain of the temple household of Umma's main deity, Šara. It appears that important offices in Umma's administration went along with exercising control over the management of agricultural land (Dahl 2007: 70–72, Vanderroost 2012i: 186–187).

3.2.2 The Royal Sector of the Umma Province

The royal sector consisted of probably newly established settlements of royal dependents (eren$_2$), who seem to have been resettled mainly from Upper Mesopotamia in the countryside of various provinces in the south but also recruited from the local population (Steinkeller 2007: 210).[39] The royal sector was governed very much like the periphery, by a hierarchy of royally appointed military personnel (Steinkeller 1987a: 24–25). At the base of the hierarchy were the

[39] This argument is based on the fact that the names of those settlements known to have been inhabited by royal settlers often employed Akkadian words (e.g., Akk. *aṣarum*, "encampment"; Akk. *ālum*, "town"). Further, when names of royal settlers are documented, as is the case for Garšana and Nagsu, the majority bear Akkadian names or foreign names, such as Amorite and Hurrian names. Steinkeller (2013: 357) argues that this indicates a large program to resettle the people from northern Babylonia and/or prisoners of war to populate the countryside of the south, where land was made arable by the construction of new irrigation canals. Indeed, as noted by Steinkeller (2007: 187), Adams (1981: 136–141) detected a considerable increase in the number of settlements and a rapid growth of urban centers at the beginning of the third millennium B.C. Further, as noted by Pollock (1999: 72–77) based on Adams's survey data, there are spikes in settlement noticeable in the Nippur-Adab area during the Akkad period, probably at the expense of settlements of the Uruk region and a similarly sudden increase in the total populated area around Ur during the Ur III period. These spikes, according to Pollock (1999: 75), suggest that "political forces rather than ecological factors were at work." The political forces she alludes to might be coercive, such as deportation following a military conquest. Resettling or deportation programs on a large scale have been employed by many early empires, such as the Assyrian, the Urartian (Northeastern Anatolia), and the Sasanian empires, and it is a tempting explanation for a sudden increase in the population of a certain areas. King Šulgi is known for having conducted many military campaigns; however, there is no evidence for the kind of large-scale deportation known from later periods. It remains unclear how the people that settled in the south during the Ur III period became available. Pollock (1999: 77) notes that the frequent shifting of settlements and people in Mesopotamia is related to a complex interplay of economic, political, and ecological factors. The diachronic increase and decrease in numbers of settlements might also be indicative of a relative "flexibility between sedentary and mobile lifestyle, [which] formed an important part of families' strategic responses to unpredictable ecological conditions and fluctuating political and economic circumstances." This can even be observed today. On my visit to Iraq in the winter of 2011/2012, I was informed that many farmers resorted to a pastoralist lifestyle to cope with the decline in the agricultural production in the Nasiriya area due to the shortage of water, now being held up upstream in Turkey. The demographic change in the Ur III period might have been the result of an influx of formerly more mobile segments of the society and/or a migration from the north or other parts of the country. The migration might have been the result of coercion but could equally have been voluntary, the result of economic incentives such as the employment and security provided by the Ur III state.

so-called hazannus, mayors who governed larger villages and towns in concert with a council of elders (ab-ba/ab-ba-rum). Major towns and cities were governed by generals (šagina) and less important sites by colonels (nu-banda3) and “officers in charge of sixty men” (ugula geš-da) (Steinkeller 2013a: 351–352). A number of these generals were members of the royal family of Ur, both consanguine and affine (Dahl 2007: 10, 19, 21, 27). Three sons of king Šulgi, among them the later king Šu-Suen, held the position of generals at Uruk (Dahl 2007: 27). Dada, king Amar-Suen’s son, held the position of general at Zabalam in Umma (see chapter 1, map 1).

According to Steinkeller (2007: 209), royal settlers are frequently described with the kinship term “territorial clan/extended family” (im-ri-a/im-ru-a). He argues that this indicates that kinship groups were absorbed and integrated into a state structure by recruiting male members for military services. “Village headmen” or “town mayors” (ha-za-num_2) might have enjoyed some degree of self-governance, as they don’t appear as part of the military organization in charge of governing the royal sectors. In addition, these villages and towns are perceived as one collective body in legal cases represented by a group of elders (ab-ba/ab-ba-rum) (Steinkeller 1987a: 24–25; 2007: 209).

Royal settlers, as well as military personal and civil servants, were granted usufruct to crown land ($gana_2$ zi-ga lugal) in return for their services in the form of corvée labor (De Maaijer 1998: 55). The royal dependents, and in particular professional soldiers (aga_3-us_2), were the main source of manpower for military campaigns as part of their corvée-duty (Steinkeller 2013a: 372). In peace-times, the corvée of royal dependents was employed heavily in national building projects, such as construction of the palace at Tummal,[40] the administrative center Puzriš-Dagan (SH35–37), and the Šara-Tempel at Umma (SS02). There is an indication that royal dependents were employed in large-scale hydraulic projects, such as the construction of the Amar-Suen-kegara-canal (AS05).

[40] The palace of Tummal was built in the thirty-fifth through thirty-seventh years of Šulgi’s reign. Even though the city was already known from earlier periods, it must have gained prominence during the Ur III Period, particularly as it became the focus of the funerary cult of Ur-Namma. There is an indication that the highest officials, such as the sukkalmah (chancellor) and possibly even the king himself, resided at Tummal. It is only 15 km from the royal administrative center of Puzriš-Dagan, and Steinkeller (2013: 363) argues that it might have been one effort to build the infrastructure that facilitated control of the state by the crown.

3.2.3 The Interaction between the Governor-run and Royal Sectors

There is very little evidence for direct interaction between the crown and the governor-run and royal sectors of any given province, and it is difficult to fully establish the nature of the power relationship between the state and its provinces and royal dependents beyond the system of taxation (Dahl 2007: 56–57, 135; Steinkeller 2004a: 41). We only learn about the royal sector when it interacts with the well-documented governor-run sector. As the governor-run sectors and the royal sectors of the Umma provinces were by and large independent of each other, these interactions are confined to a few legal cases dealing with land and water right disputes or transgressions of members of the royal sector into the governor-run sector or vice versa (Steinkeller 2013a: 361).

The relationship between the governor-run and royal sectors is best illuminated by records of their common obligation to provide the central government with corvée labor. The corvée labor system adopted in Ur III times was highly complex and formed the basis of labor mobilization and organization at the national and provincial levels. While at the provincial level corvée labor was employed in various economic sectors, such as agriculture and various workshops and industries, the corvée labor mobilized at the national level was used in national building projects, as discussed above. The amounts of labor documented vary from 100 to 180 days, which were distributed in different installments over the year. What remains somewhat unclear is how many corvée labor days a person owed to the governor-run sector, how many to the royal sector, and how many to the crown directly. The duty to perform corvée labor was, as discussed earlier, tied to grants of usufruct rights to land by the crown (see below). Since the state was considered the sole owner of all land, the obligation of corvée- labor was levied on every person who held usufruct rights to land, no matter what their social standing was. Among the individuals conscripted to perform corvée labor at the construction site of the palace of Tummal (discussed above), we find even members of the governor's family of Umma, as for example, Ur-e'e, the brother of the governor of Ur-Lisi and Akala, who administered the agricultural sector in the Apisal district (Steinkeller 2013a: 350–351). However, it can be assumed that an individual of such social standing would hire a laborer to perform the corvée duty on their behalf (Steinkeller 2013a: 367).

The conscripted corvée labor for the construction of the Tummal palaces derived only from the governor-run sectors of various provinces and had also to be provisioned with food by them (Steinkeller 2013a: 369). Due to their much greater number, royal dependents were probably much more frequently called upon for their corvée duty for the national building projects than members of the governor-run sectors. It appears, however, that the royal dependents on corvée duty were provisioned by the sectors run by the governors of the provinces. These expenses where were in turn credited to the province's bala-obligations toward the central government. Everything beyond the amount of their bala-obligations was considered a loan and had to be repaid in full (Steinkeller 2013a: 377, 381–382). One interesting aspect of grain loans given by the governor-run sector to the royal sector at Umma was that the accrued interest was to be repaid in harvest labor. For 60 liter of loaned grain, the interest paid on the loan was the reaping of a 1–2 iku (0.36–0.72 ha) plot of a grain field (Steinkeller 2013a: 381). This was one way of solving the labor bottleneck that occurred particularly around the harvest (see chapter 7).

3.2.4 Private Economy During the Ur III Period

There is some debate over the extent of a private economy in the Ur III Period. Steinkeller (2004b: 92) argues that the term "private economy" is in itself misleading as it implies the existence of extensive private landownership[41], self-employment as opposite to being employed by the state as well as a self-regulating market economy. It is fairly certain that some form of barter or exchange outside of the state-managed exchange systems must have existed to provision the population with basic materials (construction materials, household items, clothing, a variety of food, tools, etc.) for their livelihood (Steinkeller 2004b: 94–96). Steinkeller (2004b: 92) though argues instead that these "private economic activities" have to be understood as an extension of the state economy rather than a separate independent entity. The case of the

[41] Steinkeller (1999: 294, 302–306) argues that private landownership in the modern sense, which allows the appropriation and alienation of land, did not exist in southern Mesopotamia in the third and second millennia B.C. Landownership, according to Steinkeller (1998), was the prerogative of the gods, and "ownership" was restricted to usufruct rights. Practically, however, it was the rulers of the city-states and later the governors of the Ur III provinces who controlled access to and distribution of land. He further argued that that individual landownership in the southern alluvial plain is not advantageous, due to shifting watercourses and the risk of salinization. The latter can be supported with agronomic data from the 1950s as presented by Poyck (1962), which showed that the income of tenant farmers as sharecroppers was indeed higher than the income of small farm owners, due to the greater flexibility of tenant farmers to change plots when land became too saline. Concerning shifting watercourses, however, the studies of Hritz (2005, 2006) and Wilkinson (2013) suggest that irrigation systems in southern Mesopotamia were much more stable than was previously thought.

merchants clearly shows that while they traded on behalf of the state with state capital, a profit margin allowed them to invest in private commercial activities that allowed them to accumulate "private capital". The primary economic transactions, though, were those they conducted for the state and their private profit was based on "capital" that was advanced to them by the state (Steinkeller 2004b: 97–109). Similarly, there are indications that craftsmen such as architects (šidim) or potters ($bahar_3$) might have worked for a private market after their obligations to state institutions were fulfilled (Neumann 1996, Steinkeller 1996, 2004b).

3.3 Bureaucracy in Ur III Times

In order to keep track of the fulfillment of a province's bala-tax obligations and the province's revenues and costs, a bureaucracy of previously unknown dimensions was employed, which kept records of many aspects of economic life, including watercourse management (Steinkeller 2004a; Sharlach 2003). Ur III records focus mainly on the documentation of expenditures of labor and goods. The administrative documents from the governor-run sector of Umma represent a period of roughly 38 years, with the overwhelming majority of texts dating from the thirty-third year of Šulgi's reign to the third year of Ibbi-Suen's reign (2062–2025 B.C.) (Studevent-Hickman 2006: 25). The majority of administrative texts consist of primary accounts that record the expenditure of labor and goods, in most cases for a single event or work project. Based on these primary accounts, year-end accounts were drawn up that recorded the amount of labor or goods provided by an individual official or institution as part of his/its obligation to the provincial government and the state (Steinkeller 2004a: 38–39, Nissen et al. 1993).

The administration of Umma seems to have been organized according to the various branches of the economy. According to Steinkeller (2004: 41–42), there was the bureau for agriculture and grain, which handled the production, collection, storage, processing and redistribution of the grain in the governor-run sector of Umma. The labor bureau was in charge of keeping track of the fulfillment of the various labor obligations of the province's population to the central and provincial governments. The animal bureau was in charge of the province's livestock production, including the management of its animal products, such as wool and hides. Then there were bureaus of various trades, such as the leather bureau, the metal bureau and the boat bureau. The latter handled the construction and the rental of boats. The forestry sector also had its separate accounting bureau in order to systematically record the harvesting of timber and plants. Steinkeller (2004: 42) further argues that all the offices were subordinated to a fiscal bureau that had a central role in the administration of the governor-run sector, as it controlled the collection of taxes and payments. This bureau might have been equivalent to the office of the chief household administrator, which was in the hands of the gubernatorial family.

3.4 The Geographical Outline of the Umma Province

Due to the lack of archaeological data, it is difficult to describe the historical geography of the Umma province in any great detail. The geographic information recorded in the texts, however, gives a general sense of the outline of the province. As been mentioned above, it was subdivided into four districts: Da-Umma, Apišal, Gu'edena and Mušbiana. Even though the exact location of the boundaries of these respective districts cannot be established with certainty, it is clear that the Da-Umma district was located in the northwestern quadrant and Apisal in the northeastern quadrant of the Umma province. Though Gu'edena and Mušbiana are frequently mentioned as one entity, it is clear that the Gu'edena district was located in the southeastern quadrant bordering the neighboring province Girsu/Lagaš and Mušbiana was located in the southwest (see chapter 1, map 1).

Based on the geographic information given in the Umma record, Steinkeller (2007) was able to identify 158 settlements, 110 of which he could associate with the Umma province with absolute certainty. Steinkeller (2007: 189) distinguished between city, town, large village, and hamlet based on estimated population sized derived from texts and available archaeological data (see table 3.2).

A "hamlet," according to Steinkeller (2007: 190–191), constitutes the supporting settlement of a domain, which formed the basic unit of the rural organization at Umma, both physically and administratively (see below). The domain consisted of an arable field, vegetable plots, date-palm orchards, grazing land, and at times riparian forests and marshland that provided resources such as fish, waterfowl, reeds, and grasses. The settlement of each domain was equipped with a threshing floor (ki-sur$_{12}$) and a grain silo (guru$_7$, i$_3$-dub), which allowed for processing and storing the domains' grain production. Steinkeller's category of "hamlet" also includes small farmsteads or estates (e_2) and specialized agricultural outposts consisting of a threshing floor, a grain silo, and the dwellings of the grain silo caretaker.

Small-to-medium–sized villages, according to Steinkeller (2007: 193), were economically more diversified and contained structures such as storehouses (ga_2-nun), palaces (e_2-gal), sheep pens (e_2-udu), and occasionally shipyards (mar-sa) and weaving establishments (e_2-uš-bar). Frequently, these larger villages also had temples and chapels that were run by religious personnel, such as a $gudu_2$-priest and a few of female servants.

Table 3.2
Classification of sites by Steinkeller (2007: 196)

Settlement	Nr. of dwellings	Population	Total population
1. City	1	20,000–25,000	20,000–25,000
2. Town	12	5,000	60,000
3. Large village	12	600	7,200
4. Hamlet	85	50	4,250

Large villages and small towns usually had medium-sized temples associated with them. Towns also had larger temples associated with them, including onsite religious personnel and egi-zi and ereš-dingir priestesses and majordomos (šabra) or hazannus,[42] depending on the sector to which the settlement belonged (Steinkeller 2007: 194). Umma, with a population of approximately 20,000 to 25,000 inhabitants, was according to Steinkeller (2007: 196, 204) the only true urban center in the province relative to the size of the other settlements. However, most of the population living in Umma was still directly engaged in agriculture, which makes Umma by definition more a rural town than a true city. The second largest urban center was Apisal, which has been provisionally identified by Steinkeller (2001: 72) with the site Muhalliqiya. The cities Zabalam and KI.AN seem to have functioned as important cultic centers. Abi-simti,

[42] Other settlements that can be assigned to the royal sector with certainty due to the fact that hazannus (mayors) are attested for them are GARsuda, GARšana, Gišabba, Maškan, NAGsu, and Zabalam (Steinkeller 2013a: 351–352).

probably the "queen-dowager" of king Šulgi,[43] visited Zabalam four times in a five-year period and was provisioned by the Umma province.

Table 3.3
Places names mentioned in the Umma record
(Royal settlements indicated in bold and italic and in grey)

Hamlet/small village	**Large Village/small town**	**Town (1000)**	**City**
Eduru-Gu'edena	***A'ebara***	***Apisal***	Umma
Eduru-IŠ.U.U	Al-Bura	***Aṣarum-dagi***	
Id-lugal	Al-Šu-Suen	***GARsuda***	
Ašag-lugal	***Amirima***	***GARšana***	
Eduru-du-kugsig	Dintir	***GusaharDU***	
Emah	***Gišabba***	***Id-dula***	
Girgiš	***Gišgigal***	***Karka***	
Eduru-ašag-manu	***Hardahi***	***Ki'an***	
Eduru-A'abba	Kamari	Kisura (Umma)	
A'uda	***Ṣarbat***	***Maškan***	
Id-sala	Tim-Ku.KU	***NAGsu***	
	Uṣar-atigiNI	***Zabalam***	

Zabalam and KI.AN were both settlements run by generals (šagina) and belonged to the royal sector of the Umma province. Other settlements for which hazannus are attested and which can be assigned to the royal sector include GARsuda, GARšana, Gišabba, Maškan, and NAGsu (Steinkeller 2013a: 351–352; see table 3.3). The governor usually did not control any land in the vicinity of the royal settlement, while there is evidence of individual fields held by members of the royal sector within the governor-run sector (Steinkeller 2013a: 354).

[43] See Dahl (2007: 17–18, 21), who discusses the matter of her relationship to the ruling house of Ur.

3.4.1 Settlement Pattern in Umma

Steinkeller (2007: 190) showed that the majority of sites (at least eighty-five, and probably more) mentioned in the texts fell into the "hamlet" category, arguing for a settlement pattern for the Umma province being a "rural continuum" (2007: 204). He argues (2007: 201): "In my reconstruction of Umma's physical landscape, there was no dichotomy, no fixed barrier between the town and the countryside; the two blend into each other. Urban space gradually and almost imperceptibly became countryside. The central, densely built-up section of a settlement thins out into suburbs; from there, it is only a couple of kilometers to the first hamlet; along the way, here and there one sees a single farmhouse; then another hamlet, followed by a village, and finally, another town. And so on."

The distance between sites established based on textual information amounts to 4 km between hamlets and small villages and 9 km between larger villages and towns, a settlement distribution that is very similar to what has been observed archaeologically for rain-fed Upper Mesopotamia (Steinkeller 2007: 201, fn 11). According to Steinkeller (2007: 202), the texts indicate a high degree of integration between the urban and rural spheres, both economically and socially, as city-based institutions embraced even the most marginal parts of the countryside. He attributes the economic success of these provinces and the Ur III state as a whole to this high urban–rural integration, which can neither be labeled exploitive nor a vulnerable dependency of the cities on the hinterland (Steinkeller 2007: 207).

3.4.2 Population Density

The size of the population of Umma has been extrapolated by Steinkeller (2013a: 360, in press) based on recorded census data from the city of Umma and sixteen additional towns in conjunction with the settlement numbers known and the available archaeological data.[44] In his calculation, the city of Umma had about twenty-five thousand male royal dependents (eren$_2$) and only thirty to forty thousand males under the direct control of the governor. He estimates the total population of Umma province to about one hundred thousand inhabitants, of which two-

[44] Steinkeller (2013a: 360) uses the coefficient of one to two hundred people per ha multiplied by the total of the inhabited area, which has been traditionally employed for population estimates in the ancient Near East. The effectiveness of this coefficient is questionable, as we have no data on the levels of population density in villages versus cities and in different periods (Pollock 1999: 64). However, architecture visible on satellite imagery analysis shows that the population density was very similar for sites of all sizes (p.c. E. C. Stone April 8th , 2015).

thirds belonged to the royal sector and only one-third to the governor's household (Steinkeller 2007: 204). All estimates must remain preliminary until future archaeological research provides the needed evidence to obtain more robust demographic calculations for the Ur III period.

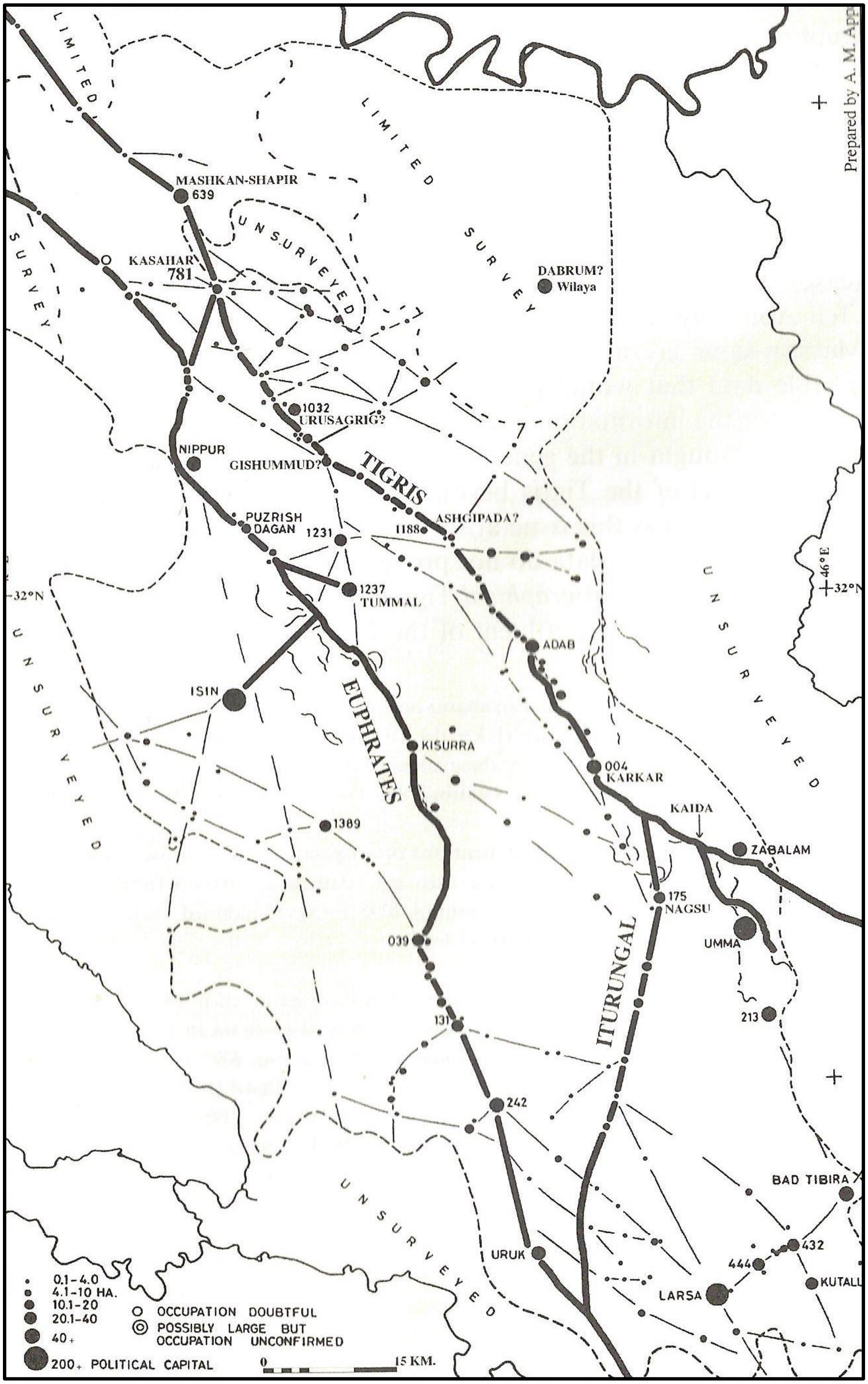
3.5 Hydrology of the Umma Province

Until recently, the conviction prevailed that the Tigris could not have been fully utilized for irrigation prior to the first millennium B.C. (Adams 1981: 19). This assumption was based on the less predictable and less controllable regime of the modern Tigris due to its greater water volumes and flow velocity. In addition, water withdrawal from an incised river course requires either water-lifting devices or long overland canals to tap water further upstream. Adams (1981: 158–159) does acknowledge that the territory north of Umma must have been watered by the Tigris in the third millennium B.C., since there are many textual references to the ancient Tigris from Umma and Lagaš. However, since "no band of dense cultivation and urban settlement along the Tigris comparable to what existed along several Euphrates branches" could be detected, Adams (1981: 158) was convinced that the Tigris played an insignificant role in the occupation of the alluvial plain (see also Jacobson 1960: 175).

This view has been challenged by (Steinkeller 2001), who points out that the references found in Ur III texts from Umma are predominantly to the Tigris (idigna, *idiqlat*), but hardly ever to the Euphrates (buranum, *purattum*). In addition, there are numerous administrative records that document construction and/or repair works at hydraulic devices (see chapter 4) that are directly linked to control of the Tigris (i.e., kunzida Idigna Apišal – Tigris barrage at Apišal-city). Other texts[45] report workmen carrying goods from point A to the bank of the Tigris. This proves that the Tigris itself or a major Tigris branch must have run in the area of the province of Umma. Based on an extensive textual analysis, Steinkeller argues (2001: 25) that the ancient cities of Maškan-Šapir (Tell Abu Duwari), Adab, Karkar (Tell Jidr), Zabalam, and Apišal (Tell Muhalliqiya) were located at the Tigris and reconstructs the Tigris's course along the line that had previously been identified as the "eastern branch of the Euphrates" (see map 2).

[45] Aleppo 180: o. 1-4: "110 guruš u4 1-še3 ga2-nun a-ša3 tur-ra-ta gu2 Idigna-še3 gi ga6-ga2" "110 workmen for one day carried reeds from the storehouse of the 'Small' field to the bank of the Tigris."

The preliminary results of Hritz's (2005: 235–241) analysis of her remote sensing data also suggest an ancient course of the Tigris in the vicinity of the Umma province. Based on SRTM data, Hritz was able to map a substantial fossil levee of a width of 4–6 km east of the modern Tigris between Baghdad and Kut, on top of which the later Sassanian Nahrwan irrigation system was built. She argues that such a substantial levee could have only been built by the fluvial dynamics of a powerful river—the ancient Tigris (Hritz 2005: 238). Hritz was able to document 851 potential archaeological sites skirting the western bank of the Tigris and in greater quantities along the eastern bank of the Shat al-Gharraf. Based on these data, she reconstructs a course east of the modern Tigris (between Baghdad and Kut) that then crossed the modern course of the Tigris in order to assume a nearly north–south path parallel to the Shat al-Gharraf. As Hritz was not yet able to perform a ground check of her remote sensing results or date the detected archaeological sites, this reconstruction remains preliminary.



Map 2 Reconstruction of the 3rd millennium B.C. Tigris (Steinkeller 2001: 50)

Chapter 4
Watercourse Management: Navigation

The next three chapters (4–6) will discuss how the ancient Tigris was managed to serve three functions—navigation, irrigation, and flood control—in the Umma province.[46] Each of these functions are described separately in the following chapters. As this functions are interrelated they from what I called the water course management system. The description of the watercourse management system of Ur III Umma rests upon the systematic study of 22 Sumerian nouns and verbs that refer to water control facilities and water management tasks (see appendixes A–W). The study of the relevant documents indicates that hydraulic devices, such as barrages, weirs, flow dividers, irrigation canals, inlets, and outlets of canals were constructed mainly from earth, reeds or products of reed such as reed mats (^{gi}kid) and reed ropes (^{gi}gilim), and plant matter (u_2), of which a specific adobe mixture is most prominent (u_2-sahar-ba). The use of timber and brushwood such as tamarisk ($^{\hat{g}eš}$šinig), willow ($^{\hat{g}eš}$ma-nu), and poplar trees ($^{\hat{g}eš}$asal$_2$) is attested, but rarely in comparison to the amount of reeds and adobe used in the construction of water control devices. Given the construction materials, irrigation systems and water control devices were very prone to erosion, and the most frequently attested maintenance work is that of inserting earth into the eroded parts (sahar si.g).

The available documents record almost exclusively watercourse management authorized and carried out by the governor-run sector of the Umma province. Even though the royal and governor-run sectors operated for the most part independently of each other (Steinkeller 2013a: 360), both sectors depended on the same water source—the ancient Tigris. The available records show that a great deal of labor and goods were invested in the management of the river for

[46] A full reconstruction of the hydrology (natural and man-made) of the Umma province, beyond the reconstruction of the course of the ancient Tigris offered by Steinkeller (2001), remains difficult and has not been attempted in this thesis. The lack of archaeological survey data for this region makes it very difficult to reconstruct the historical geography and in turn determine the course of natural and man-made canals. Only the approximate locations of certain watercourses, canals, and major water control devices and some fields are indicated on map 3 to orient the reader. A comprehensive study of the hydrology of Umma and its relevance to understanding the socio-economic and political origination of an early state is the objective of my postdoctoral research.

irrigation, waterborne transportation, and flood control, all of which would have benefited all water users. Some fields (e.g., Ukunuti field and Abagal field) were cultivated by members of both sectors (Steinkeller 2011: 381; 2013: 359, fn 53). The collective use of the Tigris and certain irrigation facilities would have required arrangements between the two sectors regarding the division of construction and repair work and the distribution of water.

Unfortunately, too little is known about the organization of the royal sector to allow for describing the level and nature of the cooperation between the two sectors. There is only indirect evidence for the existence of mutual agreements in court records that document the violation thereof (e.g., conflicts over water, improper operation of water control devices, etc.; see chapter 7). Other glimpses are provided by records that document the contribution of labor by both sectors to certain water works projects. Unfortunately, the latter are extremely rare. Thus, it is important to keep in mind that the evaluation of the social organization of watercourse management with respect to political centralization will be hampered by this shortcoming. Despite these limitations of the historical record, the information is sufficiently comprehensive to give us an understanding of the methods and strategies deployed at the time to manage a highly challenging riverine environment. The major component of the watercourse management system adopted in the Umma province was the effective control of the fluctuating water levels of the ancient Tigris to coordinate irrigation activities together with the requirements for navigation and flood control.

4.1 Navigation, Irrigation, and Flood Control

Robert McCormick Adams (2006: 139–142) has pointed out that Ur III water management had to reconcile the demands for irrigation and waterborne transport. Waterborne transport was essential for the functioning of the Ur III economy, which rested upon region-wide taxation systems with a strong redistributive character (bala) (Sharlach 2003). The movement of goods, in particular grain, was made possible by efficient and low-cost waterborne transportation (Sharlach 2003: 86–90, 284–288).[47] However, as further noted by Adams (2006: 139), "to reach its potential [river navigation] had to confront severe challenges. One of these was that alluvial river

[47] For a detailed quantitative discussion of waterborne transportation versus overland caravan transportation, see Algaze (2008: 50–62).

systems are characteristically unstable, given to course changes through channel avulsion that would naturally disrupt established patterns of human use. Another was that Ur III's irrigation agriculture made competitive, no less important demands for water, but irrigation canals in use could interfere seriously with the human towing operations that were essential for large-scale water transport.” As will be discussed below, the watercourse management system at Umma accounted for all the demands and challenges discussed above.

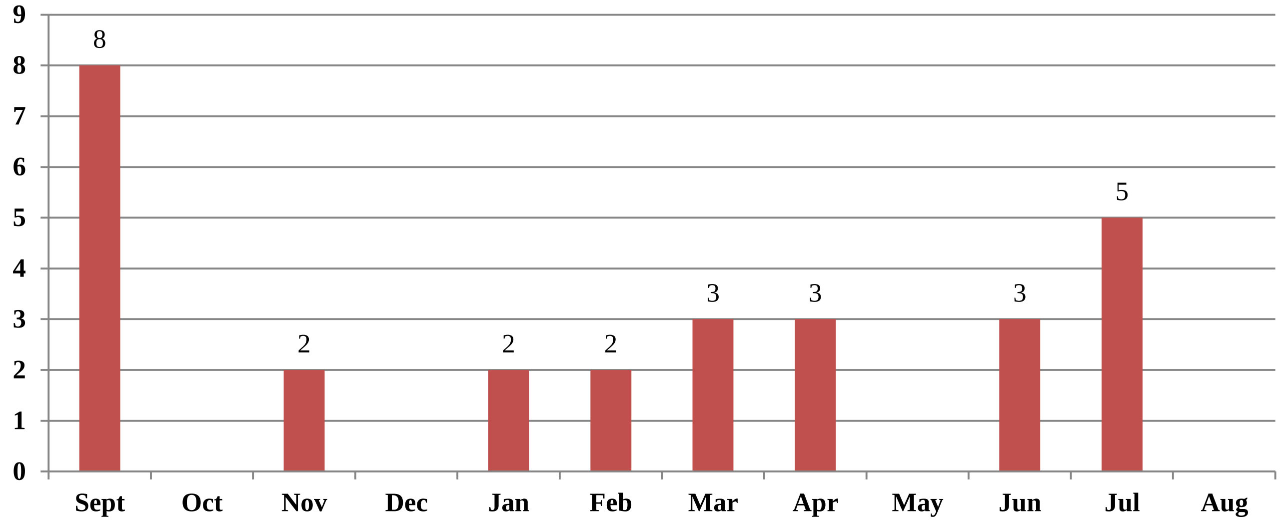
Adams analysis of Ur III water management however neglects the most challenging aspect—the seasonal fluctuation in the river’s water levels. Much attention has been paid in the available literature to the problems of high water levels coinciding with the harvest in April/May, however much less thought has been given to the problem of low water level (Adams 1981: 6 Civil 1994: 109-110, 134–135; Postgate 1992:181–182). While high water levees require extensive flood protection measures to protect the crops, fields, settlements, and water control infrastructure, low water levels are equally problematic for irrigation and more importantly for waterborne transportation. Water levels begin to drop from the end of May to the beginning of June, reaching their lowest point in September/October, which greatly impacts navigability. According to Chesney (1850: 32, 38–39), a voyage on the Tigris downstream from Diyarbakir in southeastern Turkey to Mosul in Northern Iraq (476 km) on large rafts made of 200–300 inflated skins took only 3–4 days during the flood season but nearly 15 the time of low water. In addition, boats could not draw more than 1 m of water during the months of August to November. The impact of lower waters on the rivers navigability would have been even more severe further downstream where the river’s gradient is lower.

As is shown by chart 4.1, however, grain was shipped all year round within and from Umma during the Ur III period and in particular in September, which might be related to the overall demand for seeds at the beginning of the agricultural cycle. The average capacity of cargo boats during the Ur III period varied between 30–40 tons (Sharlach: 2003: 86–90; see also Adams 2006: 140–141) and would have, when fully loaded, required a water depth that would have been lacking during the time when water levels are low. It is clear that there must have been a mechanism in place that kept water levels high enough to allow for the shipment of grain at this time of the year.

Chart 4.1

Shipment of grain (ma$_2$ še) within and from the Umma province

Sample size 28 out of 70 = 40%



How this was accomplished has so far not been understood due to the lack of a systematic study of the available evidence. The result of my study revealed that the importance of managing water levels was perfectly well understood by the inhabitants of lower Mesopotamia at the end of the third millennium B.C.. There is clear evidence that shows that the water levels in the ancient Tigris were controlled by devices very similar to the barrages documented for the early twentieth century A.D., discussed in chapter 2, section 2.3.3.1. These devices were called kun-zi-da and were located at key points of the river and its tributaries and major canals. These devices are attested in 444 references and for 113 locations in the Umma province. The high number of locations pertains to the fact that kunzidas were on the one hand barrages in the river and major tributaries, and on the other hand weirs designed to control the water flow within irrigation canals[48].

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[48] The function of a barrage is defined by the *Multilingual Technical Dictionary on Irrigation and Drainage* (*MTDID*) (International Commission on Irrigation and Drainage 1996: 2724, emphasis added), "*a barrier*, provided with a series of gates, *across the river to regulate water surface level and flow upstream and to divert water supplies into a canal*..." A"weir" on the other hand is defined as "a continuous solid, not necessarily fixed, barrier across a stream for diverting, for control or for measuring the flow" (*MTDID* 1996: 1465; 2719; 594, emphasis added). The two devices differ primarily in their location. Barrages are located in rivers and tributaries, while weirs are located in irrigation canals. While both devices serve the function of raising the head of the water, weirs are designed to do so only temporarily to facilitate the diversion of water into lower order canals or into fields. Barrages on the other hand

The location of the barrage/weir can be determined by its name. Barrages/weirs are named after rivers and canals (i_7), adjacent fields (a-$ša_3$), or nearby places such as towns (e.g., Apisal), villages/hamlets (e_2-$duru_5$), and temples (e.g. e_2-^{d}Lamma) (see appendix A, table A.1 – A.16). The naming of barrages/weirs after specific places only marks the specific location alongside a natural or man-made watercourse. The barrages of the town Apisal[49] and the village Eduru-Šulpa'e were both located at the Tigris (see appendix A). In a number of instances, the location of a particular weir or barrage is specified (see appendix A, table A.8–9) as having been located at the inlet (ka i_7) or the outlet of a canal (kun i_7). The Magur canal (see map 3), for example, was equipped with a barrage at its inlet, controlling the inflow from the Tigris, and a weir at its outlet, which allowed for the control of the water flow within the canal.

4.1.1 The Sumerian Barrage (kun-zi-da)

We know from texts that barrages, like their modern analogues, were placed in the river and posed an obstacle for river navigation. There are many references to the movement of boats and/or cargo over these barrages (Foxvog 1986: 66[50]; Steinkeller 2001: 35, fn 46), as is documented in text MVN 13 282.[51]

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are designed to raise the water level in the river more permanently to serve more than one function. One function of raising the water level by means of a barrage is to facilitate the diversion of water from the river into primary canals. Another function is to keep water levels raised more permanently to extend the period of navigability in particular in rivers with seasonal fluctuations of the water levels.

[49] Apisal has not been archaeologically identified, but there is sufficient evidence to suggest that it was located in the northeastern corner of the Umma province, and it has been tentatively identified by Steinkeller (2001: 34–35) with the site Muhallaqiyah (see map 3).

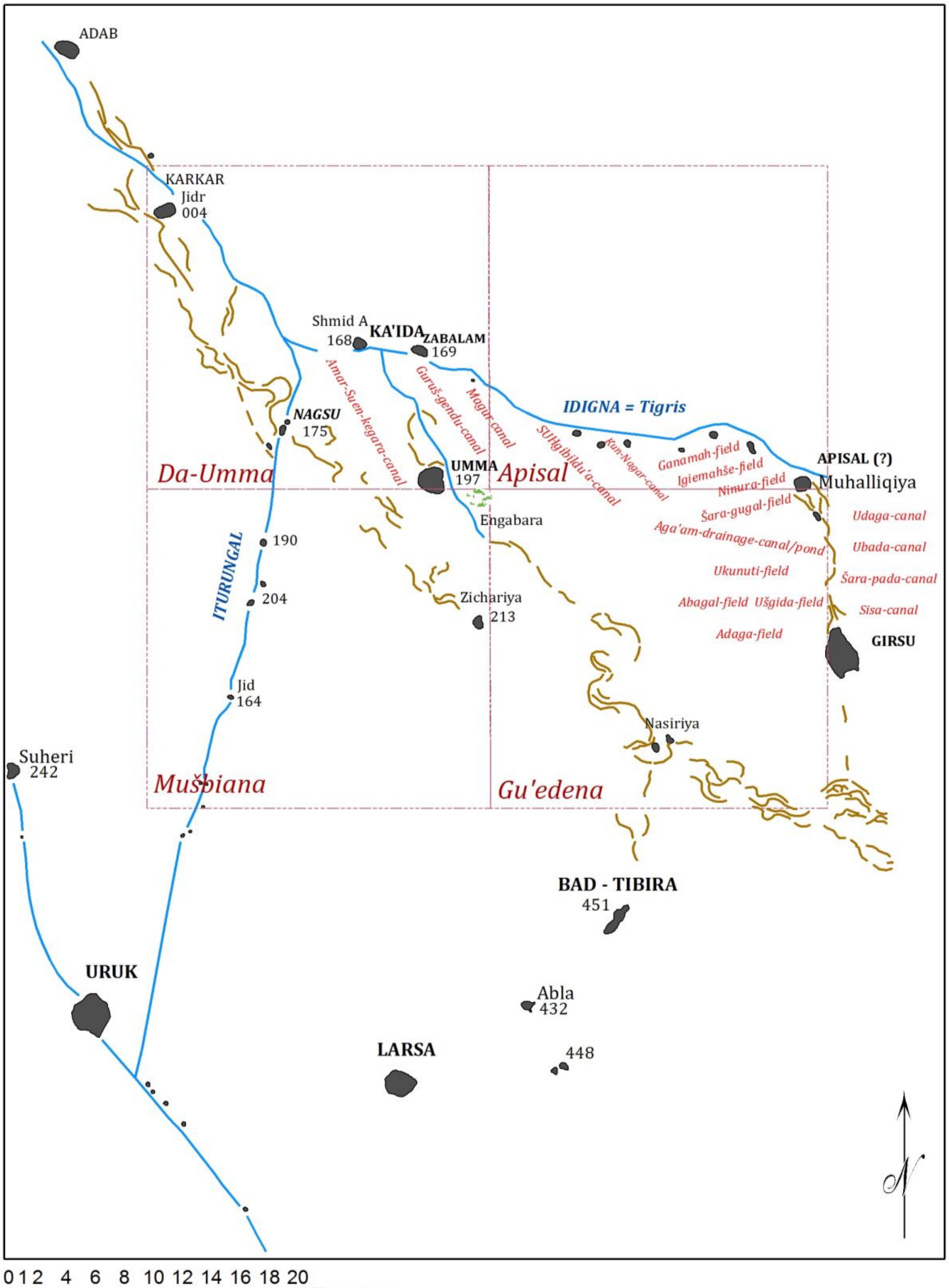
[50] Foxvog 1986: 66: "ma_2 bala a_2 refers to the transferring of a boat from one watercourse to another past weirs, locks or other barriers which blocked direct water passage." See also Steinkeller (2001: 35, fn 46; 53) who discusses this operation in greater detail.

[51] It remains somewhat unclear whether the entire boat was hauled over the barrage or whether the boatman stopped at the bank to unload the boat and transport boat and cargo further upstream—past the barrage—on foot. There is ethnographic evidence from southern Iraq (Rost and Hamdani 2011: 214, fn 19) that shows that boats of different sizes remain in the canals and that they vary in size according to the size of the canal/river they travel on. If the transportation route requires the passing of weirs, barrages, and head dams at the inlet of primary canals, only the cargo is moved from one boat to another of a different size. That the transfer (ma_2 bala-ak) took 2 days suggests that the boat was unloaded to be transferred.

MVN 13 282 ***obverse*** 1. 8 guruš u$_4$ 2-še$_3$ 2. kar-ta Gu$_2$-de$_3$-na[52]-še$_3$ 3. ma$_2$ gid$_2$-da ma$_2$ diri-ga 4. u$_4$ 3-še$_3$ še ma$_2$-a si-ga 5. u$_4$ 1-še$_3$ Gu$_2$-de$_3$-na-ta 6. kun-zi-da Maš-kan$_2$^{ki}-še$_3$ ma$_2$ gid$_2$-da *7.* u$_4$ 2-še$_3$ kun-zi-da [ma$_2$] bala-ak ***reverse*** 1. u$_4$ 3-še$_3$ kun-zi-da-ta 2. kar-še$_3$ ma$_2$ gid$_2$-da 3. u$_4$ 3-še$_3$ kar-ra ma$_2$ ba-al-la 4. še bala-a u$_3$ guru$_7$-a im ur$_3$-ra 5. ugula A-gu 6. kišib Lu$_2$-^{d}TUG$_2$.AN-ka 7. mu Si-ma-num$_2$^{ki} ba-hul Seal 1. Lu$_2$-^{d}Šara$_2$!-AN.DUL$_3$! 2. dub-sar 3. dumu Lu$_2$-^{d}Šara$_2$ 4. sag-du$_5$-ka	 **o. 1.–3.** Eight workers for 2 days (first) towed and (then) floated the boat from the harbor to Gudena **o. 4.** (then) for 3 days loaded barley into the boat **o. 5.–6.** (and then) towed the boat from Gudena to the **barrage** of the town of Maškan **o. 7.** (and) for 2 days passed the boat over the **barrage** **r. 1.–2.** (and) for 3 days towed the boat from the **barrage** to the harbor (of Umma) **r. 3.** (then) unloaded the boat in the harbor **r. 4.** (and) transferred the grain and cased the grain silo with clay **r. 5.**–7. supervisor (was) A-gu sealed (by) Lu2-^{d}TUG.AN **Year:** SS03 **Seal:** Lu-Šara-AN.DUL, scribe, son of Lu-Šara, the land surveyor

The similarities between the Sumerian barrage and those documented ethnographically become even more striking when looking at texts that document the kind of materials used in its construction.

[52] Note that Gu$_2$-de$_3$-na is just a different spelling for Gu$_2$-eden-na. The place mentioned in Text MVN 13 282 is according to Steinkeller (unpublished Ur III Umma site catalogue) a hamlet in the Gu'edena district located in the southeastern corner of the Umma province, bordering the neighboring province Lagaš/Girsu.



Map 3 Approximate locations of canals and fields in the Umma Province (districts in red)

4.1.2 Construction Materials used for Barrages/Weirs

Barrages were made of large quantities of reeds (gi) (or products of reed, such as reed mats [^{gi}kid] and reed ropes [gilim]), earth (sahar), and plant material (u_2). The use of timber is attested for 3 barrages at the Lamma Temple and the Sisa- and Ubada canals,[53] all of which were most likely located at the Tigris. The use of adobe (kin u_2 sahar-ba) is also attested for barrages but primarily for the construction and repair of weirs within irrigation canals. Furthermore, the use of earth (sahar) and plant matter (u_2) is primarily attested for barrages but not for weirs. The use of baked bricks is not attested for either.[54] The construction material used was reckoned differently depending on the kind used. Quantities of reeds are usually recorded in numbers of reed bundles (sa gi) or bales (gu-kilib),[55] while amounts of earth or adobe were given in the volume unit sar (= 18 m^3). In a few instances[56] the amount of reed is documented by the number of days spent on its transport from a specific place to the barrage (see appendix A). Amounts of plant matter (u_2) are recorded in similar fashion (i.e. Aleppo 195).[57]

Aleppo 195	
obverse	**o. 1–3**
1. 35 guruš u_4 1-še$_3$	35 workmen for 1 day carried a type of plant to the
2. kun-zi-da E$_2$-duru$_5$-Ad-da-a-še$_3$	barrage/weir of the Eduru-Adda village.
3. u_2 ga$_6$-ga$_2$	**o. 4–r. 1**
4. 11 guruš u_4 1-še$_3$	11 workmen for one day carried reeds from the
5. ga$_2$-nun ^{d}MAH-e-ni-iš-ta	storehouse of MAHeniš to the barrage of the Usur-
reverse	(canal)
1. kun-zi-da U$_3$-sur-ra-še$_3$ gi ga$_6$-ga$_2$	**r. 2–4**
2. ugula Lugal-ma$_2$-gur$_8$-re	foremen (was) Lugal-ma2-gur8-re
3. kišib Ur-mes	sealed (by) Ur-mes
4. mu ^{d}Amar-^{d}Suen lugal	Year: AS 01

[53] See text Hom. Lenoble no. 44, o.6 – r.1, r.6, which records 100 pieces of lumber for the barrage of the Sisa-canal and 60 for the barrage of the Ubada-canal, authorized by Ur-E'e.

[54] The use of baked and/or sundried bricks is only attested for a wall located above the kunzida at the inlet of the Isin canal (bad$_3$ kun-zi i$_7$-I$_3$-si-in^{ki}) in Old Babylonian texts (Walters 1970: 125–130, Text 99–105). The wall must have been substantial in size, as its construction called for 130,000 bricks and a labor force of 70 work crews (ca. 10–12 workers) working for 5 months, from June to October (Walters 1970: 125–130,137).

[55] For the sake of comparability, reed bales are converted to bundles of reeds. In most cases the number of reed bundles tied into one bale is given with the formula "n reed bundles for reed bales consisting of n bundles" (**n** sa gi gu-kilib-ba **n** sa-ta). The exact number of reed bundles can be calculated. In a number of cases, though, only the number of reed bales is given, and therefor a coefficient of 15 reed bundles per bale was used for calculating the number of reed bundles. Even though the number of reed bundles per bale can vary between 5 and 23, 15 is closest to the mean value in 78 attestations (http://bdts.filol.csic.es/, Dec. 3, 2012, search terms: "gi," "gu-kilib," "sa"). The lower numbers of 5–7 reed bundles per bale are only attested with gi-zi, which has been translated as "green reeds" used as fodder for animals (Sallaberger 1989:314; Waetzoldt 1992: 129) and has been excluded from the sample.

[56] Aleppo 195: o. 4–r. 1, UTI 5, 3108: o. 6–8, BPOA 6 0257: o. 3–6, Nisaba 23 075: o. 5–9.

[57] Text UTI 5 3334 is an exception in that it documents 60 carrying loads (gu$_2$) for the al-zi-ra plant for restoring the weir at the outlet of the Amar-Suen-adah canal.

s. # Seal illegible	s. # Seal illegible

The use of reed is only attested for fifteen major barrages, most of which were located either at the Tigris or within major tributaries (see table 4.2). With the exception of the barrage at the Gibil-canal, the amounts of used bundles were always above 1,000 and were in the five digits for the major Tigris barrages. Thus, 21,000 bundles are attested for a single repair effort of the Tigris barrage, indicating that we are dealing with quite massive structures. It is not surprising that the reconstruction of the Tigris barrage was commemorated in a year name (BPOA 2, 2477: r. 3 mu-ba i$_7$-da kun-zi-da i$_3$-gi$_4$-am$_3$ – Year: the barrage of the Tigris was restored [SH34]).

Table 4.2

Amount of reed bundles used in the construction/repair of barrages (kun-zi-da)

Name	District	Date	Publication	Reference	# reed bundles
Gibil-canal[58]	?	SS01-00-00	UTI 4 2443	o. 1–4	180
Gizi[a]	?	SS03-00-00	Princeton 2 184	r. 9–11	1230
Lamma Temple	Apisal	SS02-00-00	BPOA 6 0198	o.1–2	1400
Šara-pada-canal[59]	Apisal	SH41-00-00	SAT 2 0292	o. ii 6'–8'	1500
[village] of the gišManu-field[60]	Da-Umma / Apisal	SH41-00-00	SAT 2 0292	o. ii 2'	1720
Magur-canal[61]	Apisal/Gu'edena	AS08-01-00	BPOA 7 2277	o. 1–3	1720
Il6-[...]-?	?	SH41-XX - XX	SAT 2 0292	o. ii 9'–14'	1800
SUHgibildu'a-canal[62]	Da-Umma	SH41-XX-XX	SAT 2 0292	o.i 22 – o. ii 1'	2010

[58] The location of this canal is difficult to determine, as the word gibil simply means “new” and appears in many canals' names.

[59] YBC 15860: o. 1–3 shows that this canal was located in the vicinity of the “old” Udaga canal (U$_3$-dag-ga sumun), which was located in the vicinity of Apisal. Text Nisaba 24 10: r.ii 6–9 suggests that the canal branched off the Udaga canal (60 sar a$_2$ UN-ga6 8 1/3 sar 5 gin$_2$ / kin u$_2$ sahar-ba kin e$_2$-ta e$_3$-a kab$_2$-ku$_5$ ^{d}Šara$_2$-pad$_3$-/d[a] kun U$_3$-dag-/ga uš$_2$, “1080 m^3 volume of earth—the job of hired laborers —7.5 m^3 of adobe mixture—internal expenditure—(used) to block the flow divider of the ^{d}Šara-pada canal (located) at/and (?) the outlet of the Udaga canal”).

[60] The $^{\text{giš}}$Manu-field and the supporting settlement (E$_2$-duru$_5$-a-ša$_3$-$^{\text{giš}}$manu; see Steinkeller, unpublished site catalogue) was located in the Da-Umma district (Vanderroost 2012i: 83), but according to CST 539 also in the Apisal district, which suggests that it was located at the border of these two districts.

[61] The Magur canal branched off the Tigris in the vicinity of the Engabara, which was located east or southeast of Umma (Steinkeller 2001: 37, fn 55, 38, fn 60).

[62] The SUHgibildu'a-canal was located in the Da-Umma district, a day's boat ride from Umma (MVN 18 682), a 2-day boat ride from the threshing floor of the Amar-Suen-ki'ag field (BPOA 6 1478), and 2 days' walking distance to the Lamah field (BPOA 6 1427) (Vanderroost 2012i: 83).

Ubada-canal63	Apisal?	AS09-00-00	UTI 4 2789	o. 6 – r. 2	2460
A (?)-canal	?	IS01?]-00-00	Nisaba 24 10	r.vi 1–8	3075
Sisa-canal64	Apisal	AS09-00-00	UTI 5, 3499	r. 16–17	3600
Apisal	Apisal	AS03-00-00	UTI 5, 3421	o. 1–4	7200
Ištaran-Sisa-canal opposite of the village Luduga65	Apisal	IS01?]-00-00	Nisaba 24 10	r.v 22–30	13825
Udaga-canal66	Apisal	AS09-00-00	UTI 5, 3499	r. 7–8, r. 15	19435
Idigna (Tigris)	Apisal?	AS04-06-00	SAT 2 0323	o. 1–2	21633

There is even evidence for the use of reed mats and reed ropes, suggesting that the construction design must have been very similar to those documented ethnographically. The recorded 13,223 reed bundles used for the repair of the barrage of the Udaga canal were plaited into reed mats of 3 m^2 each. Further, text BPOA 1 0905 attests to the use of reed ropes of considerable length, suggesting that the major construction components were also big reed ropes, as described in chapter 2, 2.3.3.1.

BPOA 1 0905 ***obverse*** 1. 30 sa gi 2. 5 ^{gi}gilim gid$_2$ 12 nindan-ta 3. igi-gal$_2$ kun-zi-da 4. a-ša$_3$-^{d}Šara$_2$ a-ša$_3$-La$_2$-tur ***reverse*** 1. u$_3$ a-ša3-En-gaba-ra$_2$ 2. kišib Nam-lu$_2$-i$_3$-du$_{10}$ 3. mu us$_2$-sa bad$_3$ mar-tu ba-du$_3$ 4. mu us$_2$-sa-bi ***seal***	***o. 1– r. 1*** 30 bundles of reed for 5 reed ropes of 72 m length for the … barrage/weir of the fields ^{d}Šara, Latur, and Engabara ***r. 2–4*** sealed (by) Namlu-idu ***r. 3–4*** **Year:** SS-06-00 **Seal:** Ur-emah, priest of ^{d}Šara, the servant of Nam-lu-idu

63 Two barrages are attested for the Ubada canal, one opposite the village Eduru-Beli'arik (Nisaba 24 10: r. v. 2–7) and the other at the Eduru-kura/kuda village (Syracuse 052: o. 1–3). The Eduru-kuda village is located in the Apisal district, according to Steinkeller (unpublished Ur III site catalogue).

64 According to text MVN 16 1593: r. 1–7, 1,300 reed bundles were transported from the outlet of the Sisa canal to the barrage of the Udaga channel. They must have been located in close proximity to each other. SAT 3 1657 records the work duty performed at the barrage of the Ubada, Udaga, and Sisa canals, suggesting that they were located close to each other. Also, text UTI 5, 3108: o. 6–8 shows that the Sisa canal must have been located somewhere close to the village Du-kugsig, which was located in the Apisal district (Steinkeller, unpublished Ur III site catalogue).

65 It is not clear whether this canal is equivalent to the Sisa canal.

66 Udaga city is well attested in the archives of GARšana, suggesting that it was located nearby. In the Umma record it is only attested as a personal name and a canal name. Its inlet was located downstream of Apisal according to text UTI 4 2881: o. 12–15 (5 guruš u$_4$ 1-še$_3$ ka U$_3$-dag-ga-ta A-pi$_4$-/sal$_4$^{ki}-še$_3$ ma$_2$ gi gid$_2$-da u$_3$ ma$_2$ ba-al-la, "5 workmen for 1 day towed the boat (loaded) with reed from the inlet of the Udaga canal to Apisal"). As was the case for the Ubada canal, the Udaga canal had 2 barrages: one located opposite the tower of Nigulpa'e and the other opposite of the village Eduru-Ṣilašu (Nisaba 24 10: r. v. 21, r. vi. 12–13). This suggests that this watercourse was fairly large and might have been a major tributary of the Tigris that branched off below Apisal.

1. Ur-e$_2$-mah 2. lu$_2$-mah ^{d}Šara$_2$ 3. Nam-lu$_2$-i$_3$-du$_{10}$ 4. ša$_3$-tam arad$_2$-zu	

In addition, large quantities of earth (sar sahar) were used (see table 4.3), as well as different kinds of plant matter (see table 4.4, appendix 1.3), both of which are primarily attested for barrages made of reed.

Table 4.3

Earth volumes versus amount of reed bundles used in the construction/repair of the barrages (kun-zi-da)

Location	Date	Publ.	Line	earth (m^3)	# reed bundles
Ubada-canal opposite the village Eduru-Beli'arik	IS01?]-00-00	Nisaba 24 10	r. v 2–7 r. v 8–11[67]	2056	7148
A (?)-canal	IS01?]-00-00	Nisaba 24 10	r.vi 1–8	252	3075
Udaga-canal	SS03-00-00	Princeton 2 184	r. v 12–18	1806	13320
Ištaran-Sisa-canal opposite the village Eduru-Luduga	IS01?]-00-00	Nisaba 24 10	r.v 22–30	2399	13825
Inlet of the Udaga-canal	IS01?]-00-00	Nisaba 24 10	r. 6 –8	1474.5	17142.5

Table 4.4

Labor days for the carrying of plant material (u$_2$ ga$_6$-ga$_6$) to the barrages (kun-zi-da)

Location	Date	Publ.	Line	# work days	# men	# days
Place (?) Kinuma	SS02-00-00	MVN 16 0888	o. 1–4	**7**		
Dubla-Utu-[canal][68]	AS03-00-00	BPOA 6 1050	o. 1–4	**16**	8	2
(Ubada-canal) at the village Beli'arik	AS08-00-00	Rochester 178	o. 1–4	**24**	8	3
Udaga-canal	AS08-00-00	SACT 2 095	o. 3–5	**24**		

67 The reference found in the text Nisaba 24 10: r. v 8–11 refers to the barrage found opposite the Eduru-Beli'arik village (pad$_3$-da gaba-ri E$_2$-duru$_5$-Be-li$_2$-a-[ri-ik]). It is safe to assume that the scribe is referring to the barrage of the Ubada canal.

68 Nissen (1975: 27–28) argued that the Dubla-Utu (Dub-la$_2$-^{d}Utu, lit. "gated tower of the God Utu") was a large sluice gate, west of the city Zabalam, where the eastern Euphrates (now identified as the ancient Tigris by Steinkeller (2001) split into two branches. However, there are numerous texts that associate the Dubla-Utu with the Engabara, a marsh area located east or southeast of Umma (Steinkeller 2001: 37, fn 55). It is also more likely that the Dubla-Utu is a canal name, as it is attested with the determinative i$_7$ (see appendix C, Dubla-Utu). Even though the use of reed is not attested for the barrage/weir of the Dubla-Utu canal, the number of labor days spent on work duty (gub) there ranked among the highest. In addition, the barrage/weir of the Dubla-Utu canal is the most frequently attested, further underlining the importance of this watercourse.

Ubada-canal at the village Kura/Kuda	AS08-00-00	Syracuse 052	o. 1–3	**32**	16	2
Lamma Temple	AS08-00-00	UTI 5, 3398	r. 3	**33**		
Village Adda	AS01-00-00	Aleppo 195	o. 1–3	**35**		
Dubla-Utu	SS01-00-00	SAT 3 1241	o. 1–4	**48**	12	4
Sisa-canal	AS05-00-00	UTI 5, 3108	r. 1–4	**124**	15.5	8
(Ubada-canal) at the village Kura/Kuda	AS01-04-00	Vicino Oriente 8/1 016	o. 5–r. 2	**160**	15 17	5 5

4.1.3 Tasks Performed at Barrages/Weirs

Despite the striking similarities, there are also considerable differences between the ancient barrages and their modern analogues. These differences become very apparent when analyzing the timing of when documented construction or repair works were carried out (see table 4.5). Tasks ranged from covering the barrage with earth (coating it with adobe), restoring it, or simply being stationed at the barrage to perform any of the above-mentioned tasks. Based on the ethnographic comparative evidence we would expect that most of the construction and repair work would take place in early to late fall, when the barrages were needed to raise water for the first irrigation after sowing.

Table 4.5

Tasks performed at barrages and weirs

English	**Sumerian**	**# of reference**
restoring the barrage/weir	gi_4	45
provisioning of construction material (lit. "carrying reed, plant matter and baskets of earth" to the barrage/weir)	gi /u_2/$^{giš}il_2$ ga_6-ga_2	57
"to be assigned to do work" at the kun-zi-da	gub	210
(coating) the barrage/weir with adobe	kin u_2 sahar-ba	14
dismantling the barrage/weir (lit. "cutting/incising")	ku_5	15
Coating the barrage/weir with earth	sahar si-ga	15
blocking the barrage/weir	$uš_2$	4
Total		356

However, looking at the timing of repair or construction events reveals that work was done at the barrages all year round. This is particularly evident for the timing of work duty performed at the barrage (see chart 4.6; for details, appendix A, table A.18).

Chart 4.6

Monthly distribution of the task "stationed (gub) at the barrage/weir (kun-zi-da)"

Sample size: 51 out of 204 = 25%

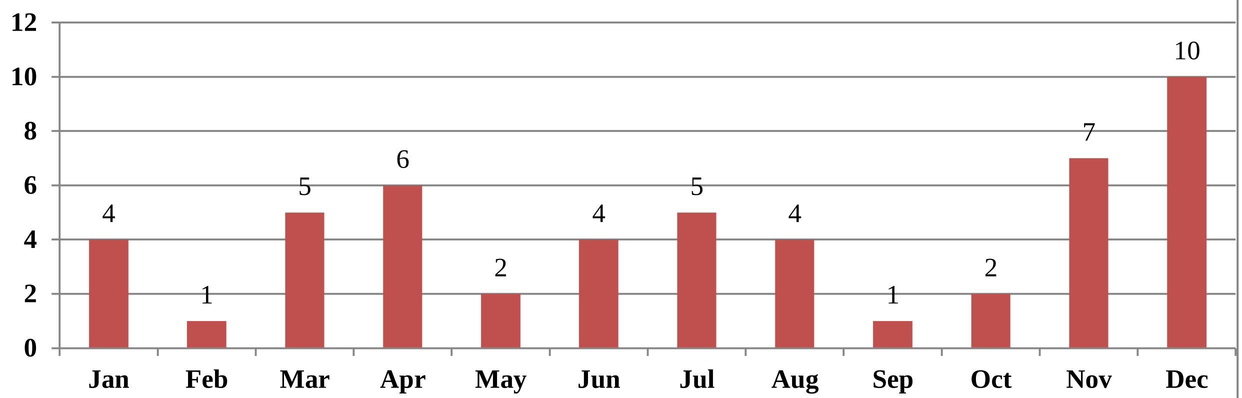
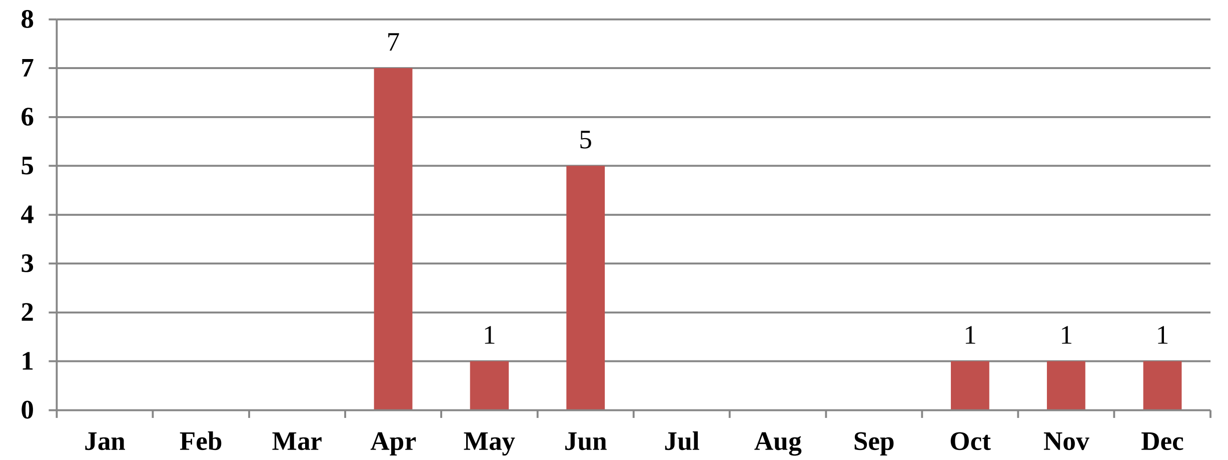


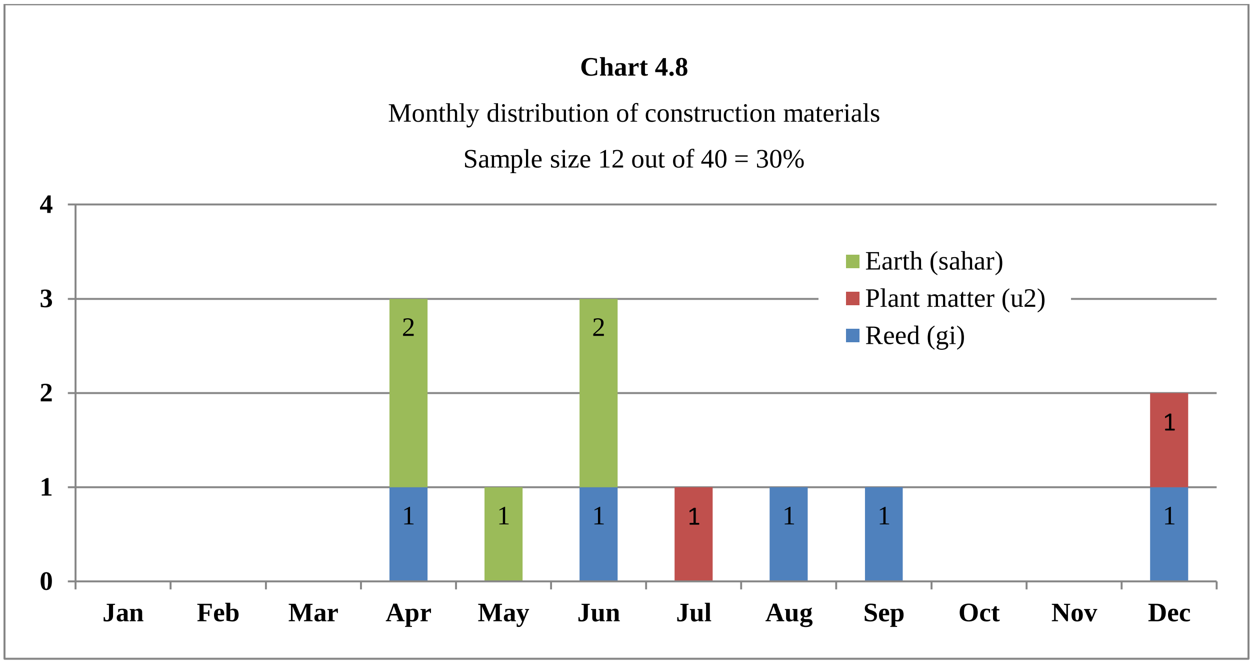
Chart 4.7

Monthly distribution of the task "restoring (gi_4-a) the barrage/weir"

Sample size: 16 out of 55 = 29%



As is also shown in chart 4.7, barrages were restored (gi_4-a) right after the flood season, when the devices would have suffered the most damage. This is also in line with the timing of the delivery of construction materials (see chart 4.8). These data suggest that the Sumerian barrages were kept permanently in the river to serve more the one function. Given the significane of waterborne transportation during the Ur III period, keeping water levels raised year round was also important to maintain the navigability of the river.



4.1.4 Context and Function of Barrages/Weirs (kun-zi-da)

The locations of some major barrages provide insight into how the control of the water levels of the ancient Tigris was realized. As can be seen from table 4.2, the majority of the barrages were located in the Apisal district and controlled the lower section of the ancient Tigris. New survey data collected by Hamdani (2008, Hamdani and Rost in prep) indicate a major avulsion point just downstream of Apisal, where the Tigris split into several branches, with the major one heading south to the neighboring province Girsu/Lagaš (see Adams and Nissen 1972: 36, fig.17, map 1). A major barrage was installed at Apisal to control the bulk water of the Tigris upstream before this bifurcation. Judging from the recorded amounts of reed bundles, the barrage at Apisal appears smaller than, for example, the Tigris barrage or the barrages of the Ištaran-Sisa and Udaga canals. However, in terms of the amount of labor invested in the course of one year, the quantity recorded for the Apisal barrage was by far the greatest (see appendix A, table A. 18). As can be seen in table 4.9, relying only on one line of evidence for establishing the relative size of a device can be misleading, as the amount of repair work must have varied from year to year.

In addition, the barrage of Apisal belonged to a subset of 8 barrages that were large enough to pose an obstacle for boat traffic that needed to be surmounted (ma$_2$ bala-ak, see table 4.10).

Table 4.9

Amount of reed bundles for the barrage of the Udaga-canal

Publication	Line	Date	# reed bundles
MVN 16 1593	o. 7–8	AS08-00-00	**1300**
UTI 5, 3499	o. 12–14, r. 7–8	AS09-00-00	**19435**
BPOA 2 2579	o. 1–3	SS02-00-00	**60**
Princeton 2 184	r. 6–8	SS03-00-00	**13714**
Nisaba 24 10	r. v 19–21	IS01?]-00-00	**10656**

The placement of a large barrage at Apisal would have made a lot of sense, as it would have effectively raised the head of the water level further upstream. Rivers and canals within a terrain as flat as southern Mesopotamia have a very low bed gradient. A barrage would have had an effect on the river's water levels upstream for a much longer stretch than in a river with a steeper gradient. In turn, long stretches of the river could have been kept free of barrages that would have obstructed boat traffic (Ertsen p.c. 2012/2013).[69] The extensive transportation of grain in the summer months, and particularly in September (see table 4.1), when water levels in the river are naturally at their lowest, suggest that water levels were sufficiently raised to allow for waterborne transportation nearly all year round.

Moreover, the fact that most of the large barrages were located *below* the main agricultural areas in the Apisal district provides a clue as to how water withdrawal from the river for irrigation was accomplished in Umma during the Ur III period. Water withdrawal for pre-mechanized irrigation systems is accomplished in two basic fashions: water flow control and water level control. One method manages the water flow, while the other manages the water level in a river. The head gate in a flow control system will always be located upstream of the irrigated area, where it diverts a specific amount of water to be used for a specific amount of land

[69] I am indebted to Dr. Maurits Ertsen, Delf Univeristy NL, for explaining and making me aware of the difference between these two water control systems. I would have otherwise not understood the significance of the concentration of the largest barrage at Apisal with regard to the functioning of Ur III irrigation systems.

to be irrigated. The control devices used in a water level control system will always be located downstream of the irrigated area, usually designed to raise and maintain the water levels in the river upstream. The device controlling the water level can be relatively disconnected from direct water use upstream and could serve more than one function. Managing the water levels in a river with great seasonal fluctuations will be beneficial for irrigation as well as for river transportation, as it extends the period of navigability.

The water levels in the ancient Tigris river would have had to be controlled again further upstream, where the damming effect of the barrages at Apisal would have ceased. There is evidence that this was done with barrages of similar size to the one at Apisal (see table 4.10).[70] The transferal of boats is attested for all barrages listed in table 4.10 indicating that they were designed to control the water level further upstream or of tributaries of the Tigris. Given our poor knowledge of the geography of the Umma province, it is not possible to determine the exact location of these barrages. However, there is evidence that suggests that the barrage at the Amar-Suen-nitum-canal,[71] at the towns Kamari[72] and Maškan,[73] were located in the Tigris. The barrage at Bad-Tibiria was most likely located in the Umma-canal, a waterway that branched off the Tigris at Ka'ida and might have extended all the way to Ur (Steinkeller 2001: 49–50, 54). The

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[70] The need for transferring boats was not restricted to barrages/weirs (kun-zi-da) but was also done at the sites of Ka'ida (14x), NAGsu and Kamsala (7x), and Namnamda (9x) and along the route from Umma to Ur (11x). Ka'ida (lit. "mouth of the canal") was located at the inlet of the Umma canals. As will be discussed in 4.2, it is very likely that this inlet was closed off by a head-dam. It is possible that similar structures obstructed boat traffic at NAGsu, Kamsala, and Namnamda.

[71] Text BPOA 1 1045: o. 1–r. 2 suggests that this canal branched off the Tigris: 4 guruš u_4 15-$še_3$ A-pi_4-sal_4^{ki}-ta $Nibru^{ki}$-$še_3$ ma_2 zi_3-sig_{15} gid_2-da i_7-^{d}Amar-^{d}Suen-ni-tum-a ma_2 bala ak ma_2 su_3 gur-ra bala $ensi_2$ $Adab^{ki}$ -$še_3$, "4 workmen for 4 days towed a boat (loaded with) flour from Apisal to Nippur; they transferred the boat at the Amar-Suen-nitum-canal and returned with the empty boat. The bala-taxation for the ensi of Adab."

[72] See Umma 097: o. 9–r. 2, which records the field Kamari as being located at the bank of the Tigris (Steinkeller 2001: 38, fn 63). According to a set of texts (Aleppo 164; BPOA 1 0957: 4–8; UTI 4 2278, UTI 5 3127), Kamari was located a 2–3 day boat ride upstream from Umma. Note that the route between Umma and Kamari upstream does not pass through Ka'ida, and a different canal or waterway must have connected these two settlements—possibly a canal branching off the Tigris near Tell Shmid.

[73] Text SAT 3 2220 indicates that Maškan was located at the Tigris, as workers first transferred a boat over the barrage of Apisal to tow the boat upstream to the barrage of Maškan. From the fact that the barrage at Apisal was located in the Tigris, it follows that the one at Maškan was as well (SAT 3 2220: o. 1–r. 7 8 guruš u_4 2-$še_3$! gi ma_2!-da la_2-a u_3 zid_2! ma_2-a si-ga; 8 guruš u_4 1-$še_3$ kun-zi-da A-pi_4-sal_4^{ki}-ka ma_2 bala-a; 8 guruš u_4 3-$še_3$ kun-zi-da A-pi_4-sal_4^{ki}-ta kun-zi-da Maš-kan_2^{ki}-$še_3$ ma_2 gid_2-da ma_2 bala ak; 8 guruš u_4 15-$še_3$ kun-zi-da Maš-kan_2^{ki} E_2-da-na-$še_3$ ma_2 gid_2-da ma_2 gur-ra; 8 guruš u_4 1-$še_3$ ma_2 ba-al, "8 workmen for 2 days bound reed rafts and piled flour (upon them); 8 workmen for 1 day transferred the boat at the barrage of Apisal; 8 workmen for 3 days towed the boat from the barrage of Apisal to the barrage of Maškan; 8 workmen for 15 days towed the boat from the barrage of Maškan to E-dana and returned the boat; 8 workmen for 1 day unloaded the boat."). Other texts record that Maškan was located 3 days upstream of Apisal (SAT 3 2220: o. 1–r. 7) and 3 days downstream of Umma (MVN 13 282: r. 1–2). On the basis of this evidence, one can establish a location somewhere in between Umma and Apisal.

location of the barrage at the [Eduru]-e'amara village, the hamlet Nanatum, and the Usur-canal remains unclear.

Taking the approximate locations of the barrages located alongside the Tigris into consideration suggests that the barrages designed to keep the water levels high were installed in the river at fairly regular intervals. The available evidence indicates that the barrage of Maškan was located at the Tigris between Apisal and Umma, and the barrage of Kamari somewhere in the vicinity of Tell Shmid or slightly further north (see map 3). According to Molina (2013: 67–68), the barrage of the Amar-Suen-nitum-canal could have been located either on the Tigris (close to Adab, see map 3) or at the Euphrates (10 km north of Nippur). Molina (2013: 68) argues for the latter solution, but I would argue for a location on the Tigris. Plotting all four approximate locations on map 3 shows that the distance between the four barrages is fairly regular—amounting to about 10 km each—which might have been the maximum distance that one barrage could control the water level of the Tigris sufficiently.

Table 4.10

Locations of barrages (kun-zi-da) that required the transferring of boats (ma_2 bala ak)

Name Barrage of/at (the)	**Publ.**	**Line**	**Date**
Amar-Suen-nitum canal	BPOA 1 1045	o. 1–r. 2	SS03-00-00
	TCL 5 5676	r. iv. 11–17	SS02-1-12-00
	UTI 4 2896	o. 11–r. 1	SS02-00-00
	UTI 5, 3455	o. 9–r. 3	SS02-12-00
Apisal (town)	BPOA 6 1402	o. 1–r. 4	SH46-12-02
Bad-Tibira (Town)	SAT 2 0844	o. 1–4	AS05-00-00
[Eduru]-e'amara (village)	BPOA 7 2239	o. 6–r. 1	AS05-00-00
Kamari (large village)	Babyl. 8 Pupil 10	o. 1–5	AS07-00-00
	BPOA 6 1014	o. 1–6	AS02-10-00
	UTI 3 1643	o. 1–. 1	SS01-00-00
	UTI 5 3416	r. 6–7	SS03-00-00
Maškan (town)	BPOA 6 1144	o. 3–r. 2	AS02-00-00
	MVN 13 282	o. 1, o. 5–r. 2	SS03-00-00
	RIAA 124	o. 1–2	SS04-00-00
	SAT 3 1396	o. 1–r. 2	SS03-08-00
	MVN 16 0753	o. 1–r. 6	XXXX-11-00
	Nik. 2 141	o. 1, r. 1–2	SS03-12-00

Nanatum (hamlet)	SAT 3 1349	o. 1–6	SS03-00-00
	UCP 9-2-2 104	o. 1–6	SS03-00-00
Usur canal[74]	Princeton 2 476	o. 1–8	SS04-10-00

4.1.5 Construction Design of Barrages

There is also evidence that the ancient barrages, just like their modern analogues, did not block an entire width of the river but had a gap allowing water to pass further downstream. The 60 m long brushwood barrages across the Euphrates River described by Mann (1921: 279) had openings 3–4 m wide. As mentioned earlier, the water levels of the Udaga canal were controlled by two barrages, one located "opposite the fortified tower of Nigulpa'e" and the other "opposite the village Eduru-Şilašu," (Nisaba 24 10: r. v. 21, r. vi. 12–13, see appendix A, Udaga canal, also Ubada canal). The specification "opposite" suggests that these barrages were located on either side of the river/canal bank and did not run across the entire width of the river or its tributaries. Further, there are four references (see table 4.11) that document the blocking of the barrage at Apisal and the barrage of the Sisa and Magur canals and the barrage/weir at the hamlet A'ura.

Table 4.11

Blocking (the opening) of the barrage/weir (uš$_2$)

Barrage of the/at	Date	Publication	Reference	# work days	# men	# days
Apisal	XXXX-**07-10** (see below)	BPOA 1 0763				
A'ura	**IS02-03-27** (June 27th)	MVN 16 0650	o. 1 – r. 1	72		
Ma[gur] canal	SH47-00-00	MVN 21 035	o. 1 – r. 1	32	8	4
Sisa canal	**IS02-03-06** (June 6th)	MVN 16 0611	o. 1 – r. 1	69		

Text BPOA 1 0763 shows very clearly that the Tigris barrage at Apisal was blocked for several months (see below). As all the references date to the summer months, it can be assumed that this was done to raise the water head during the time when water levels in the river were naturally at their lowest.

[74] The Usur canal (i$_7$-U$_3$-sur) is most likely located in the Girsu/Lagaš province, since most references derive from its archive. There are five references to its barrage in the Umma records, which might indicate that part of the canal was located in the Umma province, possibly bordering Girsu/Lagaš, as the component "sur = border" might indicate (http://bdts.filol.csic.es, accessed Nov. 10, 2013).

BPOA 1 0763	
obverse	
1. kun-zi-da A-pi_4-sal_4[ki]	**o. 1–r. 2**
2. iti nesag-ta u_4 18-am_3 ba-ra-zal-la-ta	Blocking (the opening) in the barrage of Apisal from
3. ba-ab-$uš_2$	July 18 until October 10 … tenth …
reverse	
1. iti min-$eš_3$-ta	
2. u_4 10-am_3 ba-ra-zal-la-$še_3$	
3. [...]-uš gal_2-[...]-e	
4. [...]-ku_5	

In sum, the available evidence shows that the inhabitants of southern Mesopotamia controlled the rivers' water level effectively by placing barrages at strategic points in the river to achieve the necessary water head for irrigation and navigation. However, having permanent barrages in the river obviously poses the question as to what happens during the flood. The barrages must have posed a considerable risk, as the river was more prone to overtop its levee at these locations. As has been discussed in chapter 2, section 2.1.1, geomorphological research suggests that the ancient Tigris had a more anastomosing configuration in the area of Umma and was distributed among several tributaries, which would have made both the flood and the difference between high and low water levels less severe than today. As indicated in table 2.1, the difference between high and low water in the main Tigris channel at Baghdad amounted to 2–5 m, while at a secondary channel below Amara the difference amounted only to 1.4 – 1.66 m. The fluctuation of the water levels would have been far less severe and more manageable, which would have made keeping permanent structures in the river more feasible. As *one-fourth* of the 3–4000 studied texts pertain to flood control, it is clear that it was a major concern in third-millennium southern Mesopotamia.

4.1.6 Barrages and Flood Prevention

As can be seen in table 4.12, the flood must have been particularly severe in the third and fourth regnal years of king Šu-Suen, calling for the partial or entire demolition (ku_5) of some of the major Tigris barrages. The records of the work gangs and their supervisors under the authority of Lugalemah(e), Lugal-hegal, and Lugal-nesag (see appendix D, table D.1) provide detailed insight into these events. The various work gangs were first stationed at the Tigris levee to monitor the rising water (a zi-ga gu_2 Idigna gub-ba) for a period that could last up to 2 months.[75] As the river threatened to overtop its levee, the big Tigris barrages at Apisal and Eduru- ^{d}Šulpa’e and the Sisa-canal were dismantled.

Table 4.12

Incising/cutting the kunzida (ku$_5$-ra$_2$) – barrages in grey

Name *barrage/weir* at the	**Date**	**Publ.**	**Line**	**# work days**	**# men**	**# days**
Gišaba storehouse of Gišaba	AS06-00-00	BPOA 2 2407	o. 1–4	8		
SUHgibildua canal	AS08-01-00 (April)	BPOA 1 0398	o. 4–6	15		
Dubla-Utu	AS08-00-00	JCS 24 172 94	o.i 8	26		
Kun-Nagar [canal][76]	AS05-01-00 (April)	SNAT 357	o. 1–3	10+19 **29**	10 9	1 2
				18	9	2
Idigna-Šulpa’e Tigris barrage at Šulpa’e village	SS03-00-00	BPOA 1 0894	o. 1–2	25		
	SS03-00-00	UTI 4 2728	o. 1–3	50		
	SS04-00-00	BPOA 7 2253	r. 1–2	8 **83**	4	2
Sisa canal	SS03-00-00	BPOA 1 0484	o. 5–r.2	**162**	9	18
	SS04-00-00	MVN 13 313	o. 5–6	44		
	SS04-07-00 (October)	SAT 3 1488	o. 1–4	65 109		
Apisal	SS04-00-00	UTI 5, 3077	o. 5	85	17	5
		MVN 16 0775	o. 1–2	90	18	5
		RB 92 571	r. 2–3	x 175+	x	5

The other measures taken to lower the water level in the river consisted of diverting the rising water (a zi-ga dib) via structures called “U$_3$” (see appendix D, table D.1, Lugal-nesage) as well as flooding nearby fields (a-de2, see paragraph 5.3.4).

[75] UTI 6 3810: o.i 17–o.i 20 “6 a$_2$-1/2 14 a$_2$-1/3 u$_4$-55-še$_3$ a$_2$-bi u$_4$-421 [2/3]-/kam [a]-da gub-ba kun-zi-[da] / [i]$_7$ Idigna A-pi$_4$-sal$_4^{ki}$” “6 (workers employed) half-time, 14 (workers employed only for one-third time), amounting to 421.33 labor days stationed at the water at the Tigris barrage at Apisal,” See also BPOA 6 0253; BPOA 7 2225: o.3–o.6.

[76] It is clear that the Kun-Nagar canal was somewhere close to the Engabara (see text BPOA 7 1641 (XX-06-00): o. 1–4 8 guruš u$_4$ 2-še$_3$ En-gaba-ra$_2$-ta gu$_2$ i$_7$-Kun-nagar-še$_3$ gi zi$_X$-a Lu$_2$- ^{d}Šara ga$_6$-ga$_2$ (= SIG$_7$), “8 workmen for 2 days carried cut reeds (from) Lu-Šara to the levee of the Kun-Nagar-canal”; see also PPAC 4 158: o. 1–3). However, it cannot be established with certainty that it branched off from the Tigris. BPOA 1 0603 mentions the I-sala, Kun-Nagar, and Amar-Suen-kegara canals, all of which are known to have been located in the vicinity of Engabara and the city of Umma and which were probably close to each other (see also SAT 3 1516).

MVN 21 101 ***obverse*** 1. 12 guruš [u$_4$-x-še$_3$] 2. U$_3$ i$_7$-Idign[a]-ka (=KWU_689) 3. šu ur$_3$-ra a zi-ga dib-ba 4. ugula Lugal-iti-da 5. kišib Lugal-nesag-e ***reverse*** # (seal) 1. mu us$_2$-sa bad$_3$ 2. mar-tu ba-du$_3$ ***seal*** 1. Lugal-nesag-e 2. dub-sar 3. dumu Lu$_2$-banda$_3$^{da}	 **o. 1–3** 12 workmen for x days leveling the ‘U’ of the Tigris (and) diverting the rising water **o. 4–5** supervisor (was) Lugal-itida sealed (by) Lugal-nesag(e) **r. 1–2** Year: SS05-00-00 Seal: Lugal-nesag(e), scribe, son of Lubanda

Even though the identification of the devices called U$_3$ remains uncertain,[77] two texts[78] indicate that three such devices were located in the vicinity of the village Eduru-^{d}Šulpa’e. The fact that this is also the location of one of the Tigris barrages suggests that U3 might have been a managed opening in the river levee that allowed water to be delivered into nearby depressions or wetlands if needed.

Moreover, as discussed in chapter 2, section 2.3.3.13.D, inundation canals are built-in flood protection devices, and there is evidence that they were also in use in ancient times. The excavation (ba-al) of the so-called Engabara-canal (see appendix J, Engabara), recorded in a set of nine texts (table 4.13), took place at the end of the third and the beginning of the fourth regnal years of King Šu-Sin. There are no further attestations of this canal in the Umma record, which suggests that we are not dealing with an irrigation canal, as maintenance would have eventually become necessary and would have thus been recorded. The total length of the canal only amounted to 115 m, and its construction was carried out in the month March/April. The timing of this work is, however, at odds with the overall tight labor bottleneck during that time of the year, as harvest and flood protection works had to be carried out simultaneously. Constructing a canal during that time of the year would only make sense if it served the purpose of flood control.

[77] Studevent-Hickman (2011: 43–47) suggests that U$_3$ describes the spoil bank/levee of a canal or river that is also used as a causeway (see also Steinkeller 2011: 386–387). However, the evidence presented here suggests that it is a specific location in/at the Tigris levee that allowed for diverting water as a flood prevention measure.
[78] UTI 4 2926: 1–9, UTI 3 1807: 1–8, discussed by Steinkeller (2011: 387), who follows Studevent-Hickman’s suggested translation. The two texts describe driving of a herd of cattle over a road back and forth between the village Eduru-^{d}Šulpa’e and the hamlet Ašag-Lamah. While doing so, they are crossing the three U$_3$ of the Tigris.

Text MVN 21 215 does provide dimensions of the Engabara canal, indicating that it was a wide (6 m) but very shallow canal of only 0.3 m in depth. Such dimensions are typical for inundation canals, as they are designed to only fill with water when the river level reaches a certain threshold and excess amounts are drained automatically. The name of the Engabara canal suggests that it drained into the large wetland Engabara, which was located east or southeast of the city Umma, from which most of the reed supply documented in the texts derived (see map 3). The Engabara had an approximate size of 0.92 km^2 (=264 ½ iku) or even larger (Sallaberger 1992: 123; Steinkeller 2001: 37, fn 55). It can be assumed that the Engabara canal was not the only inundation canal in the Umma province. Unfortunately, text MVN 21 215 is one of the very few texts that do provide exact dimensions of a canal, allowing for such distinctions to be made. It might be that such inundation canals were installed next to the big barrages and provided the much-needed mechanism that allowed for the control of the rivers' water level year round, while at the at the same time mitigating the risk of flood damage at these key points in the system.

Table 4.13

The construction (ba-al) of the Engabara canal

Publication	Line	Date	Total volume in m^3	Individual workload in m^3
BPOA 1 0855	o. 1–5	SS03-00-00	39.75	2.25
SAT 3 1350	o. 1–3	SS03-00-00	18	
BPOA 6 1283	o. 2–4	SS03-00-00	16.5	
BPOA 7 1790	o. 1–3	SS03-00-00	27	
MVN 16 0832	o. 3–4	SS03-00-00	69	2.25
UTI 5, 3136	o. 1–2	SS03-00-00	2.25	
UTI 4, 2755 (the barla)	o. 1–4	SS03-00-00	114.75	
MVN 21 215	o. 1 – r. 7	SS03-12-00	70	
BPOA 7 1889	o. 1–4	SS04-00-00	13.5	2.25
Total			370.75	

MVN 21 215 ***obverse*** 1. 1 nindan 4 kuš$_3$ gid$_2$ kin-bi 5/6 sar 3 1/3 gin$_2$ 2. ugula Lu$_2$-dingir-ra 3. 2 nindan gid$_2$ kin-bi 1 1/3 sar 4. ugula Lugal-iti-da 5. 1 1/2 nindan gid$_2$ kin-bi 1 sar	 **o. 1–2** 8 m length – earth volume removed was 16 m^3 (responsible) foreman was Lu-dingira **o. 3–4** 12 m length – total earth volume removed was 24 m^3 (responsible) foremen was Lugal-itida

6. ugula Šeš-kal-la 7. 1 nindan gid_2 kin-bi 2/3 sar ***reverse*** 1. ugula Lugal-ku_3-zu 2. ------------ 3. šu-$nigin_2$ 5 1/2 nindan 4 $kuš_3$ gid_2 4. 1 nindan dagal 2/3 $kuš_3$ bur_3 5. kin-bi 3 5/6 sar 3 1/3 gin_2 6. kun i_7-En-gaba-ra_2 7. ba-al-la 8. iti ^{d}Dumu-zi 9. mu Si-ma-num_2^{ki} ba-hul	**o. 5–6** 9 m length – earth volume removed was 18 m^3 (responsible) foreman was Šeš-kala **o. 7 – r. 1** 6 m length – earth volume removed was 12 m^3 (responsible) foreman was Lugal-kuzu **r. 3 – 7** In total: 36 m length, 6 m width and 0.33 m depth and the total volume of removed earth was 70 m^3 – the outlet of the Engabara canal. **r. 8–9** **Month XII (March)** **Year: SS03-12-00**

4.2 Inlet of Canals (ka i_7/ka-i_7-da)

As has been discussed so far, the watercourse management system adopted in the Umma province consisted of strategically placed barrages that allowed for controlling and stabilizing the river's fluctuating water levels to accommodate the demands for irrigation as well as navigation. The importance of waterborne transportation had an additional structuring effect, particularly on the design of canal inlets. There are numerous references to towing boats, as they travelled upstream (Steinkeller 2001), which would have required a towing path alongside the Tigris levee. As noted by Adams (2006), open inlets of primary canals and tributaries would have greatly interfered with such a towing operation. There is evidence that the inlets were closed by means of a dam that ran across the entire width of the canal opening. There is evidence that these dams were constructed in a very similar fashion as those described by Rost and Hamdani (2011: 209–214). The so-called "head-dam" or "inlet dam" was constructed from earth, plant materials, tree trunks, and reed bundles as well as reed mats. Water intake was regulated by built-in clay pipes at the bottom of the dam (Rost and Hamdani 2011: 210, fig. 4). Sealing the inlet of a primary canal by means of a dam would have resolved the conflict between the requirements of irrigation and those of towing boats. Moreover, sealed inlets were also necessary for the water level control system to work properly. With raised water levels, a major portion of the water would have been drained off through open inlets of canals and tributaries. Furthermore, sealed inlets provided the necessary flood protection.

A set of 34 texts, recording the different tasks associated with the construction/repair of a head-dam placed in the inlet of the Amar-Suen-kegara-canal[79] (see appendix B), suggests that the inlets of ancient canals were blocked in a very similar fashion to that described by Rost and Hamdani for modern times (2011: 209–214). This canal was dug during king Amar-Suen's reign, as indicated by its name: "canal established by (king) Amar-Suen" (Frayne 1997: 241– 244, see chapter 5, 5.13). This canal was located in the Umma province, probably branching off the Tigris just slightly north of Ka'ida (see map 3).[80] It remains somewhat unclear whether or not this canal was an irrigation canal. There are no documents recording the annual removal of silt (šu/šu$_2$ luh-ak) from this canal. However, as this canal appears to have been jointly managed by the royal and governor-run sectors, it is possible that the annual cleaning was carried out by the royal sector, while the construction/repair of the head-dam and the embankment/spoil bank (see chapter 5, 5.1.2) was the responsibility of the governor-run sector.

The construction of the inlet dam was probably accomplished over a period of 2–3 months in the first and second years of Šu-Sin's reign.[81] The recorded month names allow for establishing the sequence in which these tasks were carried out. The making of some type of matting (ad—ak) preceded the beginning of the construction. The term ad means raft made of

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[79] Note that this canal should not be confused with the Amar-Suen-nitum. Earlier reconstructions of the location of the Amar-Suen-kegara canals are incorrect due the confusion between these two canals (see discussion with supporting evidence in Molina [2013: 67, fn 15] and Steinkeller [2001: 57, fn 142, 84]).

[80] The location of this canal cannot be established with certainty. However, it was located in the vicinity of the city of Umma and the Engabara (see, Syracuse 069: r. 7–9: 17 guruš u$_4$ 2-še$_3$ a-ša$_3$-En-gaba-ra$_2$-ta ka i$_7$-^{d}Amar-^{d}Suen-/ke$_4$ ga$_2$-ra-še$_3$ u$_2$ ga$_6$-ga$_2$, "17 workers for 2 days carried plant matter from Engabara to the inlet of the Amar-Suen-kegara-canal"; and BPOA 1 0639: o. 1–4: 15 guruš u$_4$ 6-[še$_3$] [u$_2$]KWU_127.X zi$_X$-a (= 'šub$_5$') (=SIG$_7$) tir E$_2$-lugal-ka-ta gu$_2$ i$_7$-^{d}Amar-^{d}Suen-ke$_4$-ga$_2$-ra-še$_3$ ga$_6$-ga$_2$, "15 workers for 6 days carried cut rushes from the riverine forest of E-lugal to the levee (of the Tigris?) at the Amar-Suen-kegara-canal"). According to Steinkeller (unpublished site catalogue), the site of E-lugal was also located near the Engabara, and the 6 days of travel time might include several round trips. BPOA 7 2146: o. 1–r.1: 10+2 guruš u$_4$ 2-še$_3$ [GA]N$_2$ Ur-gu-ta i$_7$-^{d}Amar-^{d}Suen-ke$_4$-^{ga2}gar u$_2$-HAR-an ga$_6$-ga$_2$, "12 workers for 2 days carried a type of weed from Gana-urgu to the Amar-Suen-kegara-canal." [Eduru]-gana-urgu was a village located in the Da-Umma district, in the vicinity of I-sala (UTI 4 2851: o. 5–r.1) and probably south of Umma (BPOA 1 0887: o. 1–3). I would suggest that the course of this canal most likely ran somewhat parallel to the Umma canal. I would argue that it ran on the western side of the Umma canal, as the Guruš-gendu appears to have run on the eastern side of it.

[81] Even though the records from the year SS02 are not dated by month, it is fairly certain that they record the continuation of the construction project at the inlet of the canal. Two cases leave no doubt about the sequence of the tasks from blocking to filling earth into the inlet (see appendix B, table B.1). The work crews under the supervision of Adu and Ur-Nintu, whose work was authorized by Dadaga, the later governor of Umma, show that they were first involved in blocking the inlet at the end of SS01 (month XIII), and the same work crew was employed at the same spot in SS02, inserting earth into the inlet of the canal. Since much fewer texts date to the year SS02, most of the work at the inlet of the canal must have been carried out at the end of SS01.

logs bound together [82] or reed. It is possible that ad in this context describes some kind matting of bound reed or wood, that functioned as the foundation of the inlet dam. Prior to blocking (uš$_2$) the inlet (by means of constructing the head-dam), the Tigris levee on either side of the canal inlet was reinforced (gu$_2$-bi ka i$_7$ keš$_2$-ra$_2$)[83] with 620 bundles of reed. This task most likely refers to a construction technique by which the head-dam was firmly anchored into a levee of the Tigris at the inlet of the canal. After the inlet was blocked (uš$_2$), the structure built up to this point was covered with earth (ka i$_7$ sahar si-ga). The records suggest that the blocking of the inlet was done by means of layering various types of rushes, earth, and reed mattresses/assembled logs, probably in a fashion very similar to that described by Rost and Hamdani (2011: 209–211). One text stands out in the sequence of the available 34 records, providing the defining clue about the head-dam's design:

MVN 16 1016 ***obverse*** 1. 5 dug 0.0.1 5 sila$_3$ 2. ka i$_7$-^{d}Amar-^{d}Suen-/ba-gar-še$_3$ a ba-ra-a-de$_2$-de$_2$ 4. ki Lu$_2$-^{d}Utu-ta ***reverse*** 1. kišib Da-da-ga # (Seal) 2. iti ^{d}Dumu-zi 3. mu ^{d}Šu-dSuen lugal ***seal*** 1. Da-da-ga 2. dub-sar 3. dumu Ur-nigar$_X$^{gar} šuš$_3$	 **o. 1 – 2** 5 (clay) vessels of the capacity of about 15 liters (each), which are pouring out water into the inlet of the Amar-Suen-kegara canal **o.4 – r. 3** from Lu-^{d}Utu sealed by Dadaga **Month:** XII (February/March) **Year:** SS01-12-00 **Seal:** Dadaga, scribe, son of Ur-Ningar, the chief livestock manager.

The record of the delivery of the vessels dates to the month XII of the first year of Šu-Suen's reign, suggests that these vessels were installed somewhere at the bottom of the dam to function as a pipes to let water pass through the dam. This assumption is supported by the fact that the the blocking of the inlet of the Amar-Suen-kegara canal was done in the following month (month XIII). This text suggests that that the head-dam was equipped with clay pipes, just as described

[82] Based on literary evidence of king Gudea (for details, see Marchesi 1999: 105–108), there is evidence that rafts made of timber logs (mainly cedar) were floated down from Lebanon to construction sites in southern Mesopotamia. Given the scarcity of hardwood in southern Mesopotamia, most timber had to be imported.

[83] The verb keš$_2$.dr (Akk. *rakāsu*) is usually translated "to bind, to fix, to attach." In the present context I would suggest that this refers to strengthening (fixing/binding) the levee/bank with reed bundles (expressed in the ablative case prefix "ra" for inanimate things). CAD suggests a similar meaning for *rakāsu* 2: ARM 4 27:15, also 22: *ammīnim išdē Mari u Tuttul adi inanna la ta-ar-ku-ús*, "why have you not yet reinforced the foundations of Mari and Tuttul?"

by Rost and Hamdani (2011: 209–211).[84] The pipes of the ethnographic example could be blocked in order to control the inflow of water, especially during the flood season. It is conceivable this was also the case for the ancient examples, even though there is no direct evidence for that. Major repair work at the ancient inlet of the Amar-Suen-kegara canal became necessary again only 2 years later, in SS04, and even though fewer tablets regarding this operation have been preserved, the range of tasks encompass most of those that were observed in the year SS01/02, such as the making of reed mats, reinforcing the Tigris levee of the inlet with 600 bundles of reed, and removing earth from the inlet (sahar zi.g).

As mentioned earlier, numerous references to the transfer of boats (ma_2 bala--ak) prove that the inlet of the Umma canal, which gave the name to the settlement Ka'ida (lit. "mouth of the canal"), was closed off by a dam.[85] It even appears that the inlet of the Iturungal canal was controlled by a large device (see Text RA 73 034 47). The use of crossbeams suggests that the construction of this gated inlet differed from the probably much smaller inlet of the Amar-Suen-kegara canal.

RA 73 034 47 ***reverse column i*** … 7. 72 sa pa-ku_5 gu-kilib-ba 3-ta 8. 4 ^{giš}dal 20 sa ^{u2}KWU_127.ŠE_3 9. $giri_3$ Ur-e_2-diri ka i_7-En-uri_3-gal …	**r. i 7–9** 72 bundles of cut tree branches/twigs per 3 bales, 4 crossbeams (and) 20 bundles of (a type of) rush—for the inlet of the Iturungal canal under the authority of Ur'e-diri.

The Iturungal was a major tributary of the ancient Tigris of approximately 60 km in length. According to Steinkeller (2001: 41–49), it most likely branched off the Tigris just north of Ka'ida and ran in a more or less straight line via Nagsu south in order to discharge into the Euphrates just a little south of Uruk. This watercourse must have been of considerable size, as its traces are still clearly visible in satellite imagery (Pournelle 2003: 162). As an interconnection

[84] Note that there is another text, UTI 5 3124 (SS01-12-00), which records the delivery of 5 clay vessels/pipes for the barrage/weir of the Amar-Suen-ke-gara canal. The clay pipes were probably for a weir within the canal that allowed for the control of the water level without blocking the water flow entirely. It is though possible that this clay vessels in both instances were part of a water lifting device.

[85] The Sumerian term for the "inlet" of the canal is ka i_7 or ka-i_7-da. The latter is a genitive construction and attested for 13 canals (see databases CDLI and BDTNS under keyword "ka-i_7-da/ka-id_2-da"). In the case of the Umma^{ki}-canal, it is certain that this location also gave its name to a prominent settlement called Ka'ida, which was located ca. 10 km north(west) of the city Umma (Steinkeller 2001: 49–50).

between the two major rivers, the Iturungal was most certainly a major transportation artery of great economic importance, which required control of the canals' water levels, just as much as for the ancient Tigris itself. A gated inlet could have been part of such a water level regulation scheme.

Systematic analysis of the available 188 references[86] shows that inlets of major tributaries and primary irrigation canals were blocked by head-dams (e.g., the Tumal, Udaga, and Magur canals; see appendix C, table C.1). Moreover, the high frequency of references to the task of inserting earth into the inlets (sahar si.g) and the provisioning of plant materials (u_2), bundles of reeds (sa gi), and adobe (kin u_2-sahar-ba) (see table 4.14 and appendix C, table C.2, C.8, C.15) suggests that their construction design was similar to that of the head-dam of the Amar-Suen-kegara canal. Out of the inlets of 38 canals, only 6 are attested as irrigation canals (the Guruš-gendu, I-sala, I-sum, Naram-Suen, Šara, and Šara-gugal canals). As will be discussed in 5.1.1, these canals are most likely all primary canals that branched off the Tigris.

The cleaning (šu/$šu_2$ luh-ak) and the removal and collection of earth at the inlet (sahar zi.g, sahar šu--ti) probably refers to maintenance work, as sediment deposition would have been greater at the inlet of canals due to the change in water velocity (see appendix C, table C.10, C.12, C.14)

Table 4.14

Tasks performed at the inlets of canals (ka i_7)

English	Sumerian	# Ref
to be assigned to do work" at the inlet	gub	31
covering the inlet with earth	sahar si.g	23
removing earth from the inlet	sahar zi.g	9
collecting/receiving earth from the inlet	sahar šu--ti	7
cleaning/dredging the inlet	šu/$šu_2$ luh-ak	3
digging/excavating the inlet only for Ka'ida	ba-al	1
cutting/incising/opening the inlet	ku_5.dr	2
reinforcing the levee at the inlet	ka i_7 gu_2-bi $keš_2$.dr	8

[86] The number of attestations excludes the numerous references made to settlements located next to the inlets of canals (ka-i_7-da).

only at the inlet of the Amar-Suen-kegara-canal		
blocking the inlet only at the inlet of the Amar-Suen-kegara-canal	uš$_2$	6
restoring the barrage/weir at the inlet	kun-zi-da gi$_4$	4
Construction materials used		
carrying plant matter to the inlets	u$_2$ ga$_6$-ga$_2$	12
carrying reeds to the inlets	gi ga$_6$-ga$_2$	4
# of reed bundles for the inlet	sa gi	4
work with earth and plant-matter mixture at the inlet	kin u$_2$ sahar-ba	5
making a matting from bound reed or wood only at the inlet of the Amar-Suen-kegara canal	ad ak	7
twisting ropes to be used in reinforcing/tightening the inlet	gigilim sur	1
bundles of cut tree branches/twigs and crossbeams only for the Iturungal-canal	pa-ku$_5$, ^{giš}dal	1

There is one text, which records the slaughtering of a male sheep at the inlet of the Usur-magur-canal (AUCT 1 726), which might have been done at the completion of the construction of the head-dam. The slaughter of a male sheep to sanctify a construction project as well as to mark important life events (birth of a child, etc.) is still widely practiced in Iraq today. It is also related to feasting to celebrate communal efforts, such as the construction of a canal (Hamdani p.c. 2014). The inauguration ceremony of the Hindiyah Barrage in 1936 described in chapter 2, paragraph 2.3.6.1, was also commenced by the sacrificial slaughtering of several sheep (Cole p.c. 2014.).[87] The sheep were slaughtered on top of the brushwood dam that had been built to hold back the Euphrates water during the construction of the barrage.

AUCT 1 726 ***obverse*** 1. 1 udu-nita$_2$ 2. ka i$_7$-U$_3$-sur-ma$_2$-gur$_8$ šum-ma ***reverse*** 1. ša$_3$ A-pi$_4$-sal$_4$-la 2. iti RI	***o. 1 – r. 2*** Male sheep slaughtered at the inlet of the Usur-magur-canal in the Apisal (district) in the month V (August)

4.3 Maintaining the Levee of the Tigris for Human Traffic

There is no direct evidence for the existence of tow paths along the Tigris, except for numerous records on the towing operation itself. There is though a literary reference to them in the “Curse of Akkade” (line 264, 266-67): gu$_2$ ^{giš}ma$_2$ gid$_2$-da id$_2$-da-zu u$_2$ gid$_2$-da he$_2$-em-mu$_2$ gu$_2$ ma$_2$ gid$_2$-da ki a la$_2$ id$_2$-da-zu seg$_9$-bar mul muš ul$_4$ kur-ra-ke$_4$ lu$_2$ na-an-ni-ib-dib-be$_2$ “may tall

[87] I am very indebted to Camille Cole for sharing this information with me.

grass grow on the banks of your canals where boats used to be towed! On your tow paths, the place where water used to be hoisted, may antlered (?)[88] deer and speedy snakes of the mountains allow no one to pass!"[89]

Given the heavy traffic the river levee (gu$_2$ i$_7$) must have experienced from towing operations but also other uses (e.g., pedestrians, animals, carts), maintenance must have become necessary (see appendix D). There are 108 references recording tasks performed at the Tigris levee related to its management (see table 4.15).[90] Next to flood watch (a zi-ga, a-da gub, see 6.3.2), the second most frequently recorded task is the transportation of large quantities of reed to the river's levee, without any indication of it being shipped somewhere else (e.g., 1,060 bundles; see BPOA 7 2326, AS 06). Large quantities of reed were also kept in storehouses, whose location is specified as having been situated at the levee of the ancient Tigris (ga$_2$-nun gu$_2$ Idigna). While the stored reed bundles were probably used for all kinds of construction projects, those transported to the river levee were most likely used for its maintenance—possibly reinforcing the river levee and/or pathways alongside it.

Table 4.15

Tasks performed at the Tigris in Umma

English	**Sumerian**	**# Ref.**
stationed at the rising water of the Tigris	a zi-ga Idigna gub	24
stationed at the water of the Tigris	a-da gub gu$_2$ Idigna	12
carrying reed / reed bundles to the bank of the Tigris	gu$_2$ Idigna-še$_3$ gi ga$_2$-ga6	13
carrying reed bundles to the storehouse at the bank of the Tigris	ga$_2$-nun gu$_2$ Idigna-še gi ga$_6$-ga$_2$	3
carrying reeds from the bank of the Tigris to the storehouse	gu$_2$ Idigna-ta ga$_2$-nun-še$_3$ gi ga$_2$-ga$_6$	3
building the storehouse at the Tigris	ga$_2$-nun gu$_2$ Idigna du$_3$	1
carrying twigs to the bank of the Tigris	gu$_2$ Idigna-še pa-ku$_5$ ga$_6$-ga$_2$	1
carrying straw to the bank of the Tigris	gu$_2$ Idigna-še in-u ga$_6$-ga$_2$	1
carrying sesame/grain/reed to the riverbank to be shipped	gu$_2$ Idigna-še$_3$ še/ še i$_3$ ga$_6$-ga$_2$	6

[88] Cf. si-mul "antlers" (usually a$_2$-muš).
[89] I am indebted to Professor Steinkeller for making me aware of this passage and making his transliteration and translation available to me, May 2015.
[90] This number excludes numerous texts on works related to waterborne transportation, such as towing operations (gid$_2$) as well as moving boats over obstacles (ma$_2$ bala-ak) (see Steinkeller 2001). The number also excludes forest operations in the riverine thickets along the ancient Tigris (tir gu$_2$ Idgina) (see Steinkeller 1987b).

cleaning the riverbank	gu_2 Idigna šu luh-ak	1
leveling the riverbank	gu_2 Idigna šu ur_3-ra	1
making the U of the Tigris opposite of Ukunuti	uku_2-nu-ti bala-a-ri U_3 Idigna-bi ak	3

There is evidence for the use of bound reed to maintain pathways alongside fields (see appendix F). The maintenance consisted of placing either loose or bound reed (gi $keš_2$-ra_2) as well as green/young reeds (gi zi) on the path. It is conceivable that tow paths were maintained in a very similar fashion.

Hirose 318 **obverse** 1. 23 guruš hun-ga_2 2. gi zi_X-a 15 sar-ta (=SIG_7) 3. 12 1/2 guruš gi $keš_2$-ra_2 $giri_3$!-$še_3$ nu_2-a **reverse** 1. a-$ša_3$-Gi-apin-ku_5-ra_2 2. šuku $ensi_2$-ka 3. ugula Šu-ma-am_3 4. $kuru_7$ u_4 6-kam 5. iti e_2-iti-6	**o. 1–2** 23 hired laborers cut reed per 540 m^2 (per workmen) **o. 3–r.2** 12.5 workers bound reed and laid it onto the path (running alongside) the Gi'apin-kura-field **r. 2** the subsistence field of the governors supervisor was Šuma'am inspections made on the 6^{th} day of month VIII (August)

4.4 Maintaining Levees of Tributaries and Canal Embankments for Traffic

The maintenance of levees is also attested for a number of other watercourses (see table 4.16 and appendix E). The term gu_2 describes the naturally formed levee and is normally not used to refer to spoil banks of irrigation canals (eg_2 i_7).[91] There are 22 waterways for which a levee (gu_2) is documented (appendix E, table E.1), and only the dimensions of the levee of the Šulgi canal is known (OrSP 47–49 511: o. 14 – r. 2), which was 9 m wide and 2.5 m high. When looking at the available references, the range of tasks performed at the levees of watercourses is very similar to those tasks performed at the Tigris (see table 4.13 and table 4.16). The provisioning of reed is here also very prominent, suggesting that it might refer to pathways running alongside their levees.

[91] The Guruš-gendu, I-sala, and Kun-Nagar canals are also attested with a gu_2, which poses a problem, as a canal could have only had an embankment (eg_2 i_7) or a levee (gu_2)—but not both (see appendix E). However, since the I-sala and Guruš-gendu canals (and perhaps also the Kun-Nagar) branched off the Tigris, it is also possible that gu_2 in that context actually refers to the Tigris's levee and not the canals' levee. This interpretation is supported by the records on the construction of the head-dam in the inlet of the Amar-Suen-kegara canal, discussed in section 4.2. The dam is anchored into the Tigris levee even though in one instance this particular spot is only referred to as a levee (gu_2) of the Amar-Suen-kegara canal (see appendix B).

Table 4.16 Tasks performed canal banks		
English	**Sumerian**	**# References**
carrying reed to the canal bank	gu_2 i_7-CN-$še_3$ gi ga_6-ga_2	7
reed bundles for the canal bank	sa gi gu_2 i_7-CN	3
# reed bundles in the storehouse at the canal bank	sa gi ga_2-nun gu_2 i_7-CN	2
leveling the canal bank	gu_2 i_7-CN šu-ur_3-ra	5
earth for the canal bank	gu_2 i_7-CN sahar	4
carrying plant material to the canal bank	gu_2 i_7-CN-$še_3$ u_2 ga_2-ga_6	3
transporting grain/reed to the river bank for shipment	še ga_6-ga_2 gu_2-i_7-$še_3$	7
cutting plant material at the riverine canal bank	tir gu_2 i_7	7
loading cut reed ?	gi bal-a	2
stationed at the canal bank	gu_2 i_7-CN gub	1

4.3 Summary

To sum up, this chapter showed that the watercourse management system adopted in the Umma Province rested upon an intricate system of managing the fluctuating water levels of the ancient Tigris basically only with reed and mud. This entailed, on the one hand, raising the water levels throughout the year by means of large barrages in the river and, on the other hand, diverting excess water during the flood to prevent the river from overtopping its levee. This was accomplished by inundation canals, flooding fallow fields, and managed breaches in the levee. Monitoring the water levels by work crews over extended periods of time was essential for this system to function. Furthermore, closed canal inlets provided the necessary flood protection for irrigation systems, fields, and settlements. On the other hand, it also allowed for the water levels to be raised without water draining off into tributaries and canals. From a managerial point of view, the water level control system requires less oversight with regard to water distribution in comparison to a water flow control system. The raised water levels in combination with the head-dams equipped with pipes allowed for water withdrawal at any point of the year without interfering much with downstream users. Given that two largely independent entities (the royal and governor-run sectors) made use of the Tigris River, managing the water level of the river was the most cost-effective method of regulating water distribution up to the inlet of the primary canals. As will be shown in chapter 7, even though the state did regulate water disputes, these were fairly rare and might be indicative of the success of the watercourse management system.

Chapter 5 Watercourse Management: Irrigation

The Ur III documents from the archive of Umma are by far the most comprehensive record on irrigation management in antiquity. These records have so far never been systematically studied, possibly due to the general conviction that very little progress could be made in understanding the content of these texts in the absence of relevant archaeological data. The lack of archaeological data is indeed a serious impediment and a detailed reconstruction of the irrigation systems and related water control devices mentioned in the texts could not be accomplished so far. However, the systematic study of the textual records permitted a more accurate translation of the Sumerian termini technici pertaining to water control facilities. This allowed us to gain a more coherent picture of Ur III irrigation and a general sense of the size, layout and technical complexity of the irrigation systems in use in the Umma province. In turn, a more precise identification of the tasks mentioned in the texts became possible which was crucial for the assessment of the degree of centralization adopted in the management of irrigation in Umma.

As has been outlined in chapter 1, 1.3, I adopted a task based approach to assess the degree of centralization in irrigation management. I argued that the management of an irrigation system was highly centralized if all necessary tasks were organized by state officials and carried out by state financed laborers. In a less highly centralized system, certain tasks or certain sections of the irrigation system are managed by the farmers without state interference. Analyzing which tasks are recorded in those state documents allowed the determination of the degree to which the state controlled and managed all tasks related to irrigation, and to which level of the irrigation system (e.g., primary or secondary canals) state control extended. In order to understand what the operation of an Ur III irrigation system entails a better understanding of their layout is needed.

Due to the lack of more fine-grained archaeological data, the reconstructions of the irrigated landscape are mainly based on information derived from texts and ethnographic analogies. In general terms, Postgate's (1992: 173–177, fig. 9.1) and Wilkinson's (2013: 43) reconstruction of the Sumerian agricultural landscape consists of three basic zones (fig. 5.1): (1) Orchards, consisting of date palms, fruit trees,[92] and vegetable plots were found on the levee crest next to the main river channel which is also the most fertile ground in Southern Iraq. The shade of date palms provides a cooler microclimate, allowing for higher moisture levels to be retained in the soil, which is beneficial for the cultivation of fruit trees and heat-sensitive vegetables directly underneath them. In addition, the intercropping maintains, and may even enhance, soil fertility. Date palms, fruit trees, and vegetables in particular require frequent irrigation, which is accomplished by drawing water either directly from the river by means of water lifting devices or from wells (Charles 1988: 24, 39, table 8). Zone (2) consists of the grain fields on either side of the levee slope that are irrigated by gravity flow canals, which run perpendicular to the levee slope. Zone (3), according to Wilkinson (2013: 43), consists of a "mosaic of steppes, marshes, fallow fields and alluvial desert steppe beyond the main levees. […] This zone would have supplied grazing, fishing, game birds, reeds and other marshland resources" (see also Pournelle 2007). This land use is also documented in ethnographic sources (Fernea 1970, Salim 1970) as well as agronomic studies (Poyck 1962; Wirth 1962).

The descriptions offered by Postgate, Wilkinson, and others often neglect the presence and the importance of the riparian forests found along major rivers. A concise and very informative overview of the riparian forest of Iraq (Arab. *ahrash*) was done by Margaret C. Brandt[93] in a graduate seminar paper in 1982 at the University of Chicago. She notes that these riverine forests consisted of a narrow band of jungle-like vegetation, consisting of various grasses, thorny shrubs (e.g.,licorice, *shōk,* camelthorn, and *Zizyphus*) and trees (e.g., Euphrates poplar [*Populus euphratica*], willow, and tamarisk). The local population would mainly harvest poplar wood for boat building but also licorice root, which was traded all over Iraq (see also Great Britain 1944: 190). Steinkeller's (1987b) study "The foresters of Umma" showed that these riverine forests were systematically exploited and managed also in ancient times and in particular for their timber (e.g., poplar [^{giš}asal$_2$], willow [^{giš}ma-nu], etc.), but also for various species of grass and probably wild licorice (gazi). The wood was mainly used in the manufacture of tools (e.g., hoes and plowshares), while poplar was made into roof beams or planks for boats (Steinkeller 1987b: 91–93). The various

[92] See list of fruit trees in modern times Wirth 1962: 55 ff.

[93] I am very indebted to Margaret Brandt for so generously sharing her graduate student work with me and also allowing me to use her information in this dissertation.

types of grasses were collected to be used as either fodder or basketry materials. The riparian forests were also an important source of construction materials for water control devices (see chapters 4–6). In particular, willow (^{giš}ma-nu) might have been used in the construction of fascines[94] (Steinkeller 1987b: 91).

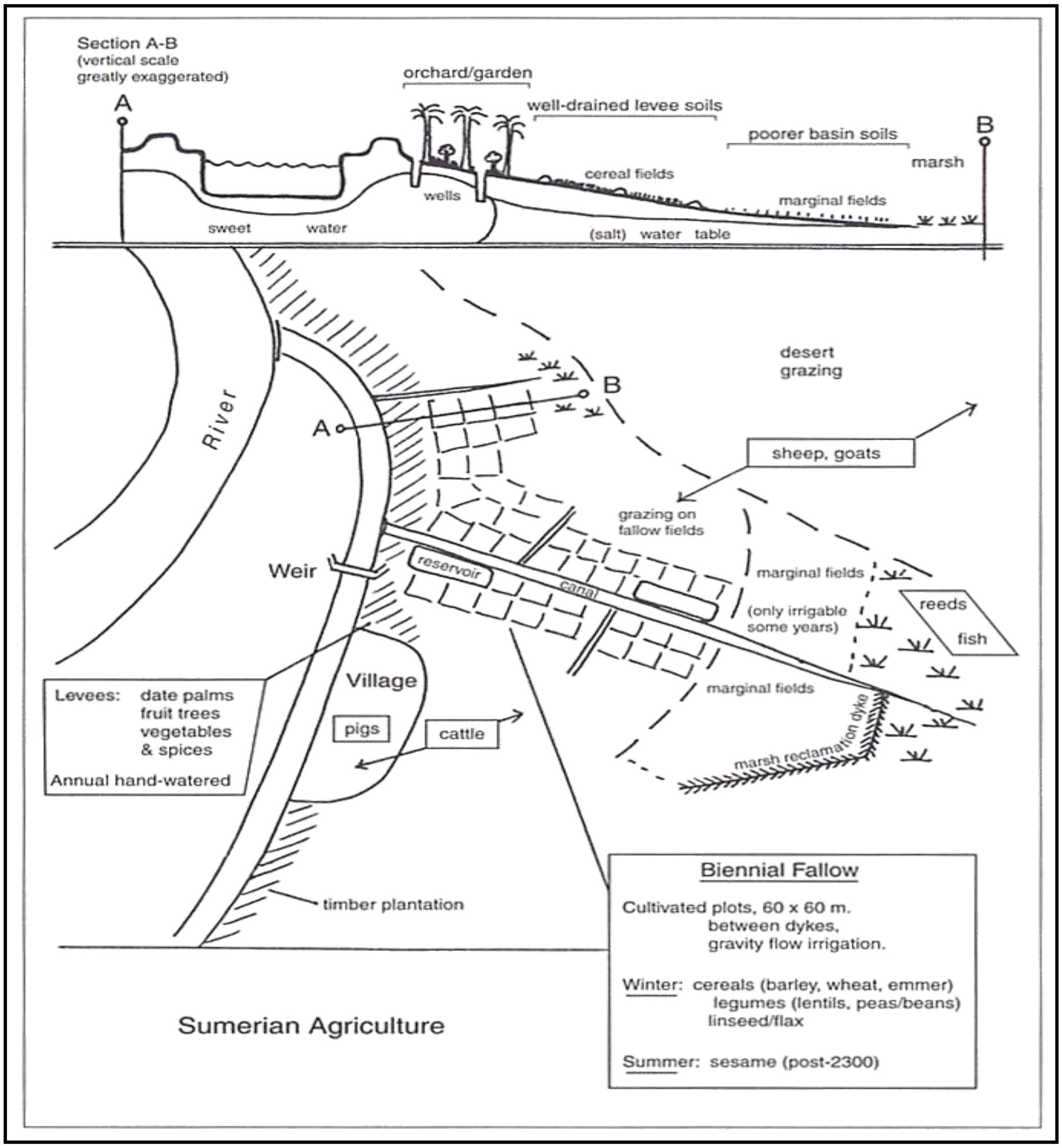


Figure 5.1 Sumerian Agriculture (Wilkinson 2003: 92, fig. 5.9 after Postgate 1992: fig. 9.2)

[94] A fascine is a bound bundle of brushwood or reed that is used to strengthen earthen structures or the bank of a water course to protect it from erosion (International Comission on Irrigation and Drainage 1967: 174).

5.1 Reconstruction of the Layout of Sumerian Irrigation Systems

The more detailed reconstruction of the agricultural landscape and irrigation systems derives from the study of Ur III cadastral texts[95] (Liverani 1990, 1996; Maekawa 1992a) that record the dimensions of individual fields. The results showed that the agricultural landscape in southern Mesopotamia was dominated by elongated rectangular fieldstrips. The average length of a field varied from 900 to 2700 m with an average width varying from 100 to 300 m (Liverani 1990: fig. 5). The average size of the majority of fields ranged from 32 to 49 ha. Taking the average levee width (2–6 km) into consideration, the elongated side of a field corresponds to the levee slope on either side of the main watercourse. A precise reconstruction of field blocks and in particular how individual fields were arranged with respect to each other is more difficult, since the text focuses more on the administrative components than on the actual physical layout of the field. In other words, in the written record the field shape is perceived as a neat rectangle of the standard size of 6 bur_3 = ca. 39 ha. Deviation from the standard form and size due to topographic variations in the landscape is expressed as "parcels to be added" (bar) and "parcels to be subtracted" (ki[-zi]). Since it is often unclear from which ends of an individual field these areas were subtracted or added, it is difficult to obtain a precise plan of a single block of field units (Maekawa 1992b: 415). The details of the irrigation system closer to the field level remain somewhat obscure and all reconstructions remain tentative.

Liverani (1990: fig. 5, see fig. 5.2) and Maekawa (1992a, see fig. 5.3) both proposed various layouts of the Sumerian irrigation system at the field level. Liverani's (1996: 18, fig. 10) reconstruction consists of various field shapes arranged in various directions to account for topographic differences. His reconstruction is close to the modern Iraqi agricultural landscape, as can be seen in Google Earth imagery from 2002 around Nasiriyah. Liverani's reconstructed fields were watered from the short, front side adjacent to the canal (Liverani 1996: 17).

[95] According to Maekawa (1992a: 180–181), field surveys were done at different times of the year. Text BM 26200 (ASJ 14 225 77), for example, documents the survey of an agricultural area of ca. 2050 ha in the province of Girsu/Lagaš in the year Šu-Sin 02 at the beginning of the agricultural season. The survey was probably done to estimate labor requirements for the cultivation of the individual fields. The so-called "round tablets," also from the Girsu/Lagaš province (Pettinato 1967i,ii; see also Liverani 1990, 1996), document a survey that was done prior to the harvest to estimate the yield (Maekawa 1992a: 180–181, 1992a: 407).

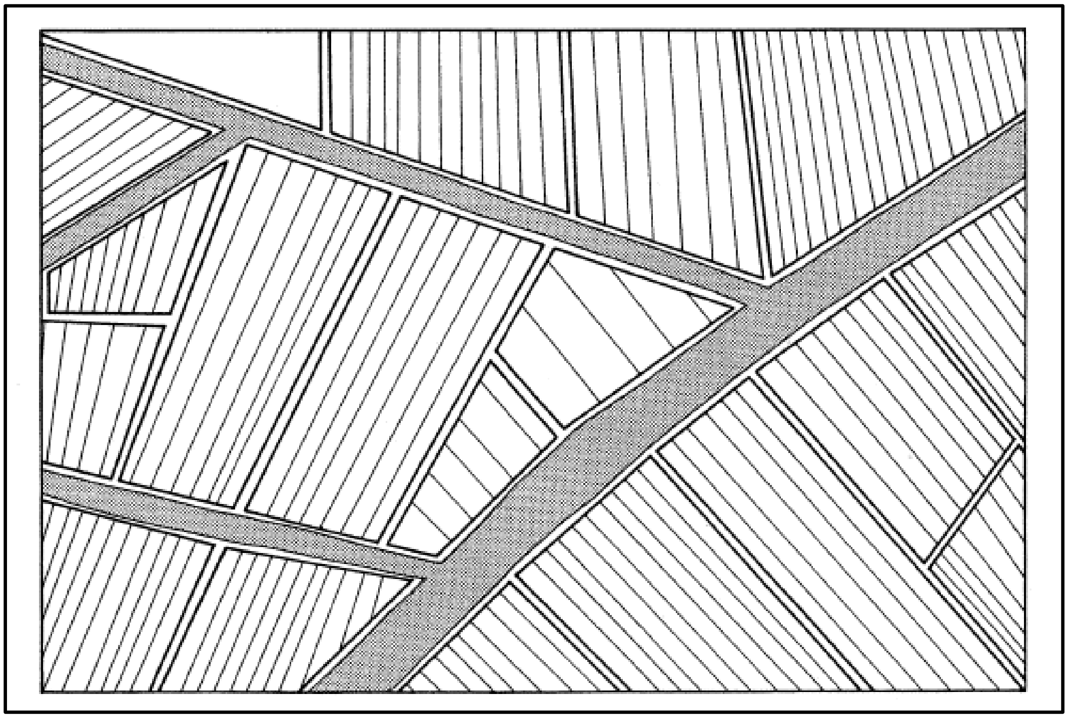


Figure 5.2 Liverani's fictional reconstruction of irrigated landscape in southern Mesopotamia (Liverani 1996: 18, fig. 10).

Maekawa (1992b: 410–411) suggests a different reconstruction of the layout of the irrigation system based on evidence from the Girsu/Lagaš province. In his view, there are two possible scenarios (see fig. 5.3): In chart 1 the field units are arranged diagonally, and in chart 2 perpendicularly, to the direction of the main watercourse, the so-called "Canal going to Nina" connecting the main cities of the Girsu/Lagaš province: Girsu, Lagaš, Nina, and Gu'abba (Rost 2011). Chart 2 is prefered over 1, as these elongated fieldstrips had to be further subdivided by smaller order canals due to the hydrological properties of furrow irrigation, which was practised in Mesopotamia at the time.

The furrow width (furrow ridge to furrow ridge) documented in 3rd-millennium texts from Nippur, Umma, and Girsu/Lagaš ranged from 0.5 to 0.75 m (Pettinato and Waetzoldt 1975: 278–279). The length of a furrow is limited, since water can only travel over a certain distance at a relatively low gradient (less than 0.5%). At a furrow depth of 0.75 m the furrow length can be 400 m, while at 0.5 m depth the furrow length can only be 280 m (Brouwer 1985: 3.4; Kay 1986). An elongated fieldstrip of 1–2 km would have had to be further subdivided by secondary canals, that supplied water for the irrigation furrows. There is evidence of minor canals (pa_4-a-da-ga) with a length of 300 m, a width of 0.5 m, and a depth of 0.25 m (Waetzoldt 1990: 8).[96] The length of these minor canals corresponds well to the width of the individual elongated field strips. In addition, the verb a-da-ga is possibly a syllabic spelling for a-du11-ga (watering/irrigating).[97]

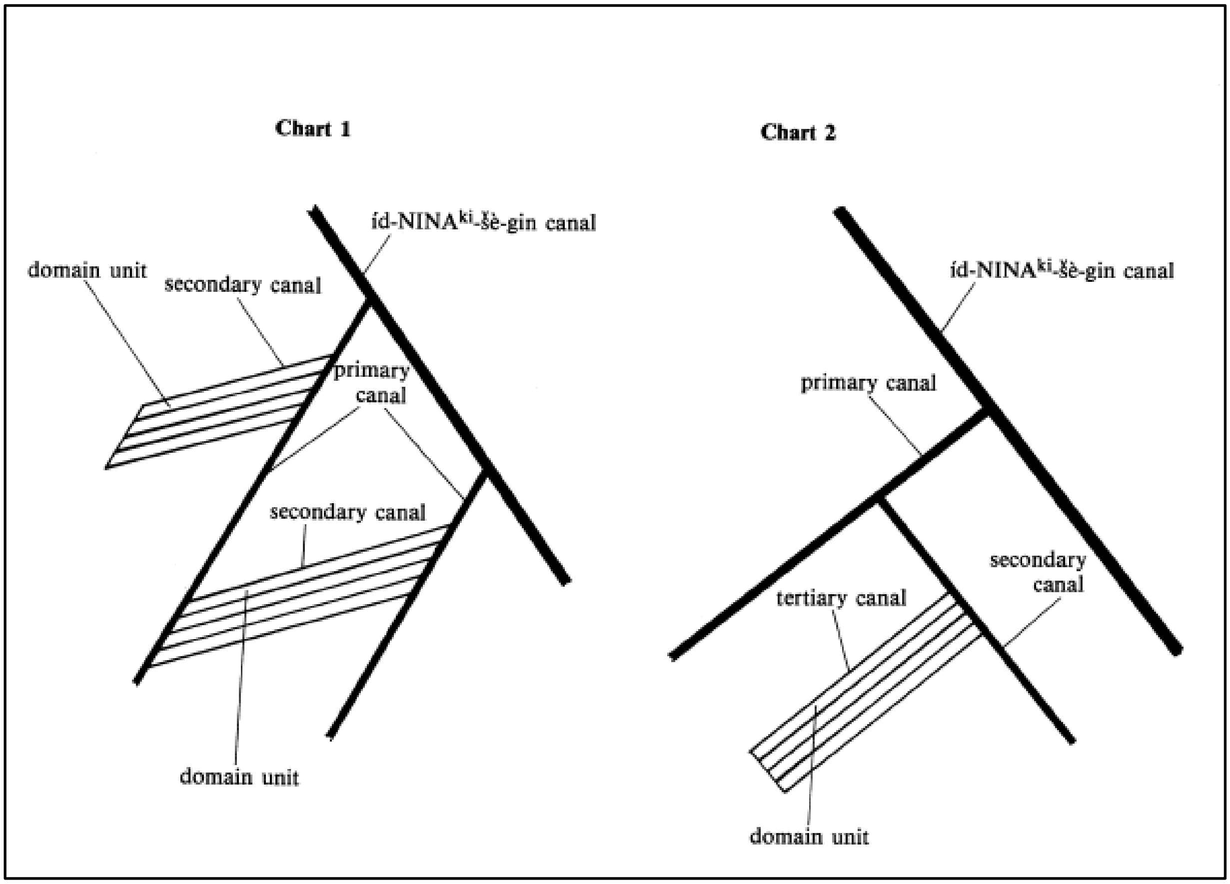


Figure 5.3 Layout of irrigation system in Ur III Girsu/Lagaš based on the cadaster text "round tablets" (Maekawa 1992a: 411).

The literate translation of pa_4-a-da-ga would be "watering/irrigation canal" which corresponds well with the function of these canals of supplying water directly to the fields

[96] Note that the size of lower-order canals (pa_5 sig) documented in Old Babylonian mathematical texts is greater, with length ranging from 1.8 to 2.16km, width ranging from 1 to 1.5m, and depth ranging from 0.5 to 0.25m. This might either indicate a difference in the layout of Ur III versus Old Babylonian irrigation systems or a difference in the use of the irrigation terminology.

[97] It is possible that some of the minor canals may have run on top of the low earth walls surrounding a field plots, as has been documented ethnographically by Fernea (1970: 122). According to Hamdani (p.c. March 23, 2015) such canals are very rarely used in modern times, since their construction is labor intensive. However, if the fields are at great distance to the river such canals might become necessary to achieve the necessary flow velocity to transport water over a great distance. According to Steinkeller (1988: 73–74), the noun pa_5 could describes such a canal as the cuneiform sign of pa_5 is a compound of the sign eg_2 "dam" and pa_4 "minor canal/ ditch". This also suggests that in certain instances the noun eg_2, which generally describes "dam/dike" might describe a canal on top of an earthen wall.

(Steinkeller p.c. March 23, 2015, see also). There is no direct evidence of the exact subdivision of these elongated fieldstrips. Maekawa (1992a: 412) however argues for a subdivision of the field strips of 1 iku (= 0. 36 ha or 60 m x 60 m), a parcel size that is very similar to those I observed in the Nasariya area in winter 2012/2013, which were 50 m x 50 m.The modified reconstruction of the late third-millennium irrigation systems by Maekawa would have had a herringbone pattern layout consisting of a main water channel at the center and primary canals arranged perpendicular to it at regular intervals, running from the levee's crest to the basin. Following this reconstruction, late 3rd millennium B.C. irrigation systems would have been two tired with primary and secondary canals. It is however conceivable that small feeder canals ran parallel to the secondary canals to provide water for the irrigation furrows.

Such a system was observed in the central alluvium area just south of Baghdad in satellite imagery by Hritz and Pournelle (in press, fig. 5). The system was located on top of an ancient Euphrates levee already observed by Adams (1981). The traces of fields were very similar to those recorded in texts (1.3–2 km long, 150–300 m wide = 35–39 ha). The sites associated with the system date to the 3rd to 1st millennia B.C. Since a ground check is still pending, the result of the satellite imagery analysis has to be regarded as preliminary. Wilkinson (2013: 42–45) suggests that this type of system was characteristic of the early forms of irrigation management in southern Mesopotamia. He argues that these systems were small in size in comparison to the later large-scale imperial systems of the Sassanian Period. Such a system could have been constructed and managed by a kin-group while the larger imperial systems were more dependent on state finances at least for their construction. Imperial irrigation systems, due to their size, also adopted a more dendritic outline to supply distant agricultural areas with water. This required large-scale engineering projects to overcome obstacles in the local topography (overland canals, aqueducts, etc.). While these construction projects are likely to have been financed and administered by the imperial state, there is no reason to assume that the day-to-day management of these systems was state run as well (Wilkinson et al. 2012: 158). While I do not disagree with Wilkinson's argument, the results of chapters 4–7 indicate that the size of an irrigation system does not allow us to predict the level of state involvement in construction and management. As this chapter will show there is clear evidence that the systems recorded in the Ur III administrative texts from Umma were entirely centrally managed on the level of the province in the governor-run sector.

As will be shown below there is also an indication that the irrigation systems in Umma were slightly more complex with primary canals up to 8 km in length.

5.2 Irrigation Systems in Umma

Beyond the above offered schematic reconstruction of Ur III irrigation systems, an exact description of the layout of the systems in use in Umma could not be accomplished. This is in part due to the fact that Sumerian does not distinguish between natural and man-made canals and between canals of various sizes (i_7). Moreover, only in very rare cases do texts provide exact dimensions of canals, such as the length, width, and depth. Otherwise, only the relative size can be established based on the volume of earth removed during construction or cleaning operations or based on the size of associated water control facilities (e.g., barrages/weirs [kun-zi-da] and flow dividers [kab_2-ku_5]).

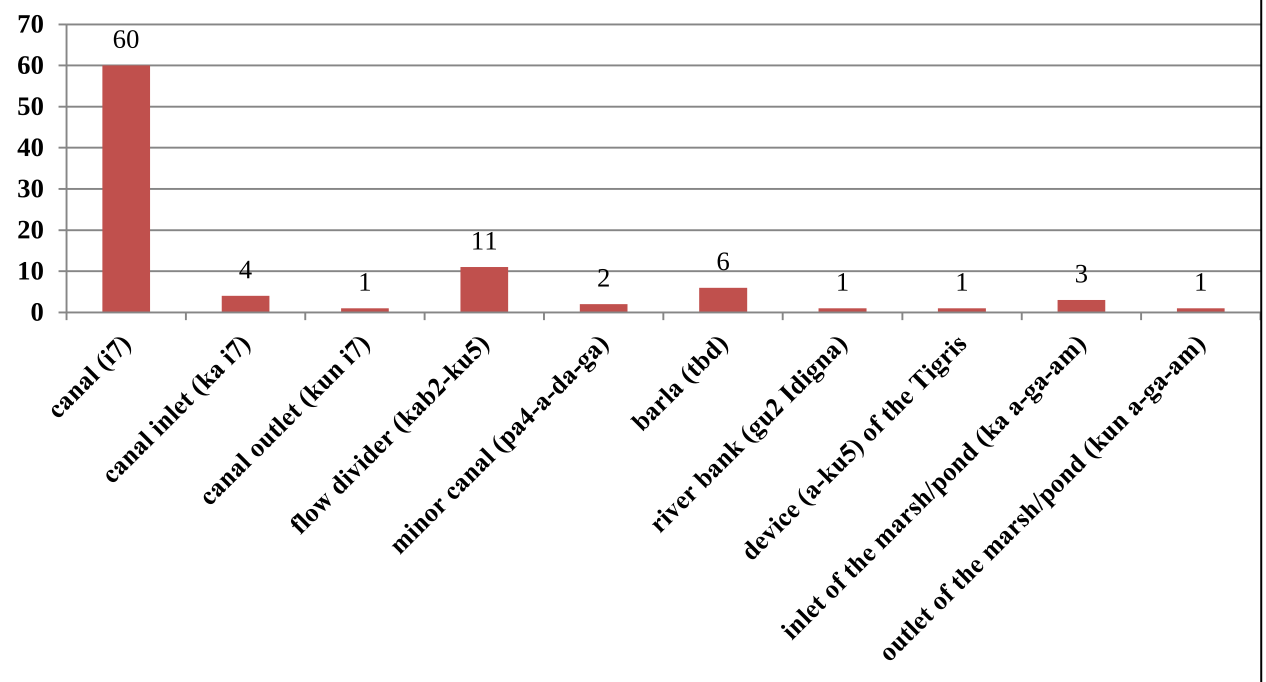
5.2.1 Cleaning of Canals

However, texts documenting the annual removal of sediment (šu/$šu_2$luh-ak) allow the distinction between irrigation canals and other watercourses. The verb "cleaning" is also attested for other control devices, such as flow dividers (kab_2-ku_5), but is mainly used for canals (see table 5.4). As can be seen in chart 5.5, the distribution of those texts dated by month coincides with the onset of the agricultural cycle, when the cleaning of canals was carried out. Based on textual records of this task, 22 irrigation canals could be identified with certainty for the governor-run sector of the Umma province (see appendix I.1, table I.1.3). While not all of these canals can be further categorized as primary, secondary, etc., the volumes of removed silt allows the identification of the seven largest canals (see appendix I, table I.1.3).[98]

[98]In some instances, low amounts of removed silt are recorded for major canals, such as the Udaga-sumun canal, which is most likely a rehabilitated bed of a Tigris tributary (sumun= old). Also, the amount of labor spent on the repair of the barrage/weirs of the [Eduru]-ašag-lamah canal and the Kun-Nagar canal fall into the top third (see appendix A, table A.18), suggesting that we are dealing with much larger canals than the amount of removed silt would lead one to believe. This discrepancy could be the result of these canals being primarily operated by members of the royal sector, with a small contribution made by the governor-run sector to its upkeep. Or we are simply dealing with a discovery bias of how the archive was uncovered (see chapter 1).

Chart 5.4

Frequency of attested cleaning (šu/šu$_2$ luh-ak) for different devices



These are the Guruš-gendu[99], I-sala[100], I-sum[101], Naram-Suen[102], Šara-adah-Amar-Suen,[103] Šara, and Šara-gugal canals.[104] When possible, their approximate locations are indicated in

[99]It is certain that the Guruš-gendu canal canal branched off the Tigris in the vicinity of Umma. See text BPOA 1 0594 (SS 04), o. 1–6: 10 la2 1 guruš u$_4$ 2-še$_3$ En-gaba-ra$_2$-ta gu$_2$ Idigan-še$_3$ gi ga$_6$-ga$_2$ 10 la$_2$ 1 guruš u$_4$ 1-še$_3$ ma$_2$ gi gid$_2$-da ka i$_7$-Guruš-gin-<du>-še$_3$, "9 workmen for two days carried reeds from the Engabari to the bank of the Tigris. 9 workmen for one day towed the boat loaded with reed to the inlet of the Guruš-gendu canal." See also text SAT 3 1514. The canal's inlet was located three days upstream of the riverine thicket of Ur-Abba (UTI 5 3152: r. 1–5).

[100]The I-sala-canal branched off the Tigris just downstream of Ka'ida. See MVN 16 0976, o.7–r.3: 11 guruš u$_4$-5-še$_3$ tir Ka-i$_7$-da ^{u2}KWU_127.ŠE$_3$ zi$_X$-a (=SIG$_7$) ma$_2$-a ga$_2$-ra u$_3$ ka i$_7$-Sal$_4$la-še$_3$ ma$_2$ diri-ga "11 workmen for 5 days cut a type of rush at the riverine forest at Ka'ida and loaded it onto a boat and floated the boat (downstream) to the inlet of the I-sala canal". How far downstream cannot be determined at this point. However the settlement I-sala was located in the vicinity of Umma (see MVN 16 0795, r. 2–4; Princeton 1 354, o. 1–4; SNAT 523, o.5–7) suggesting the the canal must have run in close proximity.

[101] The location of this canal could not be determined.

[102] The location of this canal is difficult to determine due to the limited number of sources. However, it appears that the Naram-^{d}Suen field was located in the Apisal district close to Apisal (UTI 4 2919) and Eduru-Du-kusig (Nik. 2 129: o. 1–5). It cannot be determined whether the canal branched off the Tigris directly or was a secondary canal.

[103] Location unknown.

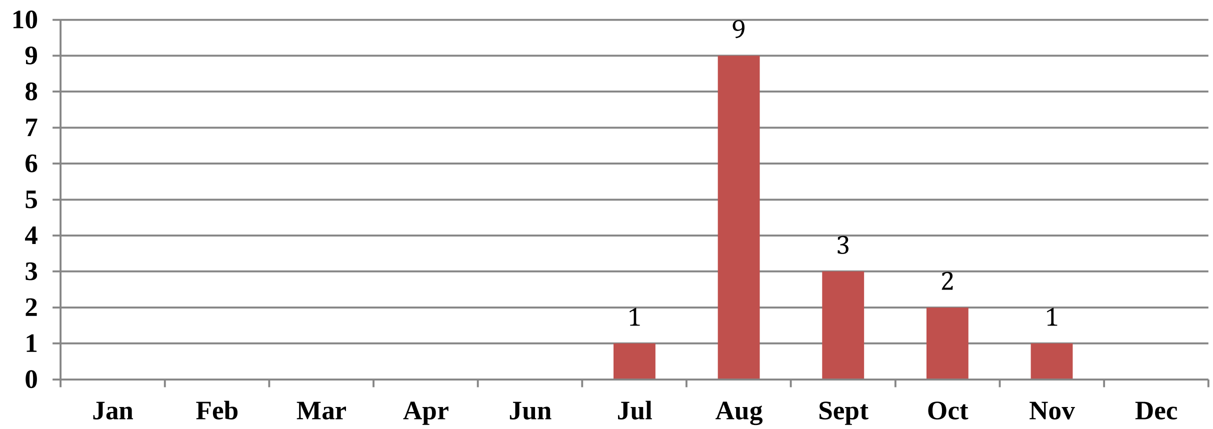
[104] Whether or not the canal branched off the Tigris cannot be determined based on the available records. It was located in the easternmost part of the Apisal district, given that the Šara-gugal field is frequently associated with the Igi-emahše and the Ninura field known to have been located in the vicinity of Apisal. These fields are among those that are associated with the drainage canal/pond (a-ga-am) (see chapter 4, 4.3.5).

Map3. The fact, that all—with the exception of the Šara-adah-Amar-Suen canal—are known to have had inlets that were sealed off by a dam across the width of the canal opening,supports the conclusion that we are dealing with primary canals branching off the Tigris (see chapter 4, section 4.2).

Chart 5.5

Monthly distribution of texts recording the cleaning of canals (i_7 šu/$šu_2$ luh-ak)

Sample size 16 out of 88 = 18%



The I-sala canal features very prominently in the historical record of Umma and appears to have been the major irrigation canal operated by the governor-run sector in the Da-Umma district (see AnOr 07 250). It branched off the Tigris a little downstream of Ka'ida. Given its prominence, it is possible that most of the agricultural land managed by the governor-run sector in the Da-Umma district was concentrated alongside the I-sala canal. The canal was in use for nearly 31 years (SH37–SS08) and might have already been in operation prior to the Ur III period. Unfortunately, there is no information on the dimension of this canal; nor is it possible to reconstruct the exact location of its course.

5.2.2 Maintenance of Canal Embankments/Spoil Banks (eg_2 i_7)

The only canal for which some dimensional information could be obtained from the documents is the Guruš-gendu canal. Its exact location remains also unknown, but it is fairly certain that it branched off the Tigris in the vicinity of Zabalam (see map 3).Two records (MVN

16 0961 and MVN 16 0912, table 5.6) that document the maintenance of the spoilbank of the Guruš-gendu make it possible to reconstruct its length and the diverting secondary canals. The 4 m wide and 1–2.5 m high spoil bank was “beaten” or “struck” (kin eg$_2$ ra-a),[105] suggesting that some force was applied, most likely to compact the waste earth removed from the canal (see Ouyang and Brookman 2012: §3.4.1).[106] Both texts list a total of six canals (the Lulal, HunubŠE, Ašag-Urgu, Dalbana, Gana-Urgu, and Kiri-ensi canals), which branch off from the Guruš-gendu canal at fairly regular intervals varying between 1 and 1.5km.

MVN 16 0961	
obverse	**o. 1–3**
1. [i$_7$]-´Guruš`-gen$_7$-du SUH a-ša$_3$-A-gu-du-ta	**From the … of the Agudu field on the Guruš-gendu**
2. [41]+1 1/2 nindan gid$_2$ 1/2 nindan 2 kuš$_3$ dagal	**canal**
5 kuš$_3$ bur$_3$	255m length, 4m width and 2.5m depth/height
3. [kin]-´bi` 141 2/3 sar	its volume is 2550m^3
4. [60]+10 la2 1 nindan gid$_2$ 4 kuš$_3$ buru$_3$	**o. 4–5**
5. [kin]-´bi` 184 sar	414m length, 2m depth
6. [41] 1/2 nindan gid$_2$ 5 kuš$_3$ buru$_3$	its work volume amounts to 3312 m^3
7 [kin]-bi 138 1/3 sar	**o. 6-8**
8. [i$_7$]-Lu$_2$-lal$_3$-še$_3$	249m length, 2.5m depth
9. [50] la$_2$ 1 nindan gid$_2$ 5 kuš$_3$ buru$_3$	its work volume amounts to 2490m^3
10. ´kin`-bi 163 1/3 sar	**to the Lulal canal**
11. [60]+48 nindan gid$_2$ 4 kuš$_3$ buru$_3$	**o. 9–10**
12. ´kin`-bi 288 sar	294m length, 2.5m depth
13. i$_7$-Hu-un-hu-ub-ŠE$_3$?-še$_3$	its work volume amounts to 2940m^3
14. 86 nindan gid$_2$ 2 kuš$_3$ buru$_3$	**o. 11–13**
15. kin-bi 114 2/3 sar	648m length, 2m depth
16. ša$_3$ i$_7$-Hu-un-hu-ub-ŠE$_3$ SUH ^{giš}kiri$_6$ Lugal-	its work volume amounts to 5184m^3
ku$_3$-zu-še$_3$	**to the HunhubŠE canal**
17. 160 nindan gid$_2$ 4 kuš$_3$ buru$_3$	**o. 14–16**
18. kin-bi 426 2/3 sar	516m length, 1m depth
19. i$_7$-A-ša$_3$-Ur-gu-še$_3$`	its work volume is 2064m^3

[105] Englund (2002: §15) translates kin eg$_2$ ra-a as “canal work.” As pointed out by Civil (1994: 109–14), the term eg$_2$ describes dams of various kinds, embankments, dikes, and field bunds, but not canals (see also Civil 1994: 109–140). The systematic analysis of the Umma records documenting work at various dams supports this conclusion. It is possible, however, that the terminology used in the neighboring province Girsu/Lagaš was slightly different, and eg$_2$ in the Girsu/Lagaš might describe a ditch on top of a dam (see discussion in fn 93). A systematic analysis is needed to establish the exact difference in the used irrigation terminology.

[106] This type of work is also attested for the embankment of the Ninhursag canal (1–2 m width x 0.5 m height, Torino 2 666, Archi et al. 1995) as well as the Amuš canal (see Syracuse 459, 6 m width x 0.5–1.25 m height). The Ninhursag canal must have been located close to the city GARšana (see CUSAS 17 276: o.ii 5’ – r.i 2). GARšana has been located by Steinkeller (2011) in the Gu’edena district close to the border with the neighboring province Girsu/Lagaš. The Amuš canal is not attested as an irrigation canal, which might explain the much larger size of its embankment. Compaction work is also attested for the dike at the bottom of fields (eg$_2$-sa-dur$_2$-ra; Ouyang and Brookman 2012: 7) and for various dams and dikes in the Gu’edena district (Englund 2002: §15 No. 15). The evidence of a tablet basket tag (MVN 18 633) containing texts documenting compaction work (kin eg$_2$ ra-a) of dams along fields and watercourses suggests that far more records must have existed in ancient times.

============ *reverse* r. ============ 1. šu-nigin$_2$ 556 nindan gid$_2$ 2. [šu]-nigin$_2$ 1486 2/3 sar sahar 3. kin eg$_2$ ra-a i$_7$-Guruš-gen$_7$-du ============ 4. mu ^{d}Šu-^{d}Suen lugal 5. Uri$_5$^{ki}-ma-ke$_4$ na-du$_3$-a 6. mah ^{d}En-lil$_2$ ^{d}Nin-lil$_2$-ra mu-ne-du$_3$	**to … of the orchard of Lugal-kuzu in the HunhubŠE canal** **o. 17–19** 960m length, 2m depth its work volume amounts to 7680m^3 **to the Ašag-Urgu canal** **r. 1-2** total of 3336m length total of 26760m^3 of earth work, “striking”/compacting the spoil bank of the Guruš-gendu canal **r. 4–6** **Year:** SS06

MVN 16 0912 ***obverse*** ***columne 1*** 1. SUH a-ša$_3$-^{giš}Ma-nu-ta 2. 110 nindan gid$_2$ 3. eg$_2$-sa-dur$_2$ a-ša$_3$-GAN$_2$-Ur-gu-še$_3$ 4. 104 nindan gid$_2$ 5. AN.PI.NI.HA-še$_3$ 6. 66 nindan gid$_2$ 7. i$_7$-Dal-ba-na ki-su$_7$-ra-ka-še$_3$ (erasure) ------------ 8. i$_7$-Dal-ba-na ki-su$_7$-ra-ka-ta 9. 181 1/2 nindan gid$_2$ 10. i$_7$-GAN$_2$-Ur-gu-še$_3$ 11. 38 nindan gi$_7$ ša$_3$ i$_7$ 12. 32 nindan gid$_2$ 13. ša$_3$ ^{giš}kiri$_6$ Gal$_5$-la$_2$-gal 14. 76 nindan gid$_2$ 15. SUH ^{giš}kiri$_6$ ensi$_2$-ka da ^{giš}Gi$_6$-par$_4$-še$_3$ ***column 2*** 1. 20 nindan gid$_2$ ša$_3$ i$_7$-^{giš}kiri$_6$-ensi$_2$-ka 2. 150 nindan [...] gan$_2$] [...] [x 3. 110 ´nindan` [gid$_2$ ...] a-ša$_3$-/ ´$^{d}$Inanna` [...] i$_7$-´Guruš-gen$_7$`-du-še$_3$ ============ ***reverse*** ***column 1*** ============ ***column 2*** ============ 1. kin eg$_2$ ra-a 2. kun i$_7$-[Guruš]-´gen$_7$-du` 3. iti^{d}[...] 4. mu na-du$_3$-[a mah ba-du$_3$]	 **o.i 1–3** From … the Manu-field to the dam at the bottom of the Gan-Urgu field—660m length **o.i 4** 624m length to AN.PI.NI.HA **o.i 4–o.i 7** 396m length to the threshing floor at the Dalbana canal o. i **o.i 8–10** from the threshing floor at the Dalbana canal to the Gana-Urgu canal—1089m length. **o. i 11** 228m length to the … in the canal **o.i 12–13** 192m length to the Galagal orchard **o.i 14–15** 456m length to the … of the orchard of the governor on the side of Gipar **o.ii 1** 120m length to the Kiri-ensi canal **o.ii 2** 900m [length ...] **o.ii 3** 660m [length ...] to the Inanna-field at the Guruš-genducanal ============ ***reverse*** ***column 1*** ============ ***column 2*** ============ compacting work at the embankment at the outlet of the Guruš-genducanal **r.ii 3-4** **Month:**^{d}[...] (12/?) **Year:** SS06 - XX - XX

Table 5.6 List of numerical values presented in text MVN 16 0961					
From the Agudu-field at the Guruš-gendu-canal					
Section	**l (m)**	**w (m)**	**d (m)**	**v (m3) noted**	**v calculated**
o. 1–3	255	4	2.5	2550	idem
o. 4–5	414	[4]	2	3312	idem
o. 6–8	249	[4]	2.5	2490	idem
to the Lulal-canal					
o. 9–10	294	[4]	2.5	2940	idem
o. 11–13	648	[4]	2	5184	idem
to the HunhubŠE-canal					
o. 14–16	516	[4]	1	2064	idem
to the orchard of Lugal-kuzu at the HunhubŠE-canal					
o. 17–19	960	[4]	2	7680	idem
to the Ašag-Urgu-canal					
r. 1–2 Total	3336			26760	idem

Assuming that both texts describe one continuous spoil bank on one side of the canal, the total length recorded amounted to 8.661 km. The length of the Guruš-gendu canal is somewhat at odds with the envisioned herringbone pattern irrigation system described above, with much shorter primary canals (max. 1–3km). This suggests a slightly more complex layout of the Umma irrigation systems.

The maintenance of canal embankments/spoil banks[107] (eg_2 i_7) is otherwise attested, though infrequently (26 references) and only for nine canals (see appendix G and table 4.12). In addition, the large majority of the references (17 out of 26 = 65%) refer to work at the embankment of the Amar-Suen-kegara-canal. Four out of the nine attested canals are irrigation canals, which suggests that the work recorded pertained to the maintenance of their spoil banks, as described above (see table 5.7).[108]

[107] An embankment is defined by the MTDID (1996: 9255, see also 9260) as a "linear structure, usually of earth or gravel, constructed so as to extend above the natural ground surface and designed to hold back water from overflowing a level tract of land, to retain water in a reservoir, tailings in a pond, or a stream in its channel, or to carry a roadway of railroad on a level above ground and/or surface water level, e.g., a dike, seawall, or fill."
[108] MTDID (1996: 3784) defines "spoil bank" as a "bank composed of waste earth which has been excavated."

Table 5.7 Canals for which work on the embankment/spoil bank (eg_2 i_7) is attested		
Canal Name	**Cleaning attested (šu/$šu_2$ luh-ak)**	**# References**
Amuš		1
Amar-Suen-Šara-para	-	1
Amar-Suen-kegara	-	17
Iba'al-nuba'al Aša-Ninura-canal	x	2
Gal-canal	-	3
Gibil-canal	-	1
Guruš-gendu	x	1
I-sum	x	1
Ninhursag	x	1

The primary job performed at these spoil banks/embankments entailed leveling/profiling work in order to achieve an even and firm surface, possibly to support a pathway alongside it (see table 5.8). The most detailed insight into such profiling work is provided by the record of the Amar-Suen-kegara canal (see appendix B). Twelve work crews, consisting on average of 15 workers, mainly under the authority of Gugūa, but also Ur-Šara and Ur-Suen (see appendix B, table B.1), were employed to profile the embankment in piecemeal fashion over a period of nearly four years, from AS08 to SS02. At the beginning of the project, 14044.5 m^3 of earth was piled up (si) alongside the canal in the year AS08, followed by smoothing out the earth to form an even and firm embankment (šu--ur_3) that was later coated (šu du_{11}-du_{11}.g), probably with some type of plastering consisting of earth and plant matter (see UTI 4 2746).

Table 5.8 Tasks performed at embankments/spoil banks of canals and watercourses (eg_2 i_7)		
English	**Sumerian**	**# References**
leveling	šu--ur_3	17
pilling up earth	sahar si.g	4
compaction work	kin eg_2 ra-a	3
coating with adobe Amar-Suen-kegar-canal	šu du_{11}-du_{11}.g	1
construction materials used		
bundles of reed Amar-Suen-Šara-para	sa gi	1

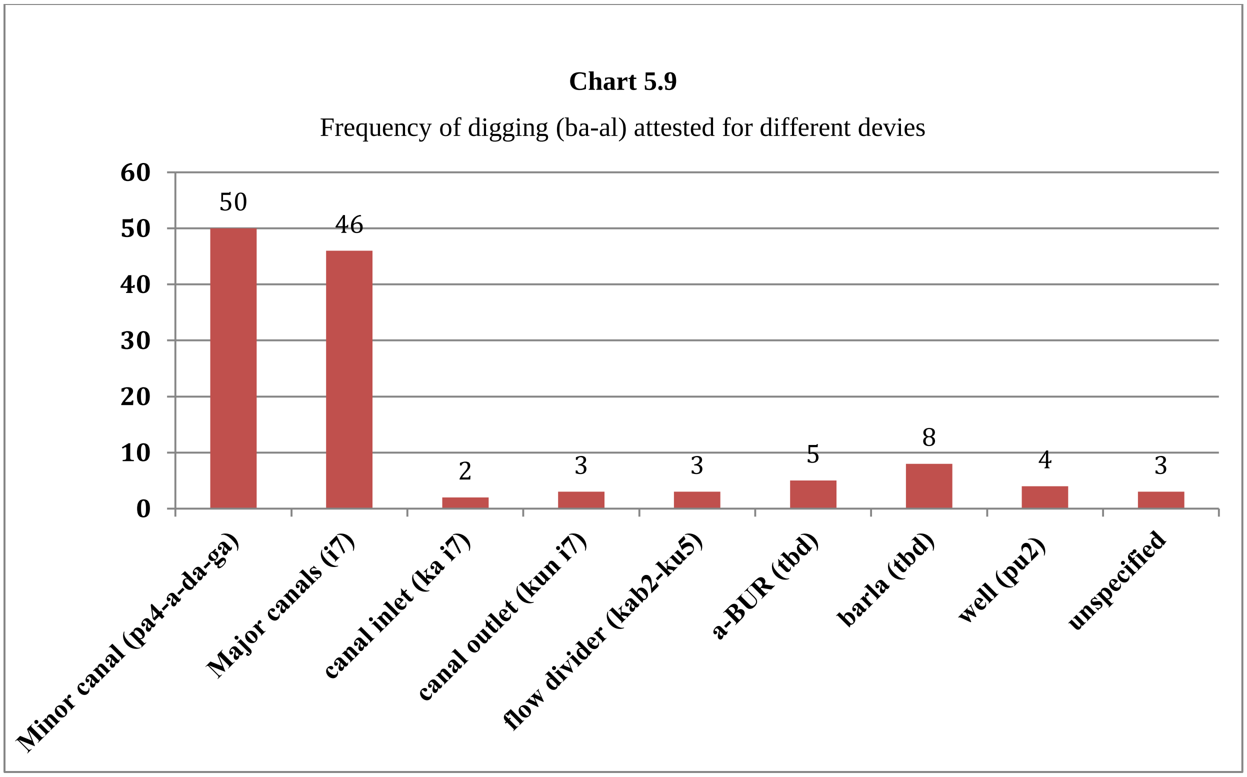
The evidence presented above indicates that canal maintenance — that is their annual cleaning and the maintenance of their spoil banks—was organized and carried out by the provincial government under the authority of the governor. Details on the administrative procedures of assessing the job to be done and assigning the work to supervisors and their work crews will be discussed in chapter 7.

5.2.3 Canal Construction

Canal construction carried out by the governor-run sector appears to have been fairly limited and was primarily done to extend pre-existing canals or add new water control facilities (see, for example, the Šara, Guruš-gendu, I-suma, and I-salacanal in appendix J, table J.1.3). The verb ba-al[109] (excavate) is primarily attested for canals but even more frequently for minor canals called pa_4-a-da-ga. The construction is also attested for devices such as the flow-dividers (kab_2-ku_5) and wells (see chart 5.9).

The recorded amounts for canal construction are fairly low (500 m^3 – 6000 m^3) and would have only been sufficient for small canals (e.g., 1–2 km in length, 1–3 m in width and 0.5–1 m in depth). However, text MVN 10 105 (undat.) does record the construction of a canal branching off the ancient Tigris of 4.230 km in length.[110] This suggests that most of the irrigation systems operated by the governor-run sector might have already been in place at the onset of the Ur III period. Most of the construction of new canals was carried out in areas of newly established royal settlements that went along with the development of agricultural land (e.g., the Amar-Suen-kegara canal; Steinkeller [2013: 358, fn 52, 376, fn 115]).

[109] Note that the verb also describes "unloading" operations such as unloading boats.
[110] MVN 10 105, o. 1'–o.3': [...] i_7-´Idigna`-ta 705 nindan gid_2 i_7 ba-al-la 10 nindan gid_2 2 sar-ta …, "[...] from the Tigris, excavating a canal of 4230 m in length.



There is also an indication of the reuse of old riverbeds for irrigation purposes, which would be an example of what Wilkinson (2003: 85) called "channel management." This entailed modifying and reinforcing naturally occurring bifurcations caused by channel avulsion to maintain and extend irrigation systems as well as the network of navigable watercourses. Such a managed avulsion point probably existed at the Udaga canal—most likely a major tributary of the Tigris branching off a little downstream of Apisal (see map 3).[111] An "old" (sumun) Udaga channel is attested for which the annual removal of sediment is recorded (šu/šu$_2$ luh-ak). This indicates that the water flow in this channel was restored for irrigation purposes by means punctual modifications of the old river bed.

[111]Udaga is recorded as a city in the records of the GARšana archive, while it appears only as a canal and a personal name in the Umma records. The town of Udaga after which the canal was named (or vice versa) must have been located in the vicinity of GARšana. See in particular text UTI 4 2881, o. 12–15:5 guruš u$_4$ 1-še$_3$ ka U$_3$-dag-ga-ta A-pi$_4$-/sal$_4$^{ki}-še$_3$ ma$_2$ gi gid$_2$-da u$_3$ ma$_2$ ba-al-la,"5 workmen for one day towed the boat (loaded) with reeds from the inlet of the Udaga canal to Apisal." This text shows that the inlet of the Udaga canal was probably downstream of Apisal. Furthermore, there is evidence of an "old" Udaga canal (see MVN 21 102: 1-2), which seems to have functioned as an irrigation canal, since cleaning work is attested for it (BPOA 1 0404: r. 3–4).

The high frequency with which the construction of minor field canals, called pa'adaga canals, is attested is somewhat at odds with there being only two records on the cleaning of these canals (see appendix J.2, Abududu field, Egirgilu field).These canals are only associated with fields and as suggested above might have been the secondary canals that subdivided the elongated field strips to provide water for the irrigation furrows. In addition, text SACT 2 124 clearly suggests that their construction is closely related to the irrigation of fields.

SACT 2 124	
obverse	**o. 1–3**
1. 13 gin$_2$ sahar	3.9 m^3 of earth (excavated when) digging the minor
2. pa$_4$-a-da!-ga[112]	canal
3. ba-al-la	**o. 4**
4. 2 guruš a-ša$_3$-ge [a] du$_{11}$-ga	2 workmen irrigated the field
5. ugula lu$_2$-[x x]	**o. 5**
reverse	supervisor was Lu-[x x]
1. a-ša$_3$-^{d}Amar-^{d}Suen-^{d}[Šara$_2$]-ki-ag$_2$	**r. 1**
2. iti ^{d}Dumu-zi	in the Amar-Suen-ki'ag-field
===========	**r. 2-3**
3. mu Hu-hu-nu-ri^{ki} ba-hul	Month: XII (March)
seal	Year: AS07-12-00
1. Lugal-e$_2$-[mah-e]	Seal: Lugal-emah(e), scribe, son of Inim-Šara
2. dub-[sar]	
3. dumu Inim-^{d}Šara$_2$	
4. sag-[du$_5$]-ka	

The construction of these canals is only attested for 20 fields out of the 97 that were cultivated by the governor-run sector of the province of Umma (Vanderroost 2012i: 83–85). In addition, the majority of them are attested with the Ninura, Kamari, Gana-urgu, Lamah, and Muru fields (see appendix J, J.2 and table J.2.1, J.2.2). It is possible that records describe the extension of an irrigation system. The sheer absence of documents recording their cleaning is puzzling. However, as has been shown in chapter 2, 2.3.3.9, minor canals are usually cleaned just prior to the arrival of irrigation water and this task can be done by a single person. It is possible that ancient scribes did not record the labor days spent on the cleaning of these canals separately but subsumed it under the general task of irrigating fields (a-ša$_3$-ge a-du$_{11}$-ga).

112 The signs are reversed in the original tablet, but it is fairly certain that this is a scribal error.

5.2.4 Removing Earth Clods from the Irrigation Furrows (ab-sin$_2$-ta la-ag ri-ri.g)

What is fairly well documented is the removal of earth clods from irrigation furrows; a task that is attested for about 33 fields in 98 references (see appendixes N and R). Only 11 references out of the 98 are dated by month (=11%, see table 5.10). However, most of these occur in late fall and show a distribution that suggests that this work coincided with the sowing of barley (mid-October) and wheat (mid-November). This conclusion is further supported by the fact that the removal of clods from irrigation furrows is almost always recorded alongside tasks related to field preparation (e.g., breaking up earth clods, removing (cutting or uprooting) different types of weed, hoeing, etc.) (see appendix N, table N.1).[113] Notably, the overlap between the removal of clods from irrigation furrows and the consecutive irrigation of the very same fields could only be attested for 8 out 33 attested fields (appendix R).[114]

Table 5.10

Monthly Distribution of "removing clods from the irrigation furrows" (ab-sin$_2$-ta la-ag ri-ri.g)

Publication	Line	Date	Month
SET 256	o. 5–8	AS01-04-00	July
UTI 3 2122	o. 3– r. 2	AS08-06-09	September 9
Santag 6 325	r. 1–3	SS08-07-00	October
BPOA 6 1343	o. 1–3	SS04-07-00	October
BPOA 6 1457	o. 1–3	SS04-07-00	October
BPOA 6 1509	o. 1–3	SS04-07-00	October
UTI 5, 3255	o. 2–3, r. 3–4	AS08-07-24	October 24
BIN 5 235	o. 8–r. 2	AS01-08-01	November
MVN 13 310	o. 1–r. 1	SH46-08-00	November
BPOA 1 0796	r. 2–3, 6	SS09-08-11	November 11
BPOA 1 1747	o. 4–r. 3	SS09-08-20	November 20

5.2.5 Water Allocation by Means of Flow Dividers (kab$_2$-ku$_5$)[115]

As the Guruš-gendu canal of 8 km in length formed the backbone of an irrigation system with probably several tiers of canals of varying sizes the more widespread spatial distribution of water and into different sub-sections of the system would have become necessary. This is evident

113 See BPOA 1 0796,which provides the timeline of field preparation tasks. Note the absence of plowing in this and other records documenting field preparation. The reason for this is the high level of labor division in the agricultural sector. Plowing was done by a specific work class of eren2 workers (engar) and was recorded separately.

114 There are overlaps for the Amar-^{giš}kiši17, Gana-Urgu, Ilugal, Kamari, Lamah, Latur, Muru, and Sulpa'e fields.

115 For its earlier reading, nag-ku$_5$, see Sallaberger (1991).

in the great number of flow dividers that are attested in the Umma record. With 590 references, the flow divider (kab$_2$-ku$_5$) is the most frequently attested device in the Umma record, reflecting its importance for irrigation in Umma (see appendix L). Since there are very few documents that provide information on its shape and dimensions, the identification of kab$_2$-ku$_5$ remains somewhat debated. Various scholars have proposed that the kab$_2$-ku$_5$ described a reservoir of some kind to divert excess water during the flood (Civil 1994: 133; Langdon 1937: 77–78), to store water for irrigation (Foxvog 1986: 60,62; Gelb 1965: 58–60; Madea 1984: 44; Oppenheim 1948: 113, fn. 117, Pemberton, et al. 1988: 217–218), or as a settling reservoir located at each intersection of a larger and a smaller canal (Kang 1973: 74–75). As will be shown below, these translations are only partially correct.

Steinkeller (1988: 74–78) suggested early on that the main function of the kab$_2$-ku$_5$ was to distribute water.[116] Steinkeller draws an analogy to the medieval flow dividers found in Syria and Valencia (Spain). He notes (1988: 78) that ku$_5$/kud is equated in the lexical list AIII/5 with the Akkadian word *batāqu*, "to take away (by cutting off)", *parāsu* "to divide" and *petû* "to open, to divert" indicating the distributary function of this device. It may be noted that the cuneiform sign for ku$_5$ also resembles that of a fork, supporting the conclusion that the kab$_2$-ku$_5$ describes a flow divider. Also, text MVN 16 1565 leaves no doubt about the identification of the kab$_2$-ku$_5$ as a flow divider.

MVN 16 1565	
obverse	**o. 1–4**
1. 25 guruš u$_4$ 1-še$_3$ 2. kab$_2$-ku$_5$ I$_3$-sum šu-luh ak 3. a ku$_5$-ra$_2$ u$_3$ 4. a-da gub-ba	25 workmen for one day cleaned the flow divider of the Isum canal and split/divided the water and were stationed at the water.
reverse	**r. 1–3**
1. ugula Ba-sa$_6$ 2. kišib Ab-ba-gi-na # (Seal) 3. mu us$_2$-sa ma$_2$ ^{d}En-ki ba-ab-du$_8$	supervisor (was) Basa (tablet was) sealed (by) Abbagina **Year:** SS03-00-00 **Seal:** Lu-^{d}Šara, scribe, son of Ursaga.
seal	
1. Lu$_2$-^{d}Šara$_2$`	

[116] Of special importance for the meaning of kab$_2$-ku$_5$ is the equation of kab$_2$-ku$_5$ with the Akkadian word *bu-tu-uq-tum* "sluice, water conduit" (from *batāqu* "to cut through, to divide", Chicago Assyrian Dictionary B, 356–358) clearly indicating flowing water and not standing water in a reservoir (Steinkeller 1988: 78). This is further supported by the singular lexical attestation of kab$_2$-ku$_5$ which is found in Proto-Izi I 367 (= MSL, p. 29), where it is preceded by a-e$_3$-a, "sluice," and is followed by i-zi$^{a-gu-ú}$, "flow of water, current" (= Akk. *agû*) (Steinkeller 1988: 74).

2. dub-sar 3. dumu Ur-sa_6-ga	

As will be discussed in greater detail in section 5.2.4.4 F and in chapter 6.3.3 it seems that kab_2-ku_5 also describes a deliberately made breach in the river's levee to divert water into nearby marshes to lower the water table in the river. As will be shown certain flow dividers had a dual function of distributing water and functioning as a diversion point for flood water (e.g., the flow divider of the I-sala canal, see below).

The design of a flow divider depends on what it is supposed to accomplish. The simplest form of a flow divider is probably the proportional flow divider, which is rectangular in shape with a splitter wall that established the proportion by which the water of the main channel is divided into two or more smaller canals. This type of flow divider divides the amount of water proportionally regardless of the amount of incoming discharge and cannot be tampered with. Such flow dividers have the great advantage of continuous operation by partitioning the water flow without supervision (Laycock 2007: 143). The decision of how the water supply is divided is made once when the flow divider is constructed. As the accurate distribution of water depended on these devices, they need to be "carefully and precisely designed, leveled, measured, and built" (Glick 1970: 39–40, 87–89). Maintenance is crucial, as the change in flow velocity leads to a greater deposition of silt and altered the accuracy of the ratio of the division (Glick 1970: 89). More complex flow dividers might have flexible gates that allow control of not only the amount of diverted water but also the allocation of water into different subsections of the irrigation system. While moveable gates allow maximum flexibility they require a lot of administrative and operative attention as there has to be someone in charge of operating the gates at the correct and appropriate amount of time. In addition, flexible gates leave room for tampering that can pose a serious managerial problem (Laycock 2007: 143).

5.2.5.1 Location of the Flow Dividers

Table 5.11 summarizes the various locations where flow dividers were found. So far approximately 132 locations have been identified (see appendix K, table K.1). As can be seen, flow dividers were located close to orchards ($^{giš}kiri_6$), towns (e.g., Apisal and Kamari), villages (e.g., Eduru-Amar-Suen), or hamlets (e.g., Kigamma), and even within towns (AAICAB 1/3 Bod. S. 157: o. 8).

Table 5.11

Locations of flow dividers (kab_2-ku_5)

Context	Sumerian	# Locations
canal	i_7 CN	40
drainage canal	aga'am / aga'am gula	2
field	a-$ša_3$ FN	39
field/canal (hamlet)	-	6
orchard	$^{giš}kiri_6$ ON	4
hamlets	-	6
village	e_2-$duru_5$	4
town	TNki	6
with personal names	kab_2-ku_5 PN	9
undetermined	?	16
Total		132
Flow dividers as part of another device		
water outlet	a-e_3-a	4
?	a-BUR_2	2
water front	a-egir	2
?	bar-la_2	9

Flow dividers are as frequently named after fields as they are named after canals. As has been shown in text SAT 02 0210[117] in particular, major canals usually had more than one flow divider. In order to distinguish between the flow dividers of the same canal, Sumerian administrators might have named them after the fields they were closest to. In many cases, though, flow dividers are attested for both (e.g., the flow divider of the Ninura field and/or the Ninura canal[118]), and more often than not the Sumerian determinatives for canal (i_7) and field (a-$ša_3$) are omitted all together. It cannot be determined with certainty whether we are dealing with the same flow divider or different flow dividers in one general area.

[117] See also OrSP 47–49 511, o. 9–13, which attests two flow dividers of the Lugal canal. Text AAICAB 1/3 Bod. S 157: o. 6–r.1 (see Steinkeller 2013a: 395) attests 2–3 flow dividers for one canal and possibly 3 for the watercourse described in AAICAB 1/1, Ashm. 1911–486.

[118] See for example Ontario 2 148, o. 4–7: 7 guruš u_4 1-$še_3$ u_2-il_2-la kun-zi-da i_7-Ur-sig_5 kab_2-ku_5 a-$ša_3$-Ka-ma-ri_2,"Seven workmen carrying grass to the kun-zi-da of the Ursig canal and the kab2-ku5 of the field Kamari."And BIN 5 272, r. ii 24'-27': 7 guruš u_4 1-$še_3$ u_2 ga_6-ga_2 kun-zi-da i_7-Ur-sig_5 kab_2-ku_5 i_7-Ka-ma-ri_2^{ki}, "Seven workmen carrying grass to the kun-zi-da of the Ursig canal and the flow divider of the canal of the city Kamari." The latter is a copy of the original receipt, and while in Ontario 2 148 the flow divider was called the flow divider of Kamari field, it was "corrected" to the flow divider of the Kamari canal.

Nine flow dividers were named after individuals (see text OrSP 47–49 346 and table 5.12), and the reason behind this practice remains unclear. It could indicate that certain sections of the irrigation system were in the control of these individuals or simply that their landholdings were located adjacent to the flow divider in question. Identifying the individuals might provide some insight into the matter, but unfortunately, that information is elusive.

<table>
<tr>
<td>OrSP 47-49 346
obverse
1. 420 sa gi
2. kab_2-ku_5 A-gu
3. u_3 kab_2-ku_5 A-kal-la
4. ba-an-uš
5. a-$ša_3$-En-gaba-ra_2
reverse
1. mu Ša-aš-ru^{ki} ba-hul
seal
1. Ur-^{d}Suen
2. dub-sar
3. dumu Ur-^{giš}gigir</td>
<td>o. 1–5
420 bundles of reeds in order to block the flow divider of Agu and the flow divider of Akalla in/from the Engabara
r. 1
Year: AS06-00-00
Seal: Ur-Suen, scribe, son of Ur- gigir</td>
</tr>
</table>

Table 5.12

Flow dividers (kab_2-ku_5) named after individuals

Name	**Location if known**
Agu	Engabara field
Akalla	Engabara field
Inima-Inanna	?
Lugal-sig	Tur field (?)
Lugal-unkene	Šara field
Lugal-urani	?
Lugal-ušur	?
Ur-Ba'u/Ur-Baba	?
Ur-Ninura	?

The most frequently attested flow divider is that of the I-sala canal, followed by that of the Engabara field and Dubla-Utu [canal] (see table 5.13). As has been discussed above, the prominence of the I-sala canal in the Umma record most likely indicates that it supplied water for the most important and possibly the largest irrigation system operated by the governor-run sector of the Umma province.

Table 5.13 Number or references by location in ascending order with 5 attestations as break-off point			
Flow dividers name	**# References**	**Flow divider name**	**# References**
Ki'uš [canal]	5	Nuna field	10
Ninhursag canal	6	Šulpa'e canal	10
Sagdu canal/field	6	Udu-^{d}Ninarali field	10
Du-kugsig [field]	7	Ninura canal/field	12
Guruš-gendu canal	7	Isum field	14
Gušuhub field	7	Naram-Suen canal	15
Sipada field	7	A'uda canal/field/hamlet	16
Gibil field/canal	8	Lugal canal/field	17
Latur field	8	Ganamah field	17
Nin-hegal canal	8	Dubla-Utu [canal]	25
Šara-hegal canal	8	Engabara field	29
^{giš}Šinig (tamarisk flow divider (?))	8	I-salacanal	76

5.2.5.2 Shape of the Ur III Flow Dividers (kab$_2$-ku$_5$)

The reconstruction of the common shape of Ur III flow dividers in Umma remains difficult since there are only two (OrSP 47–49 511 and SAT 2 0210) texts that provide three dimensional measurements. The reconstruction obtained from the measurements of SAT 2 0210 indicates that we are dealing with proportional flow dividers.

SAT 2 0210[119] ***obverse*** ***column i***	 ***obverse*** ***column i***
1. 1 ninda gid$_2$ 2 nindan dagal 4 kuš$_3$ bur$_3$	1. 6m length, 12m width, 2m depth
2. 2 kin-bi 8 sar	2. its work volume is 144m^3
3. 149 nindan gid$_2$ 2 kuš$_3$ bur$_3$	3. 894m length, [12m width], 1m depth
4. kin-bi 596 sar	4. its work volume 10,728m^3
5. e$_2$ Ur-^{giš}gigir ašgab-še$_3$	5. to the house of Ur-gigir the leather worker
6. 20 nindan gid$_2$ 2½ kuš$_3$ bur$_3$	6. 120m length, [12m width], 1.25m depth
7. kin-bi 100 sar	7. its work volume is 1800m^3
8. 80 nindan gid$_2$ 2 kuš$_3$ bur$_3$	8. 480m length, [12m width], 1m depth
9. kin-bi 320 sar	9. its work volume is 5760m^3
10. 20 nindan gid2 2½ kuš$_3$ bur$_3$	10. 120m length, [12m width], 1.25m depth
11. kin-bi 100 sar	11. its work volume is 1800m^3
12. 70 nindan gid$_2$ 3 kuš$_3$ bur$_3$	12. 420m length, [12m width], 1.5m depth
13. kin-bi 420 sar	13. its work volume is 7560m^3
14. 15 nindan gid2 3½ kuš$_3$ bur$_3$	14. 90m length, [12m width], 1.75m depth
15. kin-bi 105 sar	15. its work volume is 1890m^3
16. eg$_2$-sa-dur$_2$-ra Gan$_2$-RA-še$_3$	16. to the dam at the bottom of the field GanRA
17. ------------------	17. its work volume -–

[119] I am indebted to Professor Steinkeller for making his collation accessible to me (March 2012).

18. kin-bi 0

column ii

1. 15 nindan gid$_2$ 4 kuš bur$_3$
2. kin-bi 120 sar
3. 10 nindan gid$_2$ 3 kuš$_3$ bur$_3$
4. kin-bi 60 sar
5. 10 nindan gid$_2$ 2½ kuš bur$_3$
6. kin-bi 50 sar
7. 230 nindan gid$_2$ 2 kuš$_3$ bur3
8. kin-bi 920 sar
9. eg$_2$ a-ša$_3$-Tur-še$_3$
10. 100 nindan gid2 2 ½ kuš$_3$ bur$_3$
11. kin-bi 500 sar
12. 160 nindan gid$_2$ 2 kuš$_3$ bur$_3$
13. kin-bi 480 sar
14. 30 nindan gid$_2$ 3 dagal 4 kuš bur$_3$
15. kin-bi 360 sar
16. Hi-a-bar-ra
17. 220 nindan gid$_2$ 0 kuš$_3$-10
18. kin-bi 0
19. Hi-a-bar-ra-ta

reverse

column i

1. eg$_2$ Du$_6$-ma$_2$-gibil-la-še$_3$
2. šu-nigin$_2$ 4139 sar
3. 3½ nindan gid$_2$ 1 ½ nindan dagal 6 kuš$_3$ bur$_3$
4. kin-bi 31½ sar
5. 2 nindan gid$_2$ 1 nindan dagal 3 kuš$_3$ bur$_3$
6. kin-bi 6 sar
7. 1 nindan nu-ak
8. 2 nindan gid$_2$ 1 nindan dagal 3 kuš$_3$ bur$_3$
9. kin-bi 6 sar
10. 3½ nindan gid$_2$ 1½ nindan dagal 6 kuš$_3$ bur$_3$
11. kin-bi 31½ sar
12. 2½ nindan gid$_2$ 1 nindan dagal 3 kuš bur$_3$
13. kin-bi 7½ sar
14. 1½ nindan gid$_2$ 1 nindan dagal 4 kuš$_3$ bur$_3$
15. kin-bi 6 sar
16. ½ nindan gid$_2$ 1 nindan dagal 2 kuš$_3$ bur$_3$
17. kin-bi 1 sar
18. kab$_2$-ku$_5$ gu-la
19. 4 nindan gid$_2$ 1½ nindan dagal 6 kuš$_3$ bur$_3$

column ii

1. kin-bi 36 sar
2. 3½ nindan gid$_2$ 1½ nindan dagal 7 kuš$_3$ bur$_3$
3. kin-bi 36 2/3 sar 5 gin$_2$
4. šu-nigin$_2$ 160 sar 15 gin$_2$
5. kab$_2$-ku$_5$ a-ša3-GAN$_2$-mah 4-bi
6. šu-nigin$_2$ 4301 sar 15 gin$_2$ kin
7. mu e$_2$ Puzur$_4$-Da-gan ba-du$_3$

column ii

1. 90m length, [12m width], 2m depth
2. its work volume is 2160m^3
3. 60m length, [12m width], 1.5m depth
4. its work volume is 1080m^3
5. 60m length, [12m width], 1.25m depth
6. its earth volume 900m^3
7. 1380m length, [12m width], 1m depth
8. its work volume 16,560m^3
9. to the field bund of the “Small”-field
10. 600m length, [12m width], 1.25m depth
11. its work volume 9000m^3
12. 960m length, [9m width], 1m depth
13. its work volume is 8,640m^3
14. 180m length, 18m width, 2m depth
15. its work volume is 6,480m^3
16. (to) Hi’abara
17. 1,320m length, - m depth
18. its work volume is –
19. from Hi’abara

reverse

column i

1. to the dam of Du-magibil
2. the (sub) total is 74,502m^3
3. 21m length, 9m width, 3m depth
4. its work volume 567m^3
5. 12m length, 6m width, 1.5m depth
6. its work volume is 108m^3
7. 6m don’t have to be done
8. 12m length, 6m width, 1.5m depth
9. its work volume is 108m^3
10. 21m length, 9m width, 3m depth
11. its work volume 567m^3
12. 15m length, 6m width, 1.5m depth
13. its work volume 135m^3
14. 9m length, 6m width, 2m depth
15. its work volume is 108m^3
16. 3m length, 6m width, 1m depth,
17. its work volume is 18m^3
18. the big flow divider
19. 24m length, 9m width, 3m depth

column ii

1. its work volume is 648m^3
2. 21m length, 9m width, 3.5m depth
3. its work volume is 661.5m^3
4. its (sub) total is 2884.5.5m^3
5. the four flow dividers of the Ganamah-field
6. the total is 77,422.5m^3
7. Year: SH 39

Table 5.14 Lists of the numerical values presented in SAT 02 0210					
Part 1	**l (m)**	**w (m)**	**d (m)**	**v (m3)**	**v calculated**
o.i 1–2	6	12	2	144	idem
o.i 3–5	894	[12]	1	10,728	idem
to the house of Ur-gigir, the leather worker					
o.i 6–7	120	[12]	1.25	1800	idem
o.i 8–9	480	[12]	1.25	5760	idem
o.i 10–11	120	[12]	1.25	1800	idem
o.i 12–13	420	[12]	1.5	7560	idem
o.i 14–16	90	[12]	1.75	1890	idem
to the dam at the bottom of the GanaRA-field					
o.ii 1–2	90	[12]	2	2160	idem
o.ii 3–4	60	[12]	1.5	1080	idem
o.ii 5–6	60	[12]	1.5	900	idem
o.ii 7–9	1380	[12]	1	16560	idem
o.ii 10–11	600	[12]	1.25	9000	idem
o.ii 12–13	960	[9]	1	8640	idem (if w = 9m)
o.ii 14–16	180	[18]	1	6480	Idem (if w = 18m)
o.ii 17–18	1320	-	-	-	-
sub-total from Hi'abara to the dam of Du-magibil					
r.i 2				74502	idem
Part 2	**l (m)**	**w (m)**	**d (m)**	**v (m^3)**	**v (m^3) calculated**
r.i 3–4	21	9	3	567	idem
r.i 5–7	12	6	1.5	108	idem
r.i 8–9	12	6	1.5	108	idem
r.i 10–11	21	9	3	567	idem
r.i 12–13	15	6	1.5	135	idem
r.i 14–15	9	6	2	108	idem
r.i 16–18	3	6	1	18	idem
the big flow divider					
r.i 19– r.ii 1	24	9	3	648	idem
r.ii 2–3	21	9	3.5	661.5	idem
the flow dividers of the Ganamah-field					
r.ii 4–5	Subtotal			2920.5	idem
r.ii 6	Total			77422.5	idem

The structure of this text shows a clear demarcation into two parts (see table 5.14): The first part describes different subsections and respective workloads of an approximately 7 km stretch of a watercourse (line o.i 1–r.i 2) that extended from a town/village called Hi'abara to the dam of Du-magibil.[120] All linear dimensions are given—length (gid$_2$), width (dagal), and depth (bur$_3$)—from which the respective workloads were calculated. Hi'abara,according to Steinkeller (2001:

[120] Even though the text does not state explicitly that the individual segments listed actually describe sections of a canal, text BPOA 2 2563, r. 7–8 (kun i$_7$-da eg$_2$ Du$_6$-ma$_2$-gibil-la-ka-ta eg$_2$ a-ša$_3$-Lugal-ka ša$_3$ A-geštin-na-ka-še$_3$, "from dike of Du-magibil at the outlet of the canal to the embankment of the Lugal and Ageštin field") indicates that the Du-magibil hamlet was located at a watercourse.

38, fn61), was located at or close to the Tigris in the Da-Umma district, while the hamlet Du-magibil was situated at the tail end of a watercourse (kun i_7-da; see text BPOA 2 2563). This suggests that the workloads described concerned the entire length of the watercourse. The dimensions of 2 m depth and 12–18 m width point to a major tributary or canal branching off the Tigris close to Hi'abara. It is not entirely clear whether we are dealing with the blueprint for the construction or the partial extensions of this canal or simply the modification of an abandoned river channel. It is fairly certain, though, that the text is not dealing with the cleaning of an existing canal, as the depth of ca. 1–2 m would be a much higher annual silt accumulation than has been recorded for south Iraq for modern times (Fernea 1970: 132, 159–162; see chapter 2, 2.3.3.2).

The second part of the text (lines r.i 3–r.ii 6) is structured somewhat differently, as seven subsections are subsumed under the quote "the big flow divider" (kab_2-ku_5 gu-la) (lines r.i 3–8), and another two subsections are subsumed under the quote "the four flow dividers of the Ganamah field" (kab_2-ku_5 a-$ša_3$-$Gana_2$-mah 4-bi) (r.i 19–r.ii 5). The dimensions given in the second part of the texts describe two distinct flow dividers that were found within the 7 km (line o.i 1–r.i 2) long canal. A tentative sketch of the shape of the flow divider is provided in fig. 5.15. The envisioned design is a large flow divider that splits the water flow of the approximately 12–18 m wide parental channel, first into two approximately 9 m (lines r.i 3–r.ii 6)-wide canals on either side and then further into canals of 6 m width. The greater depth of approximately 3 m of the 9m-wide sections can be explained by the slope of the levee on either side of the main watercourse.[121]

The "big flow divider" constituted a specific type, as it is only attested for the Ganamah field and the Lugal canal (see appendix L and map 3). There is also a "small flow divider" (kab_2-ku_5 tur) attested for the Ganamah field, clearly distinguishing between small and large devices. The flow dividers of the Lugal canal were even larger than those of the Ganamah field, with 72 m length, 12 m width and 5 m depth for the first and 36 m length, 12 m width and 3.5 m depth for the second (see OrSP 47–49 511; Steinkeller 1988: 81–83). It is possible that these big flow

[121] I am indebted to Dr.ir. Maurits W. Ertsen for reviewing and discussing the hydraulic feasibility of the proposed reconstruction of this flow divider (May 2013).

dividers were originally avulsion points that that were maintained, managed, and modified over time to extend and create an artificial canal network by taking advantage of preexisting natural formations, as envisioned by Wilkinson (2003: 85). There is limited but sufficient evidence that flow dividers had parts such as the “water in the back” (a-egir),[122] or a breach or water outlet (a-e_3-a).[123] There are nine attestations of the flow divider being part of the device called bar-la_2[124] or mentioned alongside it, suggesting that these two devices were located next to each other

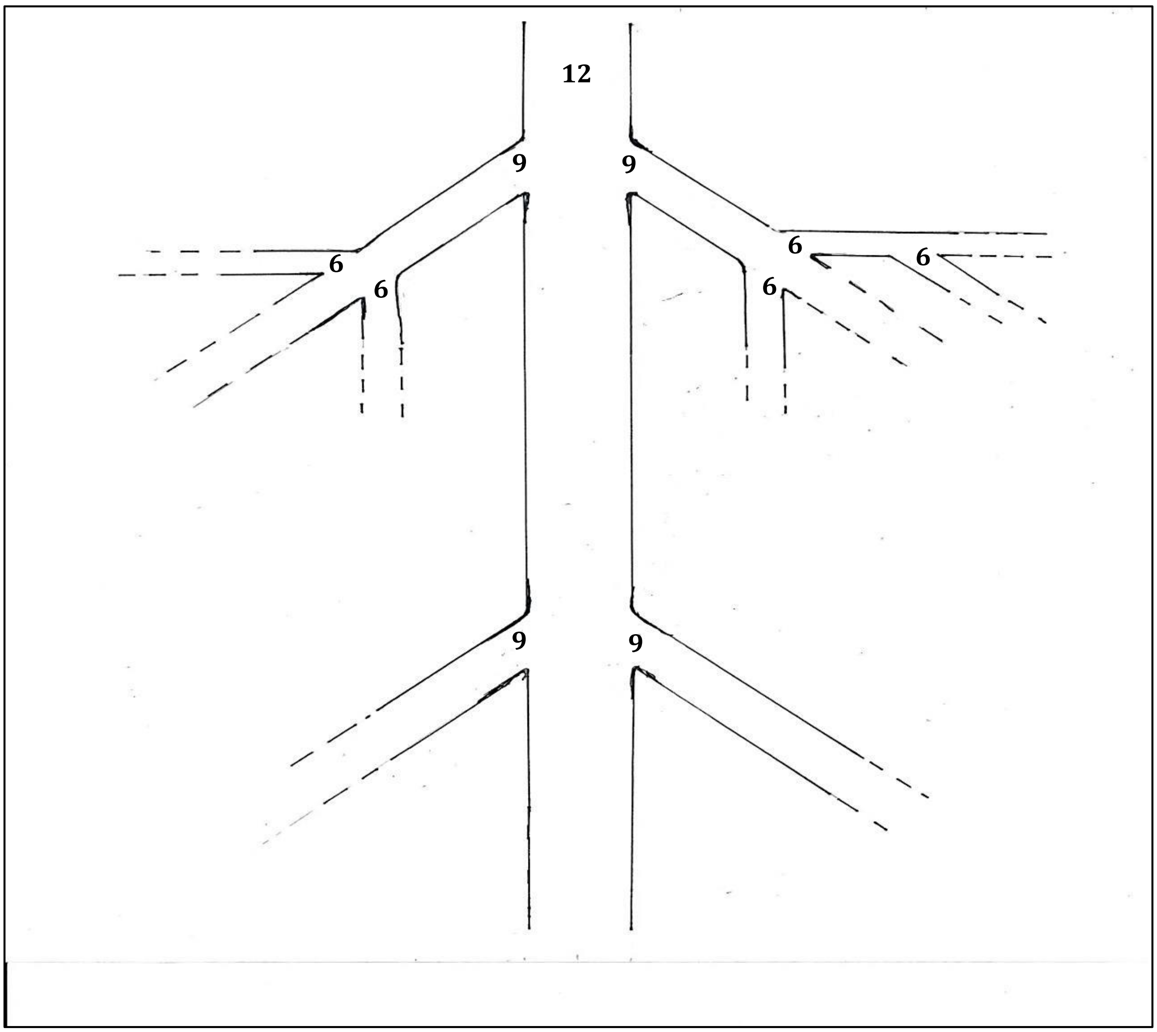


Figure 5.15 Possible reconstruction of the big flow divider (kab_2-ku_5 gu-la) of the Ganamah field

[122] BPOA 1 0948, o. 4; see appendix L under I-sala canal, year AS09-00-00. It is somewhat unclear whether this is part of the flow divider or a breach in the levee or canal embankment, which would have been more vulnerable at this particular spot due to changing water pressure and velocity.
[123] OrSP 47-49 361, o. 3; see appendix L under Ninhursag canal, year AS06-13-00.
[124] See appendix K for all the attestations to this device, whose function remains unclear.

5.2.5.3 Construction Design of the Sumerian Flow Divider (kab$_2$-ku$_5$)

The flow dividers in general were mainly constructed of earth (sahar), adobe (kin u$_2$ sahar-ba), reed (gi) and products of reed, plant material (u$_2$), and in rare cases timber (see table 5.16). Tamarisk ($^{\hat{g}eš}$šinig), poplar ($^{\hat{g}iš}$asal$_2$), or palm tree (^{giš}gišnimbar) flow dividers are attested as well or labeled simply "flow divider made of logs" (^{giš}UR$_2$xGADA) (table 5.16 and appendix L). It is not clear whether these flow dividers were simply named after these trees or actually constructed from them because the use of wooden planks/reed mattress/assembled logs (ad) is only attested for the flow divider of the Dubla-Utu canal at the Engabara field (see appendix L, table L.7).

Table 5.16

Construction materials at the flow dividers (kab$_2$-ku$_5$)

English	Sumerian	# References
insert/cover/coat the flow divider with earth	sahar si.g	127
work with adobe at the flow divider	kin u$_2$ sahar-ba	70
earth work	sar sahar	31
# bundles of reed for the flow divider	sa gi	24
carrying bundles of reed to the flow divider	gi ga$_6$-ga$_2$	11
carrying various plant materials to the kab2-ku5	u$_2$/u$_2$ HAR ga$_6$-ga$_2$	29
making wooden planks/reed mattress/assembled logs for the flow divider	ad ak	2

Despite the fact that timber is hardly attested as a construction material, text TCS 355 does suggest, that is was widely used even though we have no information on how it was used.

TCS 355	
obverse	
1. 104 ur$_2$ LAGAB	***o. 1–5***
2. kab$_2$-ku$_5$	104 logs of wood from the riparian forest of the Gala
3. tir i$_7$-Gal-la-ta	canal for the flow divider/s in the Gu'edena [field].
4. ki Ur-^{d}Šara$_2$-ta	**o. 4–6**
5. ša3 Gu$_2$-eden-na-še$_3$	from Ur-Šara
6. kišib I$_7$-pa-e$_3$	Ipa'e received
reverse	***r. 1–2***
1. iti še-sag$_{11}$-ku$_5$	**Month**: I (April)
2. mu us$_2$-sa ku$_3$ gu-za ^{d}En-lil$_2$-la$_2$! ba-du$_3$ (=LAL$_2$)	**Date:** AS04-00-00

One possibility is that it was used to construct a splitter wall or to reinforce the side walls of the flow dividers which would have both experienced considerable stresses due the rapid changes in water velocity. This made flow dividers very prone to erosion and the most frequently attested tasks are those of inserting or coating the flow dividers with earth (see table 5.16). The use of reed bundles is attested for 17 locations (see appendix L, table L.5–6) and could have also been used to strengthen the side walls of the flow dividers. Most of the recorded amounts are modest in comparison to the amount of reed used for the construction/repair of barrages (see table 5.17). The use of 5,100 bundles is attested for the flow divider of the Naram-Suen canal, suggesting that we are dealing with a fairly large flow divider (see appendix L).

The reed might have been bound together as fascines designed to strengthen the side walls of the flow dividers. That fact that some reed bundles are recorded as having been used to reinforce (keš.dr) the flow divider supports this claim. Reed was also used for other purposes, such as blocking ($uš_2$) the flow divider, as well as closing or repairing the water outlet/breach (a-e_3-a) (see appendix L, tables L.5 and L. 15). For the latter, counted reed (gi-ŠID)[125] was used, which, according to Sallaberger (1989: 315–316), describes a particularly valuable reed, mainly used for reed mats, reed ropes, reed baskets, and reed boats. The use of reed ropes (^{gi}gilim sur) is attested for the flow divider of the I-sala canal, but in what fashion they were used remains unclear (see Text BPOA 1 1143).

Table 5.17

Comparison between the amount of used reed bundle for barrage and flow dividers (kab_2-ku_5)

Statistics	**Barrage (kun-zi-da)**	**Flow divider (kab_2-ku_5)**
Average	5836.97	821.47
Min	180	2
Max	21633	5100
Median	2767.5	180
Mode	1720	30
Standard Deviation	6594.033	899.74

[125] Waetzoldt (1992: 130) translates "Spaltrohr," which means split reed. In fact, until recently reed was usually soaked, split, skinned, and pounded before it was used for making reed mats (Salim 1962: 108). Even though the verb šid means "counting," it is unclear how it should be translated in the context of reed. Sallaberger (1989: 315) suggests a translation of "processed" reed. Sallaberger argues that gi-ŠID describes the fully matured reed (12 months old) (Arab.*Jiniba*) harvested between January and March.

As has been already observed for barrages versus weirs (kun-zi-da), the flow dividers built with reed differed in their design, in that adobe (kin u_2-sahar-ba) was hardly used for their construction and/or repair. Instead, only the volume of earth (sar sahar) and the transport of plant materials (u_2 ga_2-ga_6) are recorded for the flow dividers made primarily from reed. The reverse is true as well; the use of reed is rarely attested for those flow dividers mainly constructed from adobe (compare appendix L, tables L.3–7). As was the case for the barrages and weirs, the difference in construction design corresponds to a difference in size. The flow dividers constructed with reed were associated predominantly with the largest irrigation canals, such as the Naram-Suen, Šara, and the I-sala canals (see appendix L, table L.1.3). It can be assumed that larger flow dividers differed also in shape from those made primarily from adobe. How they however differed from each other is difficult to establish at this point.

5.2.5.4 Tasks Performed at the Flow Dividers: Operation and Maintenance

The ancient records document a variety of tasks that were carried out at the different flow dividers in the Umma province (see table 5.18).

Table 5.18

Tasks performed at the flow dividers (kab_2-ku_5)

English	**Sumerian**	**# References**
excavating the flow divider	ba-al	2
removing earth from the flow divider	sahar zi.g	27
collecting earth from the flow divider	sahar šu--ti	46
cleaning the flow divider	šu/$šu_2$ luh-ak	12
Incising/opening the flow divider	ku5.dr	30
blocking the flow divider	$uš_2$	45
to reinforce the flow divider	$keš_2$.dr	5
insert/cover/coat the flow divider with earth	sahar si.g	127
restoring the weir of the flow divider	kun-zi-da gi_4 kab_2-ku_5	8
stationed at the flow divider	gub	121
to caulk (w. bitumen (?))	du_8	2
leveling the flow divider	šu--ur_3	2
“sitting” at the flow divider	tuš	1
diverting the rising water via the flow divider	a zi-ga dib	2

What each of the recorded tasks accomplished remains somewhat ambiguous since it is frequently difficult to decide whether the work done pertained to the construction, the maintenance or the operation of the flow dividers. The fact that they were frequently blocked (uš$_2$) suggests that these flow dividers were operated to some extend by means of inserting (sahar si.g) and removing earth (sahar zi.g; sahar šu--ti) or other materials. However, which text refers to the operation and which to the construction and the maintenance of the flow divider is frequently difficult to discern.

A. Earth Work for the Operation of the Flow Dividers

There is an indication that suggests that some of the attested work of moving earth in and out of the flow divider was closely related to their operation. According to text MCS 3 89 BM 111800, earth was transferred (sahar šu-bal) or collected (sahar šu--ti) from the flow divider prior to the irrigation of the Nunna-field, only to be reinserted after irrigation had taken place.

MCS 3 89 BM 111800	
obverse	***o.1–5***
1. 18 guruš u$_4$ 2-še$_3$	18 workmen for 2 days cleaned the barla of the Nunna
2. bar-la$_2$ a-ša$_3$-Nun-na-ka-ke$_4$ šu-luh ak	field, and for 2 days manually removed earth from the
3. u4 2-še$_3$ kab$_2$-ku5-ta sahar šu bal	flow dividers, and for two days irrigated the Nunna field,
4. u4 2-še$_3$ a-ša$_3$-Nun-na-´ke$_4$` a du$_{11}$-ga	and for 3 days inserted earth into the flow divider
5. u4 3-še$_3$ kab$_2$-ku$_5$-a sahar si-ga	***o. 6–r. 2***
6. ugula Lu$_2$-^{d}Šara$_2$	supervisor was Lu-Šara
reverse	sealed (by) was Lugal-inimgina
1. kišib Lugal-inim-gi-na	**Year:** AS09-00-00
2. mu en Ga-eš^{ki} ba-hun	**Seal:** Lugal-inimgina, scribe, son of Lugal-nesag
seal	
1. Lugal-KA-gi-na dub-sar	
2. dumu Lugal-nesag-e	

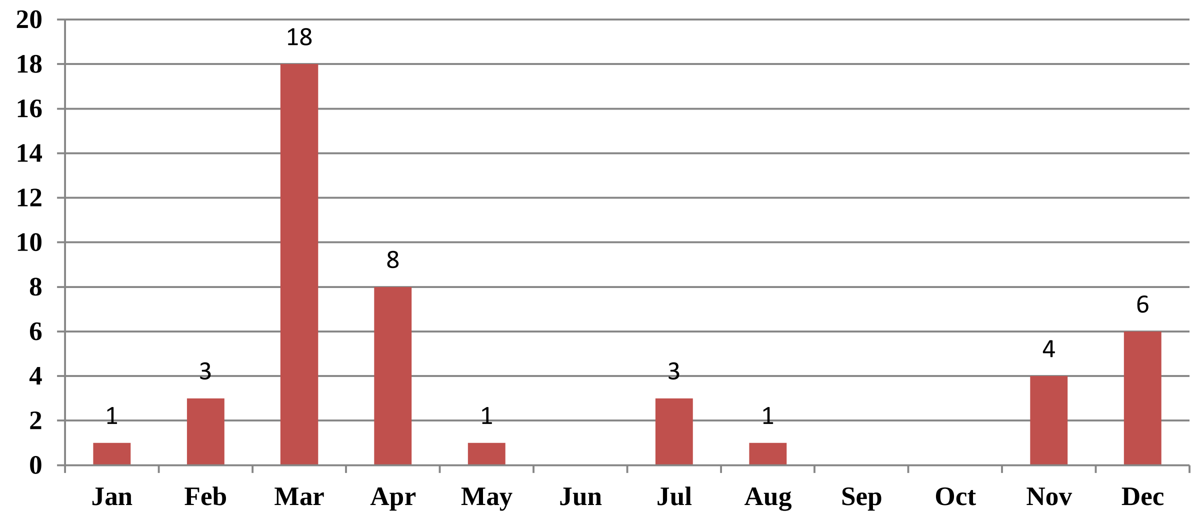
This pattern can be observed in 14 records as listed in table 5.19, which document the irrigation of fields alongside tasks performed at the flow dividers. The texts show that earth was collected (sahar šu-ti-a) from the flow divider *prior to* the irrigation of a field and earth was inserted (sahar si.g) only *after* the irrigation of a field was completed. It is plausible though difficult to prove that many of the records on inserting earth (sahar si.g) reflect the operation of the flow divider more than its maintenance, particularly since it had to happen more than once a season (compare appendix L, table L.2 and L.11 for the flow divider of the I-sala canal).

Table 5.19 References recording the operation of the flow dividers (kab$_2$-ku$_5$)	
collecting earth from the flow divider (sahra šu--ti) before irrigating a field	inserting earth (sahar si.g) into the flow divider after irrigating a field
Nik. 2 136	Aleppo 221
BPOA 1 0513	BPOA 7 1853
MCS 3 89 BM 111800	MCS 3 89 BM 111800
SAT 3 1245	Princeton 1 432
	Farmer's Instructions 2.03
	MVN 21 053
	MVN 18 195
	MVN 18 250
	UTI 3 1743
	BPOA 7 2391

Chart 5.20

Monthly distribution for the task cover/coat (sahar si.g) the flow divider (kab$_2$-ku$_5$) with earth

Sample Size: 46 out of 127 = 36%



This conclusion is further supported by the timing of when this task was carried out (see chart 5.20). With 36% of the references dated by month, the pattern observed shows that earth was inserted primarily operated in March/April. As will be discussed in greater detail below (see 5.3.3), fields appear to have been only irrigated twice per cropping cycle, but predominantly in March/April, which might be reflective of slightly moister climate conditions during the 3rd

millennium B.C. in southern Iraq. The high frequency of inserting earth into flow dividers around that time might be related to guiding water into different subsections of the irrigation system.

B. On Work Duty at the Flow Divider (kab$_2$-ku$_5$ gub)

Most records document workers being stationed at the flow divider without specifying the job they performed. However, the pattern that emerges from the sample dated by month (22% out of 121 textual references) is strikingly similar to the one observed for the task of inserting earth (sahar si.g), with a peak in early spring (March through May), another one in in December/January, and a few references dating to August/September. This latter most likely reflects initial flooding, the first and second irrigations in spring (see appendix L, table L.17, L.17.2, and compare with L.2.3).

C. Flow Dividers and Flood Control

Three tasks—the removal of earth (sahar zi.g), incising/opening (ku$_5$.dr) and blocking (uš$_2$)—indicate that flow dividers also fulfilled other functions in addition to the spatial distribution of irrigation waters. Text UTI 4 2737 clearly indicates that certain flow dividers could also function as flood control devices so that excess water could be diverted into nearby depressions or marshland to lower the water level in the river. As will be discussed in full in chapter 6, 6.3.3 there is evidence that kab$_2$-ku$_5$ were constructed ad hoc to combat serious flooding. In this context I would translate kab$_2$-ku$_5$ as “artificial breach” since its function is related to flood control and not the distribution of water for irrigation.

UTI 4 2737 ***obverse*** 1. 12 guruš u$_4$ 5-´še$_3$` 2. kab$_2$-ku$_5$ I$_7$-sal$_4$´ki` gub-ba 3. a zi-ga dib-ba 4. ugula Tab-ša-la 5. kišib <nam>-ša$_3$-tam Ur-mes ***reverse*** =========== 1. iti ^{d}Dumu-zi 2. mu ma$_2$ ^{d}En-ki ba-ab-du$_8$ seal 1. Ur-mes 2. dub-sar	 ***o. 1–3*** 12 workmen for 5 days were stationed at the flow divider of the I-sala canal to divert the rising water (of the Tigris (?)) ***o. 4-5*** supervisor (was) Tab-šala sealed by Ur-mes ***r. 1–2*** **Month:** XII (March) **Year:** SS02-12-00 **Seal:** Ur-mes, scribe, son of Ur-Ašnan

3. dumu Ur-^{d}Ašnan	

As has been discussed in chapter 2, 2.3.3.16 making an artificial breach in the river's levee to prevent flooding further downstream was a commonly practiced flood emergency measure also in modern times. The removal of earth (sahar zi.g) appears to have been done around harvest time (during the flood season) in order to flood nearby fallow or recently harvested fields as a flood prevention measure (see appendix L, table L.10, and see Text Farmer's Instruction 2.09).

Farmer's Instructions 2.09	
obverse	
1. 6 sar sahar	***o. 1–3***
2. kab$_2$-ku$_5$ i$_7$-Muru$_{13}$-ta	Removing 108m^3 of earth from the flow divider of the
3. sahar zi-ga	Muru canal
4. 92 guruš u$_4$ 1-še3	***o. 4–9***
5. a-ša$_3$-Gu$_2$-eden-na	92 workers for one day flooded the Gu'edena field (and)
6. 46 guruš u$_4$ 1-še$_3$	46 workers for one day the Gana-anše and the Adalla-
7. a-ša$_3$-GAN$_2$-anše u$_3$	gana-Lu-^{d}Šara fields
8. a-ša$_3$-A-dalla-GAN$_2$-Lu$_2$-^{d}´Šara$_2$`	***o. 10–12***
9. a-ša$_3$-ga a-de$_2$-a	supervisor (was) Ur-^{d}Ninsu
10. ugula Ur-^{d}Nin-su	sealed by Ipa'e
11. kišib I$_7$-pa-e$_3$	**Year:** SS04-00-00
12. mu bad$_3$ mar-tu ba-du$_3$	**Seal:** Ipa'e, scribe, son of Lu-^{d}Šara
seal	
1. I$_7$-pa-e$_3$	
2. dub-sar	
3. dumu Lu$_2$-^{d}Šara$_2$	
4. sag-´du$_5$`	

D. Incising/Opening (ku$_5$.dr) and Blocking (uš$_2$) the Flow Dividers

This might also explain why certain flow dividers were mainly "to divide/cut/incise/open" (ku$_5$.dr) during the flood season in April and May (see appendix L, table L.13, L.13.2). Since 30% of the references are dated by month, the pattern is representative. Once the water levels in the river decreased, flow dividers were blocked (uš$_2$) (see appendix L, L.14 and L.14.1). 48% of the 28 references are dated by month, and the majority fall into June/July, indicating that the blocking of a flow divider was related to something other than irrigation (see table L.14.1). It is possible that blocking certain flow dividers during the summer month was a way to prevent water escaping the higher order canals. Maintaining a certain water depth in primary and secondary canals might have been desirable for irrigating orchards, domestic use and for boat traffic. The materials used for the blocking of these devices were mainly adobe (kin u$_2$ sahar-ba) and earth (sahar), as well as reed (gi) and various types of plant matter (u$_2$) (see table L.14).

E. The Evidence of the Mid-Level Administrators Lu-^{d}Nanna and ^{d}Šara-Nirgal

This pattern is partially confirmed by a set of 96 tablets, which record on a nearly daily basis the various assignments of two work crews of ca. 30–36 menials (UN-ga_6) under the supervision of two mid-level administrators called Lu-Nanna and Šara-Nirgal (see appendix M). Flow dividers were opened (lit. incised [ku_5.dr]) in May and July but blocked primarily in June/July (see table 5.21). This work diary also shows that the pattern could be reversed. For example, earth was inserted (sahar si.g) into the flow divider of the Ninura-field around May 23 and July 27only to be opened (ku_5.dr) around July 30, suggesting that the function of these flow dividers varied according to location (see appendix M, table M.1).

Table 5.21

Tasks attested by frequency in consecutive month

Month	# Loc.	inserting earth (sahar si.g)	%	blocking ($uš_2$)	%	opening (ku_5.dr)	%	Others
April	19	**18**	94	**1**	5			
May	9	**6**	66.7	**1**	11	**2**	22	
June	6	**1**	16.7	**4**	66.7			1
July	9	**1**	11	**6**	66.7	**2**	22	
August	0							

F. Stationed at the Water of a Flow Divider (a-da gub kab_2-ku_5)

There are about 13 references (appendix U, table U.3.1) documenting the number of workers on water duty at flow dividers (kab_2-ku_5). In the majority of cases, water duty is mentioned alongside the operation of the flow dividers (e.g., inserting earth [kab_2-ku_5 sahar si.g],[126] collecting earth [sahar šu--ti],[127] to clean (šu/$šu_2$luh-ak),[128] to incise/to open [ku_5.dr],[129] or to

[126] See Syracuse 144, o. 4–6: 62 guruš a-da gub-ba 4 sar sahar guruš 10 gin_2-ta kab_2-ku_5 a-$ša_3$-Sag-du_3 sahar si-ga, "62 workers were stationed at the water (and) filled in a volume of 72m^3 of earth, per workman 3m^3, into the flow divider." See also, Aleppo 221, o. r. 3 CBCY3, NBC 03631, o.1–o.4; MVN 16 0991, o.1–o.5; MVN 16 1015, o.1–r. 1; Syracuse 116, o.1–4; Syracuse 144, o.4–o.6; UTI 6 3709: o.1–o.9.; Vicino Oriente 8/1 011: o.1–r.1.

[127] See MVN 01 088, o. 5–r. 1: 12 guruš u4 10-$še_3$ a-da gub-ba 16 guruš u_4 1-$še_3$ kab_2-ku_5-ta sahar šu ti-a a-$ša_3$-Lugal-ka, "12 workers for 10 days were stationed at the water. 16 workers for one day collected earth from the flowdivider of the Lugal field." See also Princeton 1 518. See also Princeton 1 518; SAT 3 1245, o. 1–o. 6; SAT 3 1382, o. 1–r. 2; UTI 5, 3402.

[128] See, MVN 16 1565; BPOA 1 0788.

[129] See, Nisaba 23 063, o.1–o.6.

reinforce it [keš$_2$.dr] it).[130] This suggests that water duty in this context must have been related to larger water-moving operations—most likely for irrigation (see MVN 16 1567 and MVN 16 1565**;** also CTMMA 1 33). The duty might have entailed monitoring the water flow at the divider to ensure that the proper amount was let into the various subsections of the irrigation system.

MVN 16 1565 ***obverse*** 1. 25 guruš u$_4$ 1-še$_3$ 2. kab$_2$-ku$_5$ I$_3$-sum šu-luh ak 3. a ku$_5$-ra$_2$ u$_3$ 4. a-da gub-ba ***reverse*** 1. ugula Ba-sa$_6$ 2. kišib Ab-ba-gi-na # (Seal) 3. mu us$_2$-sa ma$_2$ ^{d}En-ki ba-ab-du$_8$ ***seal*** 1. Lu$_2$-^{d}Šara$_2$ 2. dub-sar 3. dumu Ur-sa$_6$-ga	***o. 1–4*** 25 workers for one day cleaned the flow divider, split/divided the water, and were stationed at the water. ***r. 1–3*** supervisor was Basa sealed by Abba-gina **Year:** SS03-00-00 **Seal:** Lu-Šara, scribe, son of Ur-saga

MVN 16 1567 ***obverse*** 1. 195 guruš u$_4$ 1-še$_3$ 2. kab$_2$-ku$_5$ ^{d}Šul-pa-e$_3$-/ta sahar zi-ga 3. a-da gub-ba a-ša$_3$-^{d}Šul-pa-e$_3$ 5. kab$_2$-ku$_5$ A-u$_2$-da tur ku$_5$-ra$_2$ ***reverse*** 1. u$_3$ šu$_2$-luh ak 2. ugula Lu$_2$-^{d}Šara$_2$ 3. kišib Lugal-he$_2$-gal$_2$ # (Seal) 4. mu ma$_2$ ^{d}En-ki ba-ab-du$_8$ ***seal*** 1. Lugal-he$_2$-gal$_2$ 2. dub-sar 3. dumu Ur-nigar$_X^{gar}$	**o. 1–r. 1** 195 workers for one day removed earth from the flow divider of the Šulpa'e [canal] (and) were stationed at the water of the Šulpa'e field (and then) opened the flow divider of the A'udatur field and cleaned it. **r. 2–3** supervisor was Lu-Šara sealed by Lugal-hegal Year: SS02-00-00 Seal: Lugal-hegal, scribe, son of Ur-nigar

5.2.4.5 Administration of the Flow Dividers

It appears that the Sumerian flow dividers were just as closely managed as those of medieval Valencia (Glick 1970: 39–40, 87–89). As text YOS 04 235 suggests, flow dividers were inspected on a regular basis.

[130] MVN 13 331, o. 1–o.3: 179 guruš u$_4$ 1-še$_3$ a-da gub kab$_2$-ku$_5$ ki-gam-ma keš$_2$-ra$_2$,"179 workers for one day were stationed at the water (and) closed/tied the flowdivider of Kigama." See also UTI 5, 3371, o. 1–5.

YOS 04 235	
obverse 1. kab$_2$-ku$_5$ da Umma^{ki}-ka a-na gal$_2$-la 2. Er$_2$-dingir-e igi kar$_2$-kar$_2$-dam ***reverse*** ============ 1. mu ^{d}Amar-^{d}Suen lugal ***seal*** 1. Er$_2$-dingir 2. arad$_2$ ^{d}Šara$_2$ 3. dumu Lugal-sa$_6$-ga	**o. 1–2** Flow dividers—as many as they are in the Da-Umma district—are to be inspected by Erdingir. **r. 1** **Year:** AS01-00-00 **Seal**: Erdingir, servant of god Šara, son of Lugal-saga

The proper operation of these devices could be also be a source of contention, as the court document BPOA 1 0600 shows. The conflicting parties appear to have been the royal versus the governor-run sector, which is further supported by the fact that the bystanders (or witnesses), such as Amu’a, Lu-dingira, and Nidamu, were all peripatetic officials and royal appointees who attended trials in different provinces (Molina 2013b: 132–133, 135). Ur-gigir, who acts in this case as the plaintiff, was an agricultural administrator under the authority of Egalesi (Vanderroost 2012i: 81, 99, 111–114, 2012ii: 200–206). The latter was a high official who ran the agricultural sector of the governor’s household in the Da-Umma and Mušbiana/Gu’edena districts together with Lugalemah(e). Even though the text does not discuss the actual damage that was accrued by keeping the flow dividers open, it must have been serious enough to be brought to trial.

BPOA 1 0600	
obverse 1. 1 Muš-ki-num$_2$ šar$_2$-ra-ab-du a-ša$_3$-ga 2. 1 Gu-du-bi 3. 1 An-ne$_2$-ba-ab-du$_7$ 4. 1 Nam-ha-ni 5. 1 A-NE.GAN$_2$ 6. kab$_2$-ku$_5$ Muru$_{13}$-ka-kam 7. haš-da bi$_2$-in-eš-a / na-na-aš? ***reverse*** 1. kab$_2$-ku$_5$^{giš}Asal$_X$ (=A.TU.NIR) 2. u$_3$ kab$_2$-<ku$_5$> Sig-ga-ka 3. nu-bi$_2$-in-eš-a 4. Ur-^{giš}gigir-ra 5. nam-erim$_2$-bi ku$_5$-dam 6. [ig]i ensi$_2$-ka-še$_3$ 7. igi A-mu-a-še$_3$ 8. igi Lu$_2$-dingir-ra dumu Lugal-ba-ta-ab-e$_3$-še$_3$ 9. igi Da-ad-da-mu-še$_3$ 10. igi NI-da-mu-še$_3$ ***left edge***	***o. 1–r. 3*** Muškinum, the administrator of the fields (responsible for projections), Gudubi, Anne-ba’abdu, Namhani and A.NE.GAN2 concerning the flow divider of the Muru field: they only ordered to cut (the water flow of it). They did not order (to cut the water flow) of the ^{giš}Asal flow divider and the Siga flow divider. ***r. 4–5*** On this, Ur-gigira will take an assertory oath. ***r. 6–10*** Witnesses were: the governor, Amu’a, Lu-dingira, son of Lugal-batabe, Dadamu, Nidamu. **l.e. Month:** I (April) **Year:** AS 05

1. iti še-sag$_{11}$-ku$_5$ mu us$_2$-sa en ^{d}Nanna ba-hun	

5.2.5 Managing Water Flow within Canals for Irrigation

The water flow within irrigation canals was managed by weirs (kun-zi-da). They were simple dam structures running across the entire width of the canal. Just as has been described for modern times (chapter 2, 2.3.6.10), there is evidence that only a section of this adobe dam was closed or opened to irrigate and afterwards let water pass to downstream users. Three texts (UTI 5 3157, BPOA 6 1332; see also Farmer's Instructions 2.06) support this conclusion, as the weir is regularly restored (gi$_4$) following the irrigation of a field (a--du$_{11}$.g). The meaning of “restoring' (gi4) in this contexts is somewhat opposite to the meaning of restoring barrages discussed in chapter 4, 4.1.3. Restoring barrages meant in fact, fixing the damage that had occurred as a result of the flood. In the case of the weirs, the logic would be that part of the dam is broken down after the water is diverted to let it pass to downstream users.

UTI 5, 3157	
obverse	***o. 1–2***
1. 42 [guruš? u$_4$-1]-še$_3$	42 workers for one day cleaned the [...]-canal
2. i$_7$-A-[...]-ke$_4$ / šu-luh ak	***o. 3–r.1***
3. 52 guruš u$_4$-1-še$_3$	52 workers for one day irrigated the field and then
4. a-ša$_3$-ge a du$_{11}$-ga	restored the weir of the Muru field
5. [u$_3$ kun]-zi-da gi$_4$-a	***r. 2–4***
reverse	supervisor was (was) Agugu
1. a-ša$_3$-Muru$_{13}$	sealed by Lugal-emah(e)
2. ugula A-gu-gu	**Year**: SS03
3. kišib Lugal-e$_2$-mah-e	**Seal:** Lugal-emah(e), scribe, son of Lugal-kugani
# (Seal)	
4. mu Si-ma-num$_2^{ki}$ / ba-hul	
seal	
1. Lugal-e$_2$-mah-e	
2. dub-sar	
3. dumu Lugal-ku$_3$-ga-ni	

As has been discussed in chapter 2, the labor demand for this kind of operative work is relatively low, and the task can be completed by one or two workers. This might explain why very few texts document the incising and consecutively restoring of these weirs during the irrigation of fields. In contrast, the number of labor days recorded for weirs being restored (gi$_4$) is relatively high, as are the amounts of used adobe mixture (see table 4.4, appendix A, and table A.17). Since most of the weirs are associated with fields, I argue that these quantities refer to more than one device. This argument is further supported by the fact that the fields for which weirs are attested are quite large. So, for example, the size of the Ninura field was close to 180 ha (= 500 iku) or even larger (Pettinato 1967i: 137–139). The irrigation of such an area required certainly more than one weir in the network of canals conveying water to this field.

BPOA 6 1332	
obverse	***o. 1–2***
1. 180+20+1 guruš	200 ox-drivers for one day cut willow (?) in the Lamah
2. ša$_3$-gu$_4$ u$_4$ 1-še$_3$	field
3. a-ša$_3$-La$_2$-mah	***o. 3–6***
4. ^{giš}ma-nu ku$_5$	15 workers for 3 days irrigated the field
5. 10+5 guruš u$_4$ 3-še$_3$	**r. 1–2**
6. a-ša3 e du$_{11}$-ga	20 workers for 3 days restored the weir
reverse	***r. 3–l.ed. 3***
1. 20 guruš u$_4$ 3-še$_3$	Month: IX (December)
2. kun-zi-da gi$_4$-a	**Year:** SH34
3. iti ^{d}Li$_9$-si$_4$	Lugal-e2-mah-e
4. mu An-ša-an^{ki} ba-hul	under the authority of <>
left edge	from Lugal-Kiri
1. Lugal-e$_2$-mah-e (sic)	**Seal:** Lugal-emah(e), scribe, son of Lugal-kugani
2. gir$_3$<>	
3. ki Lugal-^{giš}kiri$_6$-ta	
seal	
1. Lugal-e$_2$-mah-e	
2. dub-sar	
3. dumu Lugal-ku$_3$-ga-ni	

5.3. Irrigation of Fields

While the spatial distribution of water via flow dividers remains somewhat obscure, the actual allocation of water to the fields is well understood and well documented. The available record documents the number of labor days spent on the irrigation of various fields. Three terms describe the watering of fields: a--gar/ga$_2$/ga$_2$,[131] a--du$_{11}$-ga, and a--de$_2$. Civil (1994: 68–69) suggests that a--gar was a more generic term for irrigating fields, while a--du$_{11}$.g refers to the systematic irrigation of a field with a specific amount of water after sowing. A--de$_2$ on the other hand describes according to Civil (1994: 68) the flooding of fields with floodwater. He suggests that the "flooding" of fields was done right around the flood season. There is evidence for the

[131]The verb a--gar/ga2-ga2 = "to irrigate" is very rarely attested in the Umma record (to my knowledge only in four texts: SET 259, o. 2, 12; Syracuse 014, o.5; UTI 5, 3241, o.2; SAT 2 0715, o.6). Text SAT 2 0715, o. 4–6, uses both verbs (a--gar and a--du$_{11}$-ga) to refer to irrigating the fields. The verb might indeed describe a slightly different inundation method. However, the number of attestations is too small to draw any firm conclusions.

flooding of fallow and/or recently harvested fields during the flood season or shortly after[132], either as preventive measure to reduce the amount of water in the river, for pasture or the cultivation of summer crops (e.g. sesame, see text BPOA 7 2472*)*. However, a closer examination of the references indicates that a--de2 primarily describes the initial irrigation of fields prior to cultivation (see also Maekawa 1990: 127–128). In a broader sense the two terms a--de2 and a--du$_{11}$.g describe irrigation understood as applying water to arable land with the purpose of aiding agriculture. The semantic difference between the two terms is temporal, indicating whether or not water was applied prior or after sowing. Sumerian clearly distinguishes between the two operations and the two verbs are deployed exactly in this fashion in the Farmer's Instruction (Civil 1994: 68–69, Steinkeller in prep).[133]

5.3.1 Initial irrigation (a--de$_2$)

The initial irrigation is documented in by text MVN 14 0225, which clearly indicates that it was done prior to plowing, most likely to soften the soils. As mentioned in chapter 2, 2.3.3.3 the soil can be dried up to a depth of 2–3 m over the summer which makes it too hard to be plowed unless it is softened with water.

MVN 14 0225	
1. 14 (bur$_3$) gan$_2$ a de$_2$-a	1.–2
2. Er$_2$-dingir-ka a-ša$_3$ a-gi	88.20 ha of the land of Erdingir was flooded. There are three flow dividers in the flooded field (but) there will be no area fit for plowing before the new moon.
3. kab$_2$-ku$_5$-bi ki 3-am$_3$ i$_3$-gal$_2$	
4. ki-uru$_4^{ru}$ u$_4$-sakar-še$_3$ nu-gal$_2$	
5. 9 (bur$_3$) 1 (iku) gan$_2$ a de$_2$-a ⌈Gu⌉-u$_2$-gu-a	5.–7.
6. [x] ⌈x⌉ [x] ⌈x⌉ DU-bi-im	51.51 ha of land was flooded, Gūgua …
7. [x] ⌈x⌉-ba he$_2$-em-e	

Unfortunately, there are only two texts dated by month. However, text SNAT 438: o.10 – r.1 shows very clearly the initial irrigation was performed between June and August. This date is also confirmed in text MVN 14 0056.

[132] See text Nik. 2 159 which lists harvest work in relation with flooding fields. The text is labeled "in the harvest/ harvest period" (ša$_3$ buru$_{14}$) indicating that the work listed was carried out right around the flood season.

[133] See "Farmer's Instructions" lines 2-6: a- šag$_4$ dib-be$_2$-da-zu-de$_3$ / eg$_2$ pa$_5$ du$_6$ du$_8$-u$_3$-de$_2$ igi kar$_2$-kar$_2$-ra-ab / a-šag$_4$ a de$_2$-a-zu-de$_3$ abi šag$_4$-ba nu-il$_2$ / ud a im-mu-e-a-e$_{11}$-de$_2$-a / a-šag$_4$ ki-duru$_5$-bi en-nu-un ak-ba ki-še-er ara-ab-tuku, "when you prepare a field (for cultivation), inspect the embankments, ditches, and elevations that need to be opened; when you are flooding a field, the water should not rise in it (i.e., the field) too high; guard the areas with standing water in the field; it should have outer limits" (Steinkeller in prep.).

SNAT 438

obverse

1. 3 guruš 10 la$_2$ 1 ´UN-ga$_6$`
2. iti še-sag$_{11}$-ku$_5$ u$_4$ 30-še3
3. a zi-ga-da gub-ba
4. u$_3$ i$_7$-da u$_3$ eg$_2$-zi-DU a$_2$ Šakkan$_6$
5. 3 guruš 10 la$_2$ 1 UN-ga$_6$
6. u$_4$ 30-še$_3$ a-da gub-ba
7. a-ša$_3$-Muru$_{13}$ a-ša$_3$-^{giš}Ma-nu
8. u$_3$ a-ša$_3$-Ensi$_2$-ka
9. iti sig$_4$ ^{giš}i$_3$-šub gar
10. 3 guruš 10 la$_2$ 1 UN-ga$_6$
11. iti še kar gal$_2$-la-ta
12. iti RI-še$_3$
13. a-da gub-ba a-ša$_3$-^{d}Šara$_2$-gu$_2$-/gal a-ša$_3$-^{d}Nin-ur$_4$-´ra` Igi-/e$_2$-mah-še$_3$ u$_3$ a-ša$_3$-Muru$_{13}$

reverse

1. a-da gub-ba a-ša$_3$-ga a de$_2$-a
2. 25 guruš 120 UN-ga$_6$ u$_4$ 1-še$_3$
3. u$_2$-HAR-an ga$_6$-ga$_2$ ^{g}igilim sur-ra u$_3$ ka i$_7$
4. a-ša$_3$-Muru$_{13}$ keš$_2$-ra$_2$
5. 24 guruš 58 UN-ga$_6$
6. eg$_2$-zi-DU a$_2$ Šakkan$_6$ gub-ba
7. 13 guruš 40 UN-ga$_6$
8. a-ša$_3$-ge a du$_{11}$-ga
9. 2 guruš 7 UN-ga$_6$
10. a la$_2$!-a a-ša$_3$-^{d}Šara$_2$-gu$_2$-gal
11. 2 guruš 6 UN-ga$_6$
12. ka E$_2$-šah$_2$-še$_3$ u$_2$ ga$_6$-ga$_2$
13. a$_2$ UN-ga$_6$ ugula Arad$_2$
14. kišib A-gu-gu
15. mu ^{d}Šu-^{d}Suen lugal

seal

1. Lugal-´ezem?`
2. dub-sar
3. dumu Da-da

o. 1–4
3 workmen and 9 menials in the I. month (April) for 30 days were stationed at the rising water of the Tigris (?) and the flood dike on the side of the Šakkan [field].

o. 5–9
3 workmen and 9 menials were stationed at the water of the field Muru and ^{giš}Manu and the governor's field in the II. Month (May)

o. 10 – r. 1
3 workmen and 9 menials from the III. – V. months (June-August) stationed at the water to flood the fields Šara-gugal, Ninura, Igi-emahše, and Muru

r. 1–5
25 workmen and 120 menials for one day carried ^{u2}Har.AN-weed, twisted ropes, and strengthened the inlet of the canal of the Muru field

r. 6–7
24 workmen and 58 menials were stationed at the flood dike on the side of the Šakkan [field]

r. 8–9
13 workmen and 40 menials irrigated the field

r. 10–11
2 workmen and 7 menials carried (?) water (to) the Šara-gugal field

r. 12–13
2 workmen and 7 menials carried grass to the inlet of the E-sah (canal)

r. 14–16
the labor of menials of the supervisor Arad
(the tablet was) sealed (by) Agugu

Year: SS01-00-00

Seal: Lugal-ezem, scribe, son of Dada

A set of 12 texts[134] however proves that the initial irrigation of fields (a-de2-a) was intimately related to the plowing and sowing of fields. These records fall into the category of "seed and fodder texts" which list the amounts of grain spent on seeds (še-numun), fodder (mur-gu$_4$) for draft animals and wages paid to hired laborers (lu$_2$ hun-ga$_2$) (see Englund 2011 for a translation of such texts). All of these texts conclude with a-de$_2$-a and the year name, clearly showing that the initial irrigation was part of the plowing and sowing operation. It is possible, that the wages mentioned in some of these texts might have been paid to laborers who were hired to perform the initial irrigation of the fields as the plowing and sowing was usually performed by

[134] ASJ 09 251 28; ASJ 11 142; BPOA 1 0716; BPOA 1 0945; BPOA 1 1599; Ontario 2 086; SNAT 319; SNAT 343; SAT 2 0731; SAT 3 1590; Sumer 54 33 3 and Sumer 54 35 4; UTI 3 1962.

cultivators (engar) and ox-drivers (ša$_3$-gu$_4$). The plowing (tug$_2$-sag$_x$) of fields began as early as July and lasted through September/October (see appendix P, table P.3). Carrying out the initial irrigation between June and August is in line with the Sumerian cultivation calendar.

Note that soils in ancient Sumer were worked several times prior to sowing, which account for the beginning of field work as early as July. This practice is also attested today as Russel (1957:3) notes: "The soil during a season of crops gets compacted by winter rains or irrigation, and by trampling of people harvesting or animal foraging. It needs to be loosened to facilitate seed coverage, seedling root development, aeration, penetration of water etc., etc." The Arabic expression for loosening the soils is described as "letting the earth breath". This type of plowing is done a month or two prior to the proper plowing and sowing (Hamdani, p.c. March 23, 2015). The Farmer's Instructions indicate that the soil was first loosened by three rounds of plowing (tug$_2$-sag$_x$), followed by several rounds of harrowing (giš--ur$_3$) and flattening the soil with a heavy maul. The soil was then hoed (al--ak) before drawing the furrows (ab-sin$_2$) with the seeder plow (^{giš}apin) (Civil 1994: 76). Since there has been no systematic study of Ur III cultivation practices it remains unclear if all steps were always performed. Maekawa's (1990: 119–124) study indicates that certain fields were plowed once or twice and harrowed for several times, while others were only harrowed but not plowed.

A group of five texts[135] from the neighboring province Girsu/Lagaš, further indicate that the initial irrigation was a tightly controlled process that included the draining of excess water. All texts record an oath reading as follows: "PN has declared under oath that his flooded fields are drying up [a ba-da-0-lahlah-0]; he is draining/removing water from them [a ba-ta-b-ga2-ga2-e] without the chancellor's permission (literally: without the chancellor being present). If they continue to dry out [ba-da-0-lah-lah-0], he will be killed." (Steinkeller, in prep.). This suggests that the three breaches/flow dividers (kab$_2$-ku$_5$) mentioned in text MVN 14 0225, line o.3 had a draining function. The saturation of the soil was not done at random but target oriented.

The initial irrigation is attested infrequently (37 references) and only for 23 fields in comparison to the subsequent irrigations of fields (appendix P). Only in 13 cases could an

[135] ITT 3 5395; MVN 10 152; TCTI 2 4225; ITT 3 4847; ITT 2 2730 (Steinkeller in prep.).

overlap between the initial irrigation (a--de_2) and the subsequent irrigation (a du_{11}-ga) of a field be detected (see appendix R). The low number of attestations suggests that not all fields were irrigated prior to cultivation.

5.3.2 Irrigation of Fields (a--du_{11}.g)

As has been already discussed in chapter 2, paragraph 2.3.6.10, grain fields are irrigated 4–5 times during one growth cycle. The first irrigation is usually applied right after sowing in October/November, the second in late January, the third at the end of February, and the fourth in March, 2–3 weeks before the harvest. The pattern that emerges for ancient times is markedly different. There are about 164 references that document the irrigation of about 48 fields, which is less than half of the number (97) that was cultivated by the governor-run sector (appendix O, Vanderroost 2012i: 83–85).

The distribution of those references' dates by month indicates that grain fields were only irrigated twice and primarily in March (see chart 5.23). The absence of an irrigation in late fall, right after sowing, is curious. This is particularly surprising since irrigation furrows, as discussed above, are cleaned right at the time of sowing (October/November), which would suggest that they were charged with water shortly after. While some moisture could have derived from the initial irrigation prior to plowing, it is questionable whether it would have been sufficient to cover the crops water demand at time of germination nearly two month later. In addition, the initial irrigation of fields prior to cultivation is only attested for a small sample of fields.

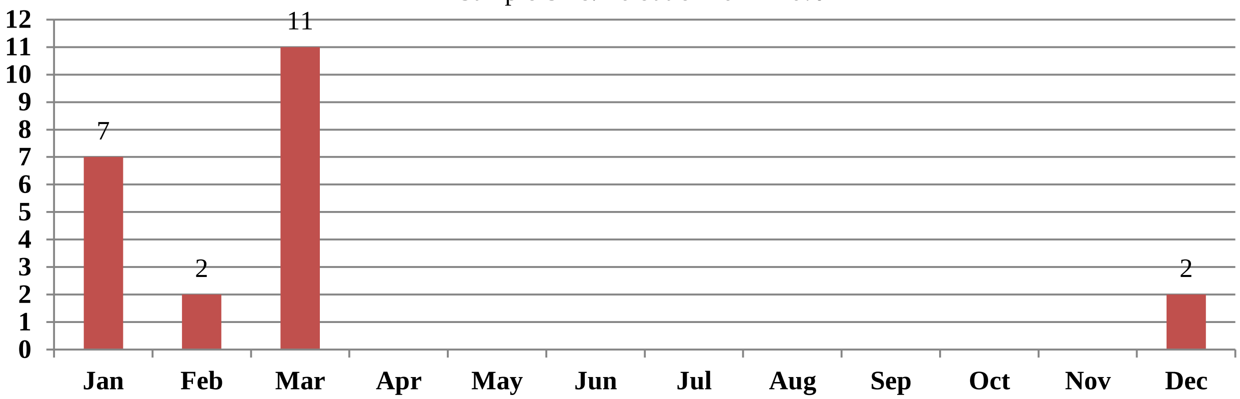


Chart 5.23

Monthly distribution of irrigating fields (a--du_{11}.g)

Sample Size: 26 out of 164 = 16%

The findings are statistically robust and not the result of the recovery bias.[136] The crops' water demand must have been met by rainfall in late fall. This would suggest that precipitation rates in the 3rdmillennium B.C. were not only considerably higher but also more evenly distributed throughout the fall and winter months. As has been discussed in chapter 2, paragraph 2.2.1, there are paleo-climatic studies that suggest moister climate conditions in Mesopotamia around that time.

Despite the abundance of labor data, it is difficult to establish the ratio between the number of work days spent and the size of the area irrigated, since there are virtually no records that provide such quantifications (see tables O.1 and O.2, appendix O).[137] The average length of an individual irrigation period, however, ranged between 5 and 6 days, with a maximum of 15 days, independent of size of the work crews (see table 5.24). Work crews consisted on average of 12 people, while the most frequently attested size was 10. Based on these data, it is safe to conclude that the irrigation of fields was accomplished in 1–2 weeks.[138]

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[136] The number of tablets per year recording the irrigation of fields increases continuously from the beginning of the reign of Amar-Suen to the end of that of Šu-Sin. The observed pattern remains consistent with increasing sample size, which proves that the finding is representative.

[137] The only exception is text BPOA 2 2476, which records the grain expenditure paid in wages to workers irrigating several fields. Since we do not know how much each of these workers was paid, the irrigated area per workday cannot be established.

[138]The exception is text Farmer's Instructions 2.01, which records that the irrigation of the Amar- $^{\text{giš}}$kiši field (Pettinato [1967i: 79] transliterates amar-$^{\text{giš}}$$ad_2$; other attested readings are amar-$^{\text{giš}}$GIR2gunu [BDTNS] and amar-$^{\text{giš}}$kiši17 [CDLI]) took 32 days with a work crew of 300 ox-drivers. The field was of considerable size (908.28 iku =

Table 5.24 Length of irrigation periods versus size of work crews Sample Size 42 out of 164 = 26.6%		
	# workers	**# work days**
Average	12	6.6
Min	4	2
Max	28	15
Median	10.25	6
Mode	10	6
Standard Deviation	5.29	3.41

5.4 Drainage

As discussed in Chapter 2, 2.3.6.12, drainage is indispensable in an environment like southern Iraq. It has been suggested by Civil (1994: 130–131) that the aga'am "was very likely a large, marshy, and permanent or semi-permanent lake used as a reservoir to dispose of flood waters" as well as excess irrigation water (Grégoire 1970: 43, 60, 284, Kang 1973: 160, 427, Sauren 1966: 45–46). The systematic analysis of the available 85 references confirms this conclusion and also indicates that there was only one aga'am, consisting of a regular (a-ga-am) section and a large (a-ga-am gu-la) section (see appendix Q). Both sections were consistently associated with the Ganamah/Emah field and the Igi-emahše, Ninura, andŠara-gugal-fields, and a few others—all of which were located in the southeastern corner of the Umma province in the vicinity of Apisal (see appendix Q, table Q.1–2, and see map 3).The aga'am was equipped with the same devices regularly attested for canals. The aga'am had several inlets (ka), an outlet (kun), a barrage/weir (kun-zi-da), a flow divider (kab_2-ku_5), a levee (gu_2) in which breaches (a-e_3-a) occurred, and another device called barla that is only attested for canals (see appendix K, table K.2 and appendix Q, table Q.3 – Q.9). This suggests that the aga'am might have had a channel like shape.

The aga'am drainage area was equipped with several inlets (ka) and is attested for the Annegara/Ninura-Annegara, Igi-emahše, Ninura, and Šara-gugal and Muru fields, while only one

326.9848 ha), which might explain why its irrigation took almost a month (Pettinato 1967i: 80). However, irrigating crops over the course of the month would have exposed some of the crops to water stress.

outlet is attested that was located close to Anzagar (see appendix Q.3 – Q.4). Anzagar according to Steinkeller (2011: 9–12), was located at the Girsu/Namhani canal at the border of the Girsu/Lagaš province, suggesting that the aga'am drained into it. The function of the multiple inlets to the aga'am is explained by text SAT 3 1300.The fact that the opening of the inlet of the aga'am happens after the irrigation of the field clearly indicates that the aga'am had the purpose of drainage. This inference is further supported by the fact that the inlets of the aga'am were cleaned primarily in spring,[139] while the cleaning of inlets of irrigation canals was done in August—prior to the onset of the agricultural season (see appendix Q, table Q.3). Also, the sequences of records authorized by Lugal-ezem (see appendix Q, table Q.14, Lugalezem) show that the flooding and irrigation of the Šara-gugal, Ninura, Igi-emahše, and Muru field went along with operating the inlets of the aga'am. As the aga'am functioned as a drainage pond, it must have been located at the lower ends of the fields and might have been a natural or man-made depression.

SAT 3 1300	
obverse	***o. 1–2***
1. 65 guruš u_4 1-$še_3$	65 workmen for one day irrigated the Muru field
2. a-$ša_3$-ge a du_{11}-ga a-$ša_3$-$Muru_{13}$	***o. 3–4***
3. 75 guruš u_4 1-$še_3$	75 workmen for one day opened the inlet of the large drainage area
4. ka a-ga-am gu-la ku_5-a	
reverse	***r. 1–2***
1. ugula Inim-^{d}Šara$_2$	supervisor was Inim-^{d}Šara
2. kišib A-gu-gu	sealed by Agugu
3. mu ma$_2$^{d}En-ki ba-ab-du$_8$	**Year**: SS02-00-00
seal	**Seal**: Lugalezem, scribe, son of Dada
1. Lugal-ezem	
2. dub-sar	
3. dumu Da-da	

The drainage area was surrounded by a dike (eg_2-zi-DU), which ran alongside its bank/levee (gu_2) and on five sides (za_3-5-us_2). The section labeled as "its five sides" (za_3-5-us_2) is associated with the Ganamah field only and further qualified as "water in the back" (a egir)[140] (see below). This supports the conclusion that we are dealing with a drainage pond whose water was contained by a ca. 10 km-long dike (see SNAT 398 and YOS 04 209 and table 5.25).

[139] See SAT 3 1183. Note that none of the texts recording the cleaning of the inlet of the aga'am are dated by month. However, the notation "harvest work" (reaping grain, threshing, making sheaves) is recorded alongside cleaning the inlet of the aga'am. Since this applies to the majority of texts, it can be safely assumed that this is the time when this task was performed.

[140] See discussion in Steinkeller (1988: 81) and MVN 16 1594, r. 5–8.

SNAT 398	
obverse	***o. 1–3***
1. [240]+150 nindan gid$_2$ [1 sar-ta]	2340m length, 18m^3 [per each 6m], its volume is 5220m^3: [the
2. sahar-bi 260+[30] sar	flood dike] on the side of the [field] of the grand vizier
3. a$_2$ sukkal-mah	***o. 4–6***
4. 443 nindan gid$_2$ 2 sar-ta	2658m length, 36m^3 [per each 6m], its volume is 15948m^3: the
5. sahar-bi 886 sar	dam at the bottom of the field
6. eg$_2$-sa-dur$_2$-ra	***o. 7***
7. 470 sar eg$_2$ sila ku$_5$-ra$_2$	8460m^3 erasing a type of dam
8. 360 nindan gid$_2$ 1 1/2 sar-ta	***o. 8–11***
9. sahar-bi 540 sar	2160m length, 27m^3 [per each 6m], its volume is 4560m^3: the
10. eg$_2$-zi-DU gu$_2$ a-ga-am gu-la	flood dike alongside the five sides of the large drainage area
11. a egir za$_3$-NI-ka	***o. 12–14***
12. 380 nindan gid$_2$ 2/3 sar-ta	2280m length, 12m^3 [per each 6m], its volume is 4560m^3: the
13. sahar-bi 253 1/3 sar	flood dike alongside the five sides of the drainage area
14. eg$_2$-zi-DU gu$_2$ a-ga-am za$_3$-NI	------------------
------------	***o. 16–17***
16. šu-nigin$_2$ 2539 sar sahar	the (sub)total is 45702m^3 [work to be done in] at the Emah field.
17. a-ša3-E$_2$-mah	***r. 1–3***
reverse	2880m length, 27m^3 [per each 6m], its volume is 12960m^3: dam
1. 480 nindan gid$_2$ 1 1/2 sar-ta	at the bottom of the field.
2. sahar-bi 720 sar	***r. 4–6***
3. eg$_2$-sa-dur$_2$-ra	1800m length, 54m^3 [per each 6m], its volume is 16200m^3: the
4. 300 nindan gid$_2$ 3 sar-ta	flood dike of the Muru [field]
5. sahar-bi 900 sar	***r. 7–9***
6. eg$_2$-zi-DU muru$_{13}$	2880m length, 12m^3 [per each 6m], its volume is 5760m^3: [the
7. 480 nindan gid$_2$ 2/3 sar-ta	flood dike] on the side of the field of Umma
8. sahar-bi 320 sar	***r. 10***
9. a$_2$ a-ša$_3$-Umma^{ki}-ka	5400m^3 cutting/incising the street dam.
10. 300 sar eg$_2$ sila ku$_5$-ra$_2$	-----------------------
------------	***r. 12–13***
12. šu-nigin$_2$ 2240 sar sahar	the (sub) total is 40320m^3 [work to be done in] the Igi-
13. a-ša$_3$-Igi-e$_2$-mah-še$_3$	emahšefield.
14. 720 nindan gid$_2$ 1 sar-ta	***r. 14–17***
15. sahar-bi 720 sar	4320m length, 18m^3 [per each 6m], its volume 12960m^3: the
16. eg$_2$-zi-DU gu$_2$ a-ga-am gu-la	flood dike at the bank of the great marsh/pond of the Ninura field
17. a-ša3-^{d}Nin-ur$_4$-ra	***r. 18***
18. 600 sar sahar eg$_2$-sa-dur$_2$-ra ^{d}Šara$_2$-gu$_2$-gal	10800m^3 earth volume for the dam at the bottom of the Šara-gugal field
19. šu-nigin$_2$ 6100 sar sahar zi-ga\`	***r. 19***
30. ša$_3$ A-pi$_4$-sal$_4$^{ki}\`	Total: 109800m^3 earth expenditure in the Apisal district
left edge	***l.e. 1.***
1. mu en Eridu^{ki} ba-hun	**Year:** AS08-00-00

The length of the dike for the big drainage canal was close to 6.5 km long, while the dike along the five sides was 2.9 km. Breaches or water outlets (a-e$_3$-a) are attested for the dike, frequently associated with the so-called barla, whose function remains somewhat unclear (see appendix Q, tables Q.7 and Q.9). Besides operating and maintaining the devices (e.g., inlet, outlet, barla, flow divider, barrage/weir), the tasks performed at the aga'am drainage area consisted of inserting earth (sahar si.g), probably repairing eroded parts of the drainage canal or closing off inlets, and profiling (šu--ur_3) most likely its levee/bank (gu_2) or the dikes (eg_2-zi-DU) constructed alongside it (see appendix Q, tables Q.11 and Q.12). In addition, workers were stationed at the rising water (a zi-ga) of the aga'am drainage pond, further supporting the conclusion that the water level in the drainage area was subject to fluctuations.

Table 5.25

Length and volume of various flood banks (eg_2-zi-DU)

Location	District	Date	Text	Length in m	Volume in m^3
Asukkalmah	?	AS08-00-00	SNAT 398: o. 1–3, o. 17	2340	5220
The large drainage pond alongside the five sides	Apisal	AS08-00-00	SNAT 398: o. 8–11, 17, r. 14–17	6480	22680
The five sides of the drainage pond Ganamah/Emah field	Apisal	AS08-00-00	SNAT 398: o. 12–14	2280	4556
Igi-emahše field	Apisal	AS08-00-00	SNAT 398: r. 4–6. r. 13	1800	16200
Umma field	Da-Umma	AS08-00-00	SNAT 398: r. 7–9, r. 13	2880	5760
Emahfield	Apisal	SS07-00-00	YOS 04 209: o.i 15–17, r. ii 10	1800	10800
Gibil-Igi-emahše field	Apisal	SS07-00-00	YOS 04 209: o.i 4–14	1350	7074

5.5 Summary

The evidence presented in this chapter clearly shows that the management of irrigation was highly centralized. As the available records derive from a state archive, we know that the work they record was organized and carried out by the provincial government under the authority of the governor. Despite the limitations with regard to reconstructing the exact layout of Umma's irrigation systems, all the tasks related to their operation are present in the Ur III documents, starting with the control of the water source (Tigris) itself and the construction and maintenance of inlets of the primary canals as discussed in detail in chapter 4. There is evidence for the extension or the construction of irrigation canals and their regular maintenance consisting of the removal of accumulated silt (šu/$šu_2$ luh-ak) and the upkeep of their spoil banks (eg_2 i_7). Water control devices appear regularly in the documents, designed to regulate the water flow within irrigation canals (kun-zi-da = weir) and to guide it to various subsections of the irrigation system (flow divider – kab_2-ku_5). Flow dividers (kab_2-ku_5) which are attested for 132locations, and weirs for approximately 90, were constantly maintained and operated which proves that water distribution was centrally managed. There is direct evidence for the inspection of flow dividers by the state official Erdingir.

As will be shown in chapter 7, this official held the position of a watcher of water mainly responsible for the water distribution of the I-sala and the Dubla-Utu canal. The available records further shows that centralized control extended all the way down to the individual field and even to the individual irrigation furrow. There are records on the initial flooding (a--de_2) of fields, the removal of earth clods from the individual irrigation furrows (ab-sin_2-ta la-ag ri-ri.g) and the irrigation of individual fields (a--du_{11}.g). There is evidence for the drainage of excess irrigation water from the fields into a drainage area (a-ga-am). As this summary description shows, the management of the six or seven irrigation systems operated by the governor-run sector was highly centralized. As we shall see in the following chapter, this is also true for flood control, which was essential for the functioning of the watercourse management system of the Umma province.

Chapter 6 Watercourse Management: Flood Control

Flood control was of great importance in the water management scheme of the Ur III period. As has been already noted by Civil (1994: 110), measures taken to prevent major flood damage are as prominent as (if not even more prominent than) irrigation works in the ancient documentation. The unfavorable timing of the flood (a-ma-ru = flood /a-eštub = carp flood[141]) required, in particular, the protection of agricultural fields and the harvest (see chart 6.1). In addition, the annual flood was a constant threat to the water management system as a whole, as the fluvial processes of sediment aggradation and scouring caused channel avulsion and rivers and tributaries shifting their course altogether, at times quite abruptly (Adams 1981: 7–11). Keeping irrigation systems operating under such volatile conditions must have been a tremendous challenge. The looming danger of disastrous floods is also vividly expressed in the metaphor a-ma-ru-kam "its urgent!" whose literate translation means "it is a matter of the flood". This expression gives a vivid image of the urgency to act if flood waters rose too high.

In the water course management system as a whole, there are several high risk areas and weak spots that needed to be protected. As has already been discussed in chapter 4 barrages were especially critical points. Being installed in the river, they posed a considerable risk since the river was more likely to overtop its levee at these locations. As has been discussed the flood protection measures consisted of installing a flood watch (a zi.g gub = stationed at the rising water) and/or diverting rising waters (a zi-ge dib) by means of inundation canals or fixed "diversion points" (u3) or by flooding fallow or harvested fields (a--de_2). At times, dangerously high water levels called for the partial demolition of the barrages (see 4.1.4.1). Other critical points were the inlets of primary canals sealed by dams. Under hydraulic pressure, a small crack could lead to a dam failure and the destruction of the irrigation system itself and the flooding of the nearby fields. Then there are topographic variations and breaches in the levee that were more likely to occur along some segments of the river than along others. This is particularly true for

[141] This is a term used primarily in literary texts.

rivers in alluvial plains that adopt a channel pattern consisting of multiple sinuous distributaries in areas with a very low gradient (<0.5%). These multiple branches tend to have weak levees, and surrounding areas are more prone to flooding (Verhoeven 1998: 226–227).

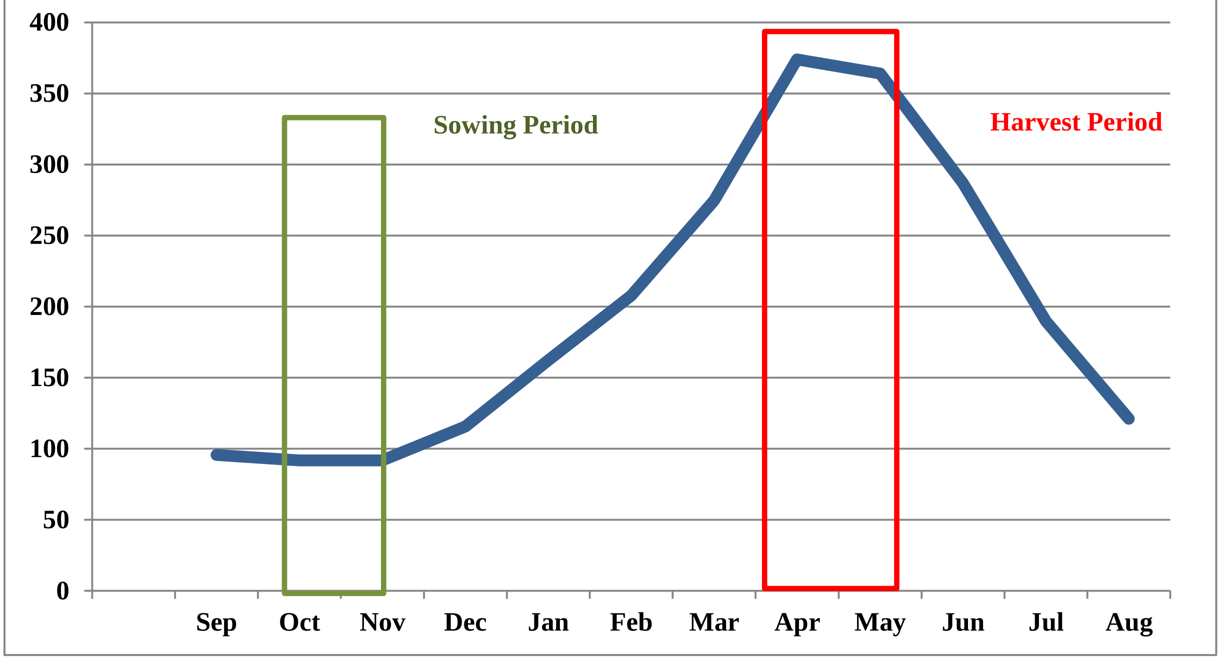


Chart 6.1

Monthly means in m^3/s at the Tigris below Amara 1919-1923

Flood preventive measures consisted, on the one hand, of observing and strategically maneuvering the water masses arriving on the alluvial plain to protect settlements, fields, and the canal systems and respective devices. On the other hand flood protection works consisted of the construction of flood dikes (eg$_2$-zi-DU) along the river itself or fields facing the river and embankments surrounding fields (eg$_2$ aša$_3$ Name) and settlements (eg$_2$ Place Name). The written evidence shows clearly that most of the dike and embankment construction was done in the southeastern part of the Umma province close to the city Apisal and the border of the neighboring province Girsu/Lagaš. This is also the area in which the ancient Tigris appears to have fanned out into multiple branches, with the major channel taking a sharp southern turn towards Girsu (see map 1). The concentration of dikes and embankments in the area of Apisal suggests that the local topography must have been particularly flat, which demanded more means of flood protection for the agricultural fields and settlements located in that part of the Umma province.

6.1 Dams and Dikes (eg$_2$ a-ša$_3$, eg$_2$-zi-DU)

In order to prevent the river from overtopping its levee, a number of flood dikes (eg$_2$-zi-DU) were placed alongside the Tigris River and major field domains (see appendix S). These dikes were usually named after the settlements or fields they protected (e.g., eg$_2$-zi-DU a$_2$ sukkal-mah, “flood dike along the [field] of the chancellor”). The text SNAT 438: o. 4, clearly states that the A- šagina dike was located next to a watercourse (i$_7$-da), which might have been the Tigris. Since this flood dike was also associated with the Igi-emahše, Ninura, and Šara-gugal field domains (see SNAT 438, r. 6–7) it must have been located at the lower section of the Tigris just upstream of Apisal. There are two other flood dikes known, the so-called A-sukkalmah dike which was associated with the Ganamah/Emah field and the A-huš dike which were associated with the Ganamah/Emah field Igi-emahše, Ninura, and Šara-gugal fields (see appendix S). Those fields were also associated with the aga’am drainage area in the southeastern corner of the Umma province. Since it is unlikely that the Igi-emahše, Ninura, and Šara-gugal fields domains were protected by two flood dikes running parallel to each I argue that these A-huš dike was located at their lower end surrounding the drainage area. As has been discussed in chapter 5, 5.4 the drainage area (a-ga-am) was enclosed by a flood dike (eg$_2$-zi-DU) whose name is never mentioned but which is known to have been associated with Ganamah field. The data suggest that there was a dike surrounding the drainage pond bordering the lower end of the Ganamah/Emah, Igi-emahše, Ninura, and Šara-gugal fields, while the upper ends of the same fields, facing the river, were protected by another dike.

SNAT 438	
obverse	***o. 1–4***
1. 3 guruš 10 la$_2$ 1 ´UN-ga$_6$`	3 workmen and 9 menials in the I. month (April)
2. iti še-sag$_{11}$-ku$_5$ u$_4$ 30-še3	performed water duty for 30 days at the rising water of
3. a zi-ga-da gub-ba	the river and the flood dike on the side of the general
4. u$_3$ i$_7$-da u$_3$ eg$_2$-zi-DU a$_2$ šagina	[field].
5. 3 guruš 10 la$_2$ 1 UN-ga$_6$	***o. 5–9***
6. u$_4$ 30-še$_3$ a-da gub-ba	3 workmen and 9 menials were performed water duty of
7. a-ša$_3$-Muru$_{13}$ a-ša$_3$-^{giš}Ma-nu	the field Muru and ^{giš}Manu and the governor’s field in
8. u$_3$ a-ša$_3$-Ensi$_2$-ka	the II. Month (May)
9. iti sig$_4$ ^{giš}i$_3$-šub gar	***o. 10 – r. 1***
10. 3 guruš 10 la$_2$ 1 UN-ga$_6$	3 workmen and 9 menials from the III. – V. months
11. iti še kar gal$_2$-la-ta	(June-August) performed water duty and the initial

12. iti RI-še$_3$ 13. a-da gub-ba a-ša$_3$-^{d}Šara$_2$-gu$_2$-/gal a-ša$_3$-^{d}Nin-ur$_4$-´ra` Igi-/e$_2$-mah-še$_3$ u$_3$ a-ša$_3$-Muru$_{13}$ ***reverse*** 1. a-da gub-ba a-ša$_3$-ga a de$_2$-a 2. 25 guruš 120 UN-ga$_6$ u$_4$ 1-še$_3$ 3. u$_2$-HAR-an ga$_6$-ga$_2$ ^{g}igilim sur-ra u$_3$ ka i$_7$ 4. a-ša$_3$-Muru$_{13}$ kešd$_2$-ra$_2$ 5. 24 guruš 58 UN-ga$_6$ 6. eg$_2$-zi-DU a$_2$ šagina gub-ba 7. 13 guruš 40 UN-ga$_6$ 8. a-ša$_3$-ge a du$_{11}$-ga 9. 2 guruš 7 UN-ga$_6$ 10. a la$_2$!-a a-ša$_3$-^{d}Šara$_2$-gu$_2$-gal 11. 2 guruš 6 UN-ga$_6$ 12. ka E$_2$-šah$_2$-še$_3$ u$_2$ ga$_6$-ga$_2$ 13. a$_2$ UN-ga$_6$ ugula Arad$_2$ 14. kišib A-gu-gu 15. mu ^{d}Šu-^{d}Suen lugal ***seal*** 1. Lugal-´ezem?` 2. dub-sar 3. dumu Da-da	irrigation at the fields Šara-gugal, Ninura, Igi-emahše, and Muru ***r. 1–5*** 25 workmen and 120 menials for one day carried ^{u2}Har.AN-weed, twisted ropes, and strengthened the inlet of the canal of the Muru field ***r. 6–7*** 24 workmen and 58 menials were stationed at the flood dike on the side of the [field] of the general ***r. 8–9*** 13 workmen and 40 menials irrigated the field ***r. 10–11*** 2 workmen and 7 menials carried (?) water (to) the Šara-gugal field ***r. 12–13*** 2 workmen and 7 menials carried grass to the inlet of the E-sah -(canal) ***r. 14–16*** the labor of menials of the supervisor Arad (the tablet was) sealed (by) Agugu **Year:** SS01-00-00 **Seal**: Lugal-ezem, scribe, son of Dada

As shown in table 6.5 ,these dikes were of considerable length, and the two protecting the Ganamah/Emah[142], Igi-emahše, Ninura, and Šara-gugal fields amounted to about 10.5 km.[143] Dikes were also constructed alongside the Engabara and the Umma field domains. The latter is frequently mentioned together with the Igi-emahše field domain. It is possible that the 3 km-long dike on the side (a$_2$) of the Umma field was a continuation of A-huš-dike, which was associated with the Igi-emahše, Ninura, and the Šara-gugal fields (see appendix S, Umma; see MVN 16 1482).

MVN 16 1482	
obverse	
1. 10 guruš u$_4$ 2-še$_3$	***o. 1–r. 1***

[142] An additional dike is attested for the Ganamah field, most likely surrounding the associated village Eduru-Lumah, after which the dike is named (see JNES 50 262: o.ii 4, r.i 19). This village was located at the outlet (kun) of the old Udaga canal (UTI 4 2372: o. 9)—a canal, as discussed earlier, that branched off the Tigris just a day's boat ride south of the city Apisal (see map 2).

[143] According to Pettinato (1967i: 194, 1967ii: 138), the Emah agricultural domain alone was at least 1439 iku (= 498.64 ha) in size, and the Ninura field domain about 500 iku (= 180 ha). There are no data for the Ganamah field—probably because Emah-Ganamah is the same field, since the signs for e2 and GAN2 are very similar and it is possible that many adopted transliterations are incorrect. Since only of a few of the tablets that make reference to these two fields have been photographed, this issue could not be resolved at this point. Note that this would also entail that the field Igi-emahše be read Igi-ganamahše.

2. 8 guruš u$_4$ 4-še$_3$	10 workers for 2 days, 8 workers for 4 days performed
3. a-da gub-ba	water duty at the flood dike on the side of the Umma^{-}
4. eg$_2$-zi-DU a$_2$ a-ša$_3$-Umma^{ki}	field and Igi-emahše field
reverse	***r. 2–3***
1. a-ša$_3$-Igi <e$_2$>-mah-še$_3$	supervisor was Lugal-^{d}Ištaran
2. ugula Lugal-^{d}Ištaran	sealed by A’akala
3. kišib A-a-kal-la	**Month:** I. (April)
# (Seal)	**Year:** AS09-01-00
4. iti še-sag$_{11}$-ku$_5$	**Seal**: A’akala, scribe.
5. mu us$_2$-sa en Eridu^{ki} ba-hun	
seal	
1. A-a-kal-la	
2. dub-sar	

The records suggest that these dikes consisted primarily of adobe and earth (see table 6.2, and see appendix S, table S.1). Workers were frequently stationed on work duty (gub) at these dikes, most likely performing some kind of flood watch (a-da gub) to identify any potential breaches (see appendix S, tables S.2 and S.3). Other tasks, such as profiling the dikes and dismantling them, are insignificant compared to the attested earth work (see appendix S, table S.4). Even though these dikes are of substantial length, they appear to have been of modest width and height. Unfortunately, the available records only provide the length, but never the width or height of these dikes. Civil (1994: 127) has calculated the cross-section of the dikes and dams mentioned in text YOS 04 209 and found that they ranged from 4.5 to 6 m^3, suggesting that these dikes could have been 4–6 m in width and 1 m in height (see table 6.3).

Table 6.2

Task attested at the dikes (eg$_2$-zi-DU)

English	**Sumerian**	**# References**
work with adobe mixture	kin u$_2$ sahar-ba	10
earth work[144]	sar sahar	9
stationed at the dike	gub	8
stationed at the (rising) water/performing water duty	a-da gub/a zi-ga-da gub	7
leveling/compacting	šu--ur$_3$	2
dismantling/incising	ku$_5$.dr	1
carrying plant material to the dike	u$_2$ ga6-ga$_2$	1

144 The references for these are listed in texts YOS 4 209 and SNAT 398, respectively.

Text YOS 4 209 lists all major types of dams for the Ganamah/Emah and Igi-emahše field domains. As can be seen, the dikes at the bottom of the fields (eg_2-sa-dur-ra) were similar in length to the flood dikes (eg_2-zi-DU) (see table 6.). Based on etymological considerations, Civil (1994: 125–129) concludes that these dikes were located at the lower ends of the fields. The fields appear to have been protected by dikes at their upper ends facing the river and their lower ends facing the depression and marshlands. The latter experienced fluctuations in their water levels just as much as the river itself, due to the influx of excess irrigation water and flood water, and saline water would have encroached into the agricultural area if left unprotected.

YOS 04 209[145]	
obverse	
column i	***o.i 1–3***
1. 200 nindan gid_2 2 sar-ta	1200 m length, 36 m^3 [per 6 m]
2. kin-bi 400 sar	its job is 7200 m^3
3. **eg_2-sa-dur_2-ra**	**dam at the bottom of the field**
4. [60]+11 nindan gid_2 2 sar-ta	***o.i 4–14***
5. kin-bi 142 sar	426 m, 36 m^3 [per 6 m]
6. 40 nindan gid_2 1 1/2 sar-ta	its job is 2556 m^3
7. kin-bi 60 sar	240 m length 27 m^3
8. 40 nindan gid_2 2 sar-ta	its (earth) job is 1080 m^3
9. kin-bi 80 sar	240 m length, 36 m^3 [per 6 m]
10. 74 nindan gid_2 1 1/2 sar-ta	its job is 1440 m^3
11. kin-bi 111 sar	444 m length, 27 m^3 [per 6 m]
12. **eg_2-zi-DU**	its (earth) job is 1998 m^3
13. ------------	**the flood dike**
14. [x] gibil a-$ša_3$-Igi e_2-mah-$še_3$	------------
15. [300] nindan gid_2 2 sar-ta	**[x] of the Igi-emahše-field**
16. [kin]-´bi` 600 sar	***o.i 15–17***
17. **[eg_2]-´zi`-DU**	1800 m length, 36 m^3 [per 6 m]
column ii	its job is 10800 m^3
1. 195 nindan gid_2 [2 sar-ta]	**the flood dike**
2. kin-bi 390 [sar]	***o.ii 1–3***
3. **eg_2-sa-dur_2-ra**	1 1170 m, 36 m^3 [per 6 m]
4. 200 nindan gid_2 1 1/2 sar-ta	its (earth) job is 7020 m^3
5. kin-bi 300 sar	**the dam at the bottom of the field**
6. **eg_2-sag-du a_2 a-ša3-^{d}Nin-ur_4-ra**	***o.ii 4–11***
7. ------------	1200 m length, 27 m^3 [per 6m]
8. šu-$nigin_2$ 2083 sar sahar	its (earth) job is 5400 m^3
9. še-bi 249.4.4 8 $sila_3$ gur	the “**head dam” on the side of the Ninura-field**
10. a_2 lu_2 hun-ga_2 6 $sila_3$-ta	------------
11. **a-$ša_3$-Igi-e_2-mah-$še_3$**	Total: 37,494 m^3
12. 350 nindan gid_2 1/3 sar-ta	its grain (expenditure) is 74988l grain
13. kin-bi 116 2/3 sar	10 job of hired labor 6 l/(day)
14. 30 nindan gid_2 4 sar-ta	**in Igi-emahše-field**
15. kin-bi 120 sar u_3 ki-ta nim	***o.ii 12–17***
16. 236 2/3 sar sahar	2100m length, 6 m^3 [per 6 m]

[145] Civil (1994: 127) has presented a detailed discussion of this text.

17. ša$_3$ za$_3$ 5 us$_2$-ka
18. 14 nindan gid$_2$ 4 sar-ta
19. kin-bi 56 sar u$_3$ ki-ta nim

reverse

column i

1. 90 nindan gid$_2$ nu-tuku
2. 12 nindan gid$_2$ 5 sar-ta
3. kin-´bi` 60 sar u$_3$ ki-ta nim
4. 32? 1/2 nindan gid$_2$ nu-tuku
5. 10 nindan gid2 30 sar-ta
6. kin-bi 300 sar
7. **a-e$_3$-a gu-la**
8. 28 nindan gid$_2$ nu-tuku
9. 2 nindan gid$_2$ 5 sar-ta
10. kin-bi 10 sar kab$_2$-ku$_5$
11. 8 nindan gid$_2$ nu-tuku
12. 2 nindan gid$_2$ 6 sar-ta
13. kin-bi 12 sar
14. 28 nindan gid$_2$ nu-tuku
15. 2 nindan gid$_2$ 6 sar-ta
16. kin-bi 12 sar kab$_2$-ku$_5$
17. 1 nindan gid$_2$ nu-tuku
18. [121]+7 1/2 nindan gid$_2$ 2 sar-ta
19. [kin]-bi 257 ´sar`
20. [x]+7 nindan gid$_2$ [nu-tuku]
21. ´kin`-bi 707 sar

column ii

1. [eg$_2$]-zi-DU gu$_2$ a-ga-am
2. [a] egir za$_3$ 5 us$_2$
3. ------------
4. šu-nigin2 220 sar sahar
5. a$_2$ lu$_2$ hun-ga$_2$ 6 sila$_3$-ta
6. še-bi 26.2.0 gur
7. šu-nigin$_2$ 723 2/3 sar sahar
8. kin šuku-ra
9. 943 2/3 sar sahar
10. a-ša$_3$-E$_2$-mah
11. ------------
12. šu-nigin$_2$ 2303 sar sahar
13. še-bi 276.1.4 8 sila$_3$ gur
14. šu-nigin 723 2/3 sar sahar
15. kin šuku-ra
16. 3026 2/3 sar
17. [x] [x ra-a
18. [x] ´x` ´x` GAR
19. [mu ^{d}Šu-^{d}Suen lugal Uri$_5$^{ki}-ma-ke$_4$ ma]-da
[Za-ab-ša]-li^{ki} mu-hul

its job is 2100 m^3
180m, 72 m^3 [per 6 m]
its earth volume 2160 m^3 and …
4260 m^3
the five sides
o.ii 18–r.i 7
18 84 m, 72 m^3 (earth volume)
19 its job is 1008 m^3 and ….
540 m length is not done
72 m length, 90 m^3 [per 6 m]
its job 1080 m^3 …
195 m length is not done
60 m length, 540 m^3 [per 6 m]
its job is 5400 m^3
the great breach
r.i 8–r.ii 2
168 m length is not done
12 m length, its cross-section is 180 m^2
its job is 180 m^3 for the flow divider
48 m length is not done
12 m length, 108 m^3 [per 6 m]
its job is 216 m^3
168 m length is not done
12 m length, 108 m^3 [per 6 m]
its job is 216 m^3 for the flow divider
6 m length is not done
771 m length 36 m^3
its job is 4626 m^3
[x] +42 m length is not done
its job 12,726 m^3
the dike alongside the bank/levee of the drainage pond
[water] at the back of its five sides
r.ii 3–10

Total: 3960 m^3 volume of earth
work of hired laborer with a daily wage of 6l of grain
its grain is 7920l
total 13,026 m^3
hired work
16,986 m^3 earth work
in the Emah field
r.ii 11–19

Total: 41,454 m^3
its grain is 828,78l
Total 13,026 m^3
hired work
16 54,480 m^3
17 [x]
18 [x]
Year: SS07-00-00

Table 6.3

Summary table of dimensions listed in YOS 04 209

Field name	Type of dam/dike	Sum.	L in m	v in m^3	Line
Igi-emahše-field	dike at the bottom of the field	eg_2-sa-dur_2-ra	1200	7200	o.i 1–3
	dike of […] new Igi-emahše field	eg_2-zi-DU	1350	7074	o.i 4–14
	dike	eg_2-zi-DU	1800	10800	o.i 15–17
	dike at the bottom of the field	eg_2-sa-dur_2-ra	1170	7020	o.ii 1–3
	"head-dam" on the side of the ^{d}Ninura field	eg_2 sag-du	1200	5400	o.ii 4–6
Ganamah/Emah – field	alongside the five sides [of the drainage area]	$ša_3$ za_3 5 us_2	2280	4260	o.ii 12–17
	is not done	*nu-tuku*	540	-	
	the big breach	a-e_3-a gu-la	411	5400	o.ii 18 – r.i 7
	is not done	*nu-tuku*	168	-	r.i 8
	flow divider	kab_2-ku_5	12	180	r.i 9–10
	is not done	*nu-tuku*	48	-	r.i 11
	flow divider (?)	[kab_2-ku_5]	12	216	r.i 12–13
	is not done	*nu-tuku*	168	-	r.i 14
	flow divider	kab_2-ku_5	12	216	r.i 12–13
	is not done	*nu-tuku*	6	-	r.i 17
	the dike alongside the bank/levee of the drainage canal	eg_2-zi-DU a-ga-am [a] egir za_3 5 us_2	771	4626	r.i 18–19
	is not done	*nu-tuku*	42	-	r.i 20

6.2 Field Embankments (eg_2 a-$ša_3$ FN)

Another flood protection method practiced in Umma was to surround entire fields with embankments to prevent water from pouring in. Protective field embankments are attested for 22 field domains (see appendix T, table 6.3) and, as recorded in text MVN 14 0222, were also of considerable length. The majority of the field domains for which embankments are attested were located in the south eastern corner of the Umma province. One third of the references (21 out of 58 = 36%) concern the embankment of the Abagal field domain. This domain was subdivided into the Abagal-gula and Abagal-Enlil sections. The Abagal field was adjacent to the Ukunuti field,[146] for which an embankment (eg_2 a-$ša_3$) is attested as well. Both field domains were located in the Gu'edena district, close to the border of Umma and Girsu/Lagaš, probably south of the

[146] The Ukunuti field consisted of two parts: the "larger" part (a-$ša_3$ Ukunuti gu-la) facing west, towards Umma (bala Umma), and the smaller part labeled "on the other side" (a-$ša_3$ Ukunuti bala-a-ri) of a watercourse. The field appears to have been situated on the left side of the Girsu/Namhani canal, which ran alongside the border of Umma and Girsu/Lagaš (Steinkeller 2011: 381–382, fn 44; see also UTI 3 153, o. 1–2).

Ganamah/Emah, Igi-emahše, Ninura, and Šara-gugal fields and north of Anzagar (see map 3). A field embankment is also attested for the Ninura field domain. This evidence supports the earlier made claim that this particular area of the Umma province was very much prone to flooding and most flood protection efforts were concentrated in this area.

MVN 14 0222 **obverse** 1. KA murgu$_2$ a$_2$ šuku-ra-ta 2. 300 nindan-gid$_2$ 1 sar-ta 3. kin-bi 300 sar 4. 200 nindan-gid$_2$ 1/2 sar-ta 5. kin-bi 100 sar 6. kin eg$_2$ ra-a 7. gaba a-ša$_3$-Gu$_2$-de$_3$-na 8. mu ^{d}Šu-^{d}Suen lugal-e 9. na-du$_3$-a mah ^{d}En-lil$_2$ 10. ^{d}Nin-lil$_2$-ra mu-ne-du$_3$ (plan)	***o. 1*** …. subsistence land allotments ***o. 2–3*** 1800 m length, 18 m^3 per 6 m, its job is 5400 m^3 ***o. 4–5*** 1200 m length, 9 m^3 per 6 m, its job is 1800 m^3 ***o. 6–7*** work (related to) compacting the embankment on the border of the Gudena field Year: SS06-00-00

Text MVN 14 0222 is the only text that provides dimensions of field embankments, while the other 58 references only provide the earth volumes deployed in the construction or repair of these devices (see appendix T). Out of the 59 references, only three kinds of tasks are recorded as having been performed at these embankments, consisting mainly of earth work covering and piling up earth (sahar si.g, sar sahar) and leveling/compaction of the embankments (šu--ur3). Profiling work at times went along with being stationed at the water of the embankment (a-da gub) (see table 6.4 and appendix T, tables T.1–T. 4).

Table 6.4

Tasks performed at field embankment (eg$_2$ a-ša$_3$ FN)

English	**Sumerian**	**# References**
earth work	sahr si.g, sar sahar	24
work with adobe mixture	kin u$_2$ sahar	4
leveling/compacting	šu--ur$_3$	11
leveling/compacting and stationed at the water	šu--ur$_3$ u$_3$ a-da gub	7
being stationed at the embankment	gub	4

As has been discussed above, flood dikes were constructed primarily from adobe (kin u2-sahar-ba), while field embankments appear to have consisted primarily of mud, though text

BPOA 7 2315 (see below) suggests that embankments could consist of up to one-third organic matter.[147] It is possible that adobe was used in both cases to coat the earthen core.

BPOA 7 2315	
obverse	***o. 1–2***
1. 30 guruš u$_4$ 1-še$_3$	30 workers for one day reaped grain in the Ukunuti field
2. še gur$_X$-a a-ša$_3$-Uku$_2$-nu-ti	***o. 3– r. 1***
3. 10+5 sar sahar	hoeing 270 m^3 of earth, 4.5 m^3 per workman per day, its
4. al-e 10+5 gin$_2$-ta	plant (content) is one third – compacting/smoothing the
5. kuš$_3$-bi igi 3-gal$_2$-bi-im	embankment of the Abagal field domain
reverse	***r. 2–4***
1. eg$_2$ a-ša$_3$-A-ba-gal šu ur$_3$-ra	supervisor was Urmes
2. ugula Ur-mes	sealed by Kas
3. kišib Kas$_4$	**Year**: SS02-00-00
4. mu ma$_2$ ^{d}En-ki ba-ab-du$_8$	**Seal**: Enkas, scribe, son of Ur-^{d}Ištaran
seal	
1. En-kas$_4$	
2. dub-sar	
3. dumu Ur-^{d}Ištaran	

Text Nisaba 23 066 is the only text that records the use of reed bundles for the construction or repair of the middle embankment of the Abagal-gula field domain. How the reed was deployed remains unclear.

Nisaba 23 066	
obverse	***o. 1–2***
1. 1620 la$_2$-1 sar / kin sahar	29142 m^3 earth work
============	thereof:
2. ša$_3$-bi-ta	***o. 3***
3. 420+27 sar kin sahar / ba-al-la	8046 m^3 earth work: excavating it
4. 180+43 gi kilib kin u$_2$	***o. 4–6***
5. eg$_2$ muru$_{13}$ a-ša$_3$-A-ba-gal gu-/la ba-a-si	223 bundles of reed and adobe (mixture) piled up at the
6. 480+41 sar kin sahar-ra	middle dam of the Abagal-gula field
7. 120+10 1/3 sar kin u$_2$	***o. 6***
8. eg$_2$ a-ša$_3$-A-ba-gal ^{d}En-lil$_2$-la$_2$ / ba-a-si	9378 m^3 earth work
9. 7 sar kin sahar-ra	***o. 7–8***
10. 60+45 sar kin u$_2$	2346 m^3 adobe piled up at the field embankment of the
11. eg$_2$ e$_2$ ^{d}Li$_9$-si$_4$ ba-a-si	Abagal-Enlil field
reverse	**o. 9**
1. a-ša$_3$-En-gaba-ri$_6$-ta	126 m^3 of earth work
===========	***o. 10–r. 1***
2. šu-nigin$_2$ 1800+46 5/6 sar / kin sahar	1800 m^3 adobe filled up at the embankment of the E-Lisi
3. [zi]-ga-am$_3$	[canal]
4. ´diri` 180+´48` 5/6 sar sahar	***r. 2–5***

[147] Also attested for the Muru field domain (UTI 4 2903, o. 1–4) and the Me'enkar field domain (MVN 18 263: o. 1–r.3).

5. nig_2-kas_7 ak kin ´šuku-ra`-/ka 6. $giri_3$ Gu-u_2-gu-a	the total is 33242 m^3 earth work expenditure 4119 m^3 extra account of hired work under the authority of Guguna

The amount of recorded earth work varied greatly, but the highest amounts are attested for the Abagal field (see table 6.5 and appendix T, table T.2). The Ga-^{giš}išub field domain is mentioned in three texts as being associated with or adjacent to the Abgala field[148] and Ukunuti field domains.[149] These data further support the notion that this section of the Gu'edena district was very prone to flooding that required additional protection of the fields located in this area.

Table 6.5

Maximum amounts of earth recorded for field embankments (eg_2 a-$ša_3$ FN)

Field Name	**volume in m^3**	**possible length based on MVN 14 0222**	**District**
Abagal(-gula)	15,936	5,3 km	Gu'edena
Ga-^{giš}išub	1264	0,8 km	Gu-edena
Dununuz	3803	2,5 km	Gu'edena (?)[150]
Lugal	2592	1,7 km	Da-Umma^{ki}
Ninura	1842	1,2 km	Apisal

Only 6 out of 59 references are dated by month (10%), but all of them fall into the third, fourth, and fifth months (June through August). This suggests that major repair work was done in the summer during the agricultural off-season.

6.3 Flood Watch: Being Stationed at the Water / Performing Water Duty (a-da gub)

Constructing flood dikes and field embankments was only one component of a larger flood protection scheme. As dikes and embankments were constructed at points which were prone to flooding, these devices had to be monitored during the flood season to make sure that they hold. This is particularly true for the dam sealing the inlets of primary canals which were very

[148] Ontario 2 175, o. 2; UTI 4 2604, o. 13.
[149] See BPOA 1 1256.
[150] See SNAT 364, o. 1–9, suggests that the full name of this field was Du-nunuz-Ninsu, located in the vicinity of GARšana. However, text Princeton 2 348 suggest that this field was close to the Lugal field, which was located in the Da-Umma district (Vanderroost 2012i: 83–85). It is possible that it was located at the border between the Gu'eden and Da-Umma districts.

vulnerable to hydraulic stress. A tremendously important aspect of the flood protection scheme adopted in the Ur III period was the flood watch (a-da gub). The literate translation of this job is "being stationed at the water" and has also been translated as "water duty" (Civil 1994: 126).

6.3.1 Locations of Where "Water Duty" was Performed

425 references record the amount of labor days spent on workers being placed on water duty at various key points of the river and canal system and alongside fields (see table 6.6).

Table 6.6

Stationed at the water (a-da gub) of at different locations

Location	**Sumerian**	**# References**
fields	a-ša$_3$ FN	297
field bund	eg$_2$ a-ša$_3$ FN	12
dam at the bottom of the field	eg$_2$-sa-dur$_2$-ra a-ša$_3$ FN	22
… and digging minor field canals	… pa$_4$ a-da-ga ba-al	8
… and flooding the fields	… a-de$_2$	16
		356
canals	i$_7$ CN	15
at the rising water of the river levee/river levee	a zi-ga gu$_2$ i$_7$ Idigna	17
settlements at the Tigris[151]		6
inlet of the canal	ka i$_7$ CN	1
outlet of the canal	kun i$_7$ CN	3
		41
flow dividers	kab$_2$-ku$_5$	13
barrages/weirs	kun-zi-da	5
flood dikes	eg$_2$-zi-DU	8
breaches	a-e$_3$-a	**3**
	Total	**425**

Over two-thirds of the references (356 out of 425, see table 6.5) refer to water duty at fields, which has prompted some scholars to assume that it entailed primarily the management of water for irrigation (Englund 2003: § 21, Waetzoldt 1990: 11). However, a closer examination of the records showed that the term has multiple meanings and describes mainly, although not exclusively, the management of water for flood control. A direct connection between being on "water duty" (a-da gub) and "irrigating" a field (a--du$_{11}$.g) is only attested in four references, all

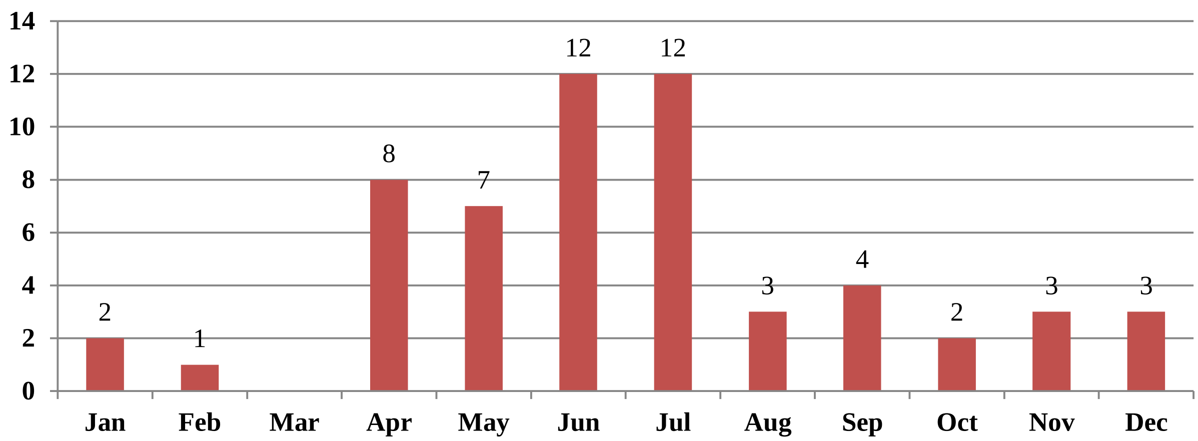
[151] The task of being stationed at the water is recorded for Abba KI.AN, Kamsala, Kisura, and I-sala. Kamsala was, according to Steinkeller (2001: 38), located at the Tigris. I-sala was most likely located at the Tigris as well. I argue that the sites mentioned were all located somewhere along the Tigris and that flood watch in the form of being stationed at the water was therefore performed.

dating to the reign of Šulgi (see appendix U, table U.2).[152] The construction of minor field canals (pa$_4$ a-da-ga) in relation to being stationed at the water, mainly attested for the Ninura field, might record irrigation works as well (see appendix U, table U.3). Also, as discussed in chapter 5, 5.2.4.4 F water duty at flow dividers was most likely also related to irrigation. "Water duty" is, however, much more frequently attested (13 references) in relation to flooding fields during the flood season and the initial irrigation of fields (see appendix U, table U.4). This also corresponds to the pattern emerging from those texts dated by month (see chart 6.7 compare with chart 6.1).

Chart 6.7

Stationed at the water of fields (a da gub a-ša$_3$)

Sample Size: 59 out of 298 References = 19.8%



The pattern might suggest that water duty performed at a field in April/May was related to flooding fields as a flood protection measure in order to reduce the water levels in the river. The water duty in June and July is certainly related to the initial flooding to soften the soil prior to cultivation. This pattern is confirmed by a set of three texts (BPOA 1 0388, SAT 2 0648; see also BPOA 7 1646) that lists mainly harvest work next to the amount of labor days spent on water duty. In all three cases, the water duty was performed during the summer months, which shows that this task must have been related primarily to the initial irrigation of fields or the flooding for pasture and flood protection. Text BPOA 7 1646 even suggests that the water duty at the Amar-

[152] MCS 3 85 BM 105447, o. 1–3 (SH41-10-00); Aleppo 221: o. 1–r. 3 (SH41-00-00); CBCY 3, NBC 03631, o. 1–r. 1 (SH41-00-00), which all date to Šulgi's reign. It is possible that the use of the term later on was more specific.

^{giš}kiši and Gu'edena fields was performed for a period of nearly three months, between May and July. 19 references are evenly distributed throughout the cultivation period. It remains unclear whether we are dealing here with "water duty" for irrigation or still initial flooding prior to plowing the fields. As has been discussed in chapter 5, 5.3.2 fields appear to have been irrigated once or twice in spring but not in the fall. This finding remains somewhat ambiguous.

BPOA 1 0388	
obverse	***o. 1–2***
1. 613 guruš u_4 1-$še_3$	613 workers for one day reaped grain
2. še gur_{10}-a	***o. 3–4***
3. 142 guruš u_4 1-še3	142 workers were on water duty
4. a-da gub-ba	***o. 5–6***
5. 41 guruš ki-su_7-ra gub-ba	41 workers were stationed at the threshing floor
6. I Ur-$nigar_X^{gar}$ tu-ra	***o. 6***
reverse	Ur-nigar was sick
1. iti še-sag_{11}-ku_5-ta	***r. 1–2***
2. iti nesag-$še_3$	from the month I (April) to month IV (July)
3. 6 guruš al 6 sar-ta	***r. 3–4***
4. a-$ša_3$-Ka-ma-ri_2	6 workers were hoeing, 216 m^2 (per workman per
5. 17 guruš u_4 1-$še_3$ ka i_7-^{d}$Šara_2$ sahar si-ga	day) in the Kamari field
7. ugula Lugal-iti-da	***r. 5–6***
8. kišib Ur-^{giš}gigir	17 workmen for one day inserted earth into the inlet
9. mu ma_2 ^{d}En-ki ba-ab-du_8	of the Šara canal
seal	***r. 7–9***
1. Ur-^{giš}gigir	supervisor was Lugal-itida
2. dub-sar	sealed by Ur-gigir
3. dumu [...]	**Year**: SS02-00-00
	Seal: Ur-gigir, scribe, son of [...]

Stationing workers at the water alongside field embankments (eg_2 a-$ša_3$) and dikes at the bottom of fields (eg_2-sa-dur_2-ra) (see appendix U, tables U.4 and U.5) is more clearly related to flood control. All the texts[153] dated by month date to March (2x) and April (1x). Further, water duty at field embankments is frequently attested with profiling work (šu--ur_3), which might refer to the repair or the reinforcement of potential breaches.

SAT 2 0648	
obverse	
1. 291 guruš $_{u4}$ 1-$še_3$	***o. 1–3***
2. a-da gub-ba	291 workers for one day were stationed at the water of
3. a-$ša_3$-Tur u_3 a-$ša_3$-La_2-mah	the Tur and the Lamah fields
4. ugula Lugal-mu-ma-ag_2	***o. 4–5***
5. $kuru_7$ ak u_4 39-kam	supervisor was Lugal-muma'ag

153 SACT 2 023: o.1–3 (SS01-01-00) (see appendix T, Igi-emahše field); Ontario 2 149, o.1–3 (AS09-12-00); UTI 3 1716, o.1–3 (AS09-12-00) (see appendix T, ^{giš}Manu- field).

6. iti še-kar-ra-ga$_2$-la	inspection was made on the 39^{th} day
7. ša$_3$ iti nesag	***o. 6–8***
reverse	between month III (June) and month IV (July)
1. mu us$_2$-sa Ha-ar-ši Ki-maš^{ki} ba-hul	***r. 1***
seal	**Year**: AS01-04-00
1. Lugal-e$_2$-mah-e	**Seal**: Lugal-emah(e), scribe, son of Lugal-kugani
2. dub-sar	
3. dumu Lugal-ku$_3$-ga-ni	

6.3.2 Stationed at the Water of the Tigris, Tributaries, and Canals

Water duty alongside the Tigris, major tributaries, and canals without doubt describes monitoring water levels as a flood prevention measure (see appendix U, table U.10). Even though nine canals are attested, the majority of the references (24 out of 35) record workers performing the water duty at the Tigris (table 6.8).[154]

Table 6.8

Stationed at the rising water (a zi-ga a-da gub) of various locations

Name of location	**Sumerian**	**# Ref.**
Tigris levee	gu$_2$ Idigna	28
drainage canal/pond	a-ga-am	1
A-huš	eg$_2$-zi-DU a$_2$-huš	1
flood dike on the side of the [field] of the general	eg$_2$-zi-DU a$_2$ šagina	1
Amar-Suen-kegara-canal	i$_7$-Amar-Suen-ke$_4$-ga$_2$-ra	1
Ganamah-field	a-ša$_3$-GAN$_2$-mah	2
flow divider of the Isum [canal]	kab$_2$-ku$_5$ [i$_7$]-I$_3$-sum	1
flow divider of I-sala	kab$_2$-ku$_5$ I$_7$-sal$_4$-la^{ki}	1
the U Lugalinimda	U$_3$ Lugal-inim-da	1

The water duty consisted of monitoring the rising water (a zi-ga) at the levee of the Tigris (gu$_2$ Idigna) over a period of one to two month. 21% of the 28 references to the Tigris that are dated by month fall into March/April (see appendix V, table V.2), a pattern that holds when all records of this task are considered (see chart 6.9). Monitoring of the rising water levels was not only performed directly at the river but also other key points such as the inlet of the Amar-Suen-kegara canal. This was most likely done to ensure that the dam sealing the inlet and regulating water inflow would hold. As has been discussed by Rost and Hamdani (2011: 213–214) cracks in

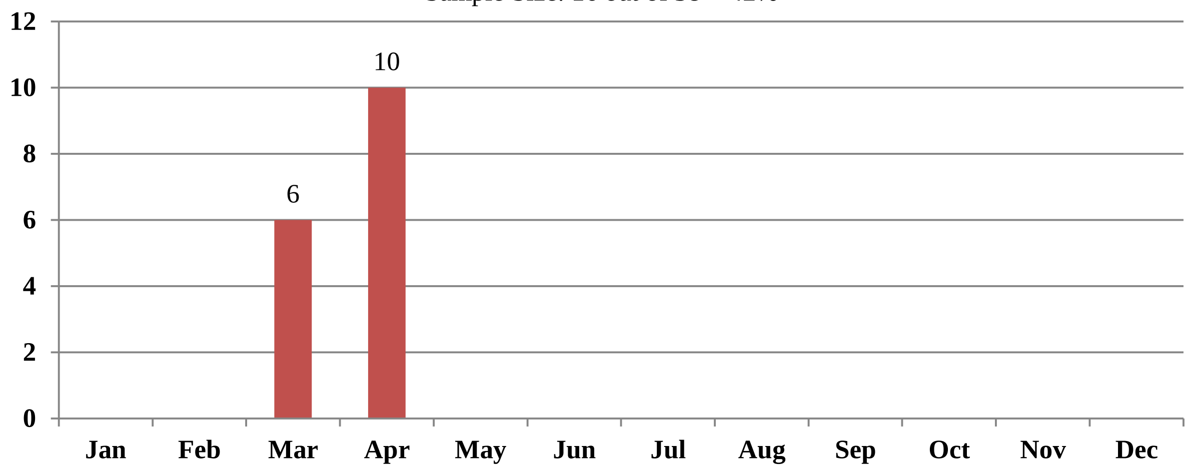
[154] This number also includes the inlet of the Guruš-gendu canal, a major irrigation canal that branched off the Tigris close to Umma.

head-dams can cause these dams to fail. Monitoring the rising water (a zi-ga) was also performed alongside dikes (eg$_2$-zi-DU), supporting the conclusion that their primary function was to protect fields against potential flood damage (see appendix S, table S.3). The reference to the Ganamah field most likely documents guarding the flood dike protecting the field against flood damage.

Chart 6.9

Monthly distribution of the task of "being stationed at the rising water of the river/canal" (a zi-ga gub)

Sample Size: 16 out of 38 = 42%



The majority of references (22 out of 38) provide specific data on the size of the work crew and the number of days spent on performing the flood watch (see table 6.10). The size of the work gangs ranged from 6 to 22 workers but consisted on average of 15, which is, along with 12, the most frequently attested number. The work crews, independent of size, were stationed at the Tigris levee and other locations for about two weeks, with 15 days being the most frequently attested time period. At times, as in the Years SS06 and SS07, the flood watch was in place for one or two months with a fairly large number of people (e.g., 49 in SS06). Different work crews were installed at various high-risk points simultaneously, while others alternated in patrolling the river levee to cover a period of 1–2 months (see appendix D, table D.1).

Table 6.10							
Sizes of work crews and amounts of time for being stationed at the rising water mainly at the Tigris							
Name	**Date**	**Publication**	**Line**	**# work days**	**# men**	**# days**	**Type**
Ganamah-field	AS06-00-00	CBCY 3, NBC 01437	o. 1–2	32	16	2	lu_2-mah (priest)
Idigna	AS06-12-00	Princeton 1 384	o. 1–3	30	15	2	UN-ga_6 (30 sila/m)
	AS06-12d-09?	BPOA 1 1322	o. 1–4	287	13	6	guruš
	AS06-13-00	CBCY 3, NBC 00530	o. 1–4	157.5	13	4	guruš
	AS08-00-00	UTI 6 3810	o. i. 21 – o. ii. 1–3	168 2/3	7 2/3	22	UN-ga_6
	SS01-00-00	MVN 21 148	o. 1–8	393	15	26.2	guruš
	SS02-00-00	UTI 3 1694	o. 5 – r. 2	160	16	10	guruš
	SS03-00-00	Princeton 1 500	o. 1–3	150	10	15	guruš
	SS04-00-00	UTI 6 3811	o. 1–3	168	12	14	guruš
	SS05-00-00	SA 078 (Pl. 081)	o. 1–3	150	10	15	guruš
	SS06-00-00	MVN 20 210	o. 1–3	1568	49	32	guruš
	SS06-00-00	MVN 21 111	o. 1–2	180	12	15	guruš
	SS06-00-00	SAT 3 1699	o. 1–3	180	12	15	guruš
	SS06-01-00	BPOA 6 0495	o. 1–3	150	10	15	guruš
	SS06-12-00	Nik. 2 104	o. 1–4	120	6	20	guruš
	SS06-XX-XX	SAT 3 1689	o. 1–2	180	12	15	guruš
	SS07-00-00	MVN 21 123	o. 1–2	300	20	15	guruš
	SS07-01-00	MVN 21 118	o. 1–2	420	28	15	guruš
	SS07-12-00	UCP 9-2-2 091	o.	210	14	15	guruš
	SS09-01-00	BPOA 1 0950	o. 1–2	300	20	15	guruš
I-sum-canal	SS03-00-00	MVN 13 291	o. 4–5	56	8	7	guruš
I-sala	SS02-12-00	UTI 4, 2737	o. 1–3	60	12	5	guruš
Average					15.24	13.70	
Median					13	15	
Mode					12	15	
Max					49	32	
Min					6	2	
Stdev.					8.84	7.32	

6.3.3 Flood Emergency Measures

As has been discussed already in chapter 4, 4.1.6, the flood watch consisted not only of patrolling the Tigris levee and other key points but taking actions if necessary to decrease the water level in the river. This entailed on the one hand the demolishing barrages, diverting the rising water (a zi-ga dib) to nearby depressions and wetlands, and/or flooding) fallow and harvested fields (see sections 4.1.6 and 5.3.4). As has been shown in 5.1.4.4.C, excess water was diverted from the Tigris via the flow divider (kab$_2$-ku$_5$) of the I-sala canal. Being stationed at the water rising water at the flow divider of the I-sala and I-sum canals probably records the diversion of excess water. This form of flood emergency measure is very well described in the so-called "Letter to the generals" (Civil 1994: 182–184).[155]

Farmer's Instruction 8.1.4	**1.–3.**
1. sagina-e-ne 2. u$_3$-na-dug$_4$ 3. šabra-ke$_4$ na-ab-be$_2$-a 4. igi i$_7$-Buranun-na 5. Tum-ma-al^{ki}-še$_3$ ba-ni-ib$_2$-e$_3$ 6. u$_3$ kab$_2$-ku$_5$ mah ugnim ib$_2$-ak-e 7. a-ša$_3$-Giš-gi-dun$_3$-la$_3$-še$_3$ ba-ni-ib$_2$-e$_3$ 8. a-zi-ga 1½ kuš$_3$ im-ma-an-zi 9. tukum-bi ^{d}Utu nu-um-ta-e$_3$ 10. 7200 erin$_2$ ugu-ba nu-ub-DU (gub) 11. 600 (bur$_3$)[156] […] ⸢x⸣ […. b]a-ab-tum$_3$ 12. a$_2$ ma-tur nu-mu-un-da-uš$_2$-en 13. a-ma-ru-kam	Say to the generals: (thus) speaks the majordomo: **4.–6.** The level (lit. the face) of the Euphrates has overflowed in the direction of Tummal, and the troops are now making a big flow divider / breach. **7.** It will overflow in the direction of the Gišgi-dunla field. **8.** The water has risen 0.75 m. **9.** If the sun does not come up, even 7200 soldiers will not be able to stand against it (i.e., the flood water). **11.** 3888 ha of land has already been carried away My work force is too small. I am unable to dam it (water/Tigris) up. **13.** It is urgent.

This letter was part of the "Sumerian Epistolary Miscellany (SEpM); a collection of 17 letters and four miscellaneous compositions of the Old Babylonian scribal curriculum. This is also the reason for there being eleven versions of this letter (Kleinerman 2014). The letter describes a disastrous flood as the Euphrates overtopped its levees near the city of Tummal. The ancient city of Tummal was tentatively identified with the site of Tell Dlehim, located some 20 km south of Nippur by Steinkeller (2001: 66–71) and others (Yoshikawa 1989: 285–291; Wilcke 1973: 5). The major domo was probably a member of the governor run-sector of the Nippur province appealing to the generals of the royal sector for more manpower as the one available to him was insufficient to contain the flood. A large amount of (agricultural) land had been destroyed by the flood already. The most important passage is given in line 6 describing that the troops dug a large breach (kab$_2$-ku$_5$) – a flood emergency measure to diver excess water into

[155] I am indebted to Professor Steinkeller, who has made his personal notes on a corrected translation of this letter available to me including the discussion of the existence of marshes in the Tummal area (March 2015).

[156] In an unpublished version Ni 13225 ii 7' ff the number given is 3600 bur$_3$ (23,328) (Civil 1994: 182-183) as well as in the version published by Kleinerman (2014).

marshes or depressions in order to lower the water level in the river to prevent flooding further downstream.

A very important point about the letter is that the region of Tummal is known to have had large marshes. An inscription of Šu-Suen[157] describes Tummal as giš-gi Tum-ma-al^{ki} "canebrake of Tummal" and the temple hymn to Tummal as a "canebrake with beautiful old and young reeds" (Sjöberg and Bergmann 1969:19, l. 41; see also Wilcke 1973: 5; Yoshikawa 1989: 285–291). In addition, the field a-ša$_3$-Gišgi-dunla, which is mentioned in Sargonic and Ur III texts from Nippur is named after a canebrake (Civil 1994: 184). This indicates that the overflow of the Euphrates was directed into that particular (marshy) area, to prevent any further destruction downstream.

This practice is also described in a royal inscription of Šin-iddinam (1849–1843 B.C.)[158], king of Larsa which reads: "In order to provide sweet water for the cities of my country … (An and Enlil) commissioned me to excavate the Tigris (and) to restore it (to its original bed). At that time, by the decree of An and Inana (and with the assistance of other gods), (and) through my own achievement I grandly excavated the Tigris, the river of Utu's abundance. After I had taken it (all the way) to its intake at the earthen wall of my (divinely) chosen border, I grandly directed (its overflow) into swamps (as a preventive measure to avoid uncontrolled flooding). (In this way) I provided perpetual water, an unceasing abundance, for Larsa (and) my land.... By the might of my (entire) country I completed this work-project. Through the orders (and) decisions of the great gods I restore the Tigris, a wide river to (its original bed)" (Steinkeller 2001: 31–32). It is clear that the diversion of water into marshland was a common flood protection measure.

6.4 Flood Damage (breaches = a-e$_3$-a).

How vulnerable the entire system remained despite all the flood protection measures taken is shown in the numerous references (177 in total) to breaches in dikes and dams alongside fields and watercourses (see appendix W). Breaches (a-e$_3$-a) are primarily attested for fields, followed

[157] RIME 3/2 Šu-Suen 9: xii 7 (Frayne 1997: 318).
[158] RIME 4 Šin-iddinam 2: 17–68 (Frayne 1990: 158–160).

by canals and various towns, villages, and hamlets as well along the dikes of the drainage canal/pond (a-ga-am) (see table 6.11, appendix W, table W.1 – W.5).

Table 6.11

Locations of breaches (a-e_3-a)

Context	Sum.	# References	# Locations
field	a-$ša_3$ GN	102	29
canal	i_7 CN	29	12
drainage canal/pond	aga'am / aga'am gula	14	1
settlements	e_2-$duru_5$, GN	12	5
dike at the bottom of the field	eg_2-sa-dur_2-ra	5	3
flow divider	kab_2-ku_5	7	5
barla	bar-la_2	7	3
undetermined	?	1	1
Total		**177**	**59**

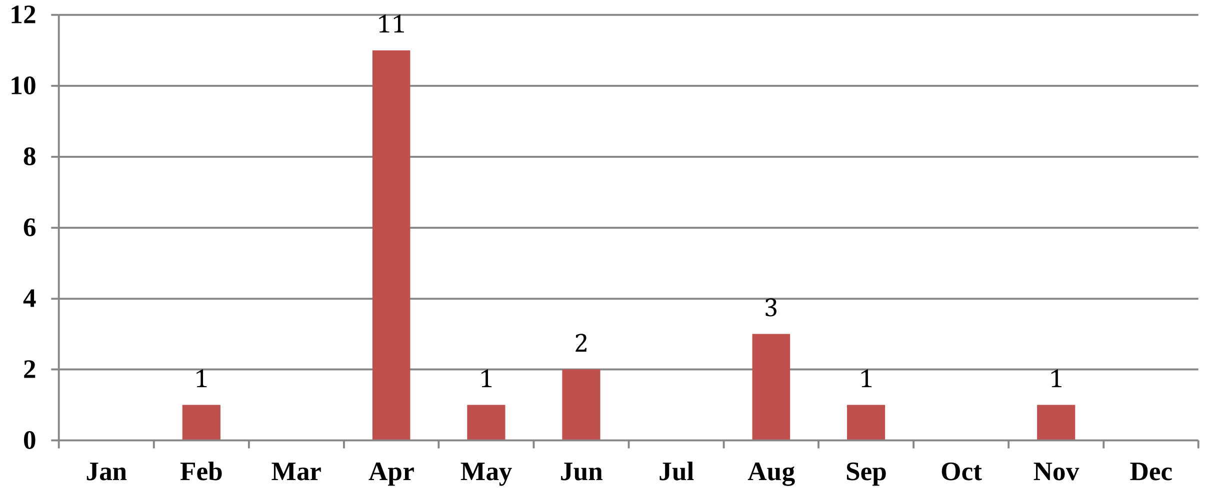
6.4.1 Breaches Alongside Field Embankments and Dikes

The association of breaches with fields might suggest at first glance that we are dealing with field installations, such as an outlet in a field bund as has been suggested earlier by the Pennsylvania Sumerian Dictionary (A1: 62–63). However, as can be seen in chart 6.12, breaches (a-e_3-a) were closed primarily in April during the flood, when they would have most likely occurred. In addition, the fields for which the most breaches are attested (Engabra 18x, Igi-emahše 11x, Ganamah 9x, and Abagal 8x; see appendix V, table V.1) are those that were located in the southeastern part of the Umma province, which was prone to flooding and constituted a high-risk area. As has been discussed in paragraphs 6.1 and 6.2, all these fields were protected by dikes and embankments (tables W.1 and W.2).

Chart 6.12

Monthly distribution of works done at the breaches (a-e$_3$-a) at fields

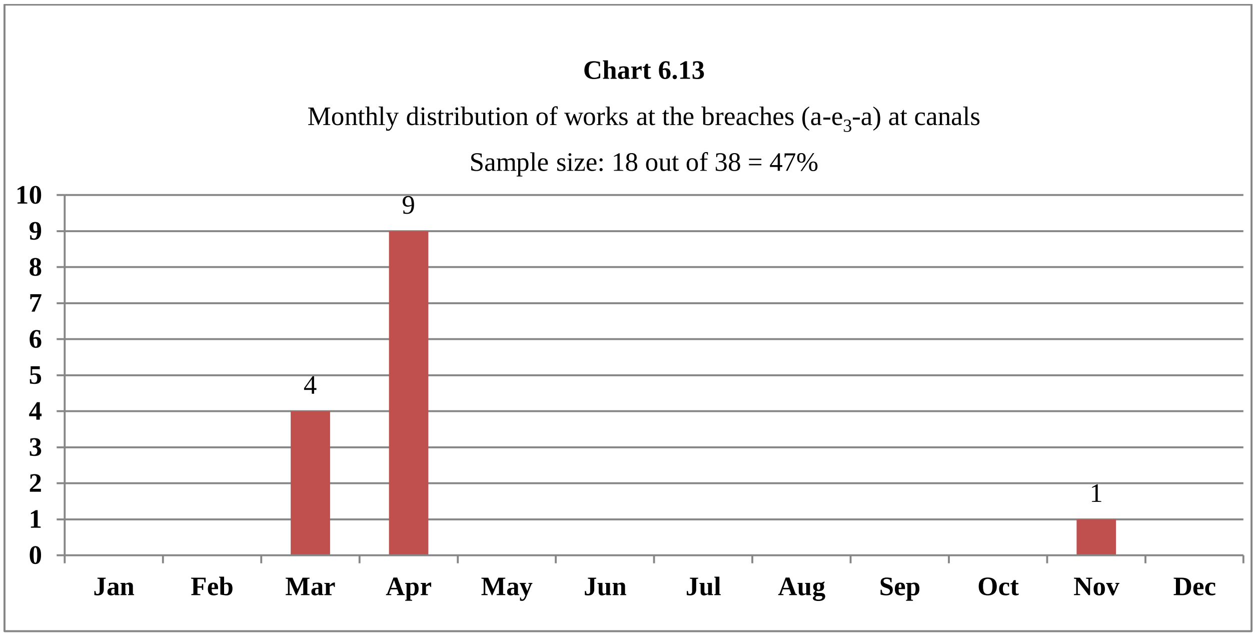
Sample size: 20 out of 100 = 20%



6.4.2 Breaches (a-e$_3$-a) Alongside Canals (i$_7$) and Settlements

The same is true for the breaches in the levees or spoil banks of canals (see appendix W, tables W.3 and W.4). Most of the work was done in March/April during the flood season, when breaches most likely occurred (see chart 6.13). The majority of references (15 out of 38) record labor deployed at the breach at the I-sala. As the I-sala-canal itself was an irrigation canal, it is unlikely that the breaches occurred alongside its spoil bank. It seems more likely that the breaches occurred in the Tigris levee at I-sala town. This location appears to have been particularly vulnerable, as breaches occurred in the 35^{th} and 43^{rd} years of king Šulgi's reign, in the 2^{nd} year of Amar-Suen's reign, and in the 6^{th} year of Šu-Suen's reign (see appendix W.3).

Breaches also occurred alongside the drainage pond (a-ga-am) (appendix W, tables W.5 and W.6). As discussed earlier, the water of the drainage pond was contained by dikes of considerable length. Breaches are also recorded for embankments surrounding settlements (e.g., Eduru-lumah; see section 6.1) or alongside watercourses where they were located (see appendix W, table W.8). The breach at Amrima appears to have caused damage to the flow divider and barrage, as both needed to be restored. Amrima was a royal (Steinkeller 2013a: 356) town, and the participation of the governor-run sector in this repair project might suggest that both sectors made use of these water control devices and shared the responsibilities for its upkeep.



6.4.3 Breaches at Water Control Installations

Breaches did also occur alongside flow dividers (kab$_2$-ku$_5$) and dikes at the bottom of fields (see appendix W, tables W.9 and W.10). Also, breaches are frequently mentioned in connection with the barla (which so far has not been identified), in particular those installed in the drainage ponds (see appendix W, table W.7).

6.4.4. Works Done at the Breaches

Breaches were closed primarily with reed, which corresponds well with the ethnographic account (see chapter 2, paragraph 2.3.6.16) (see table 6.14). The number of reed bundles used is limited in comparison to what was employed, for example, in the construction of barrages. The highest number attested is 2,110 bundles for the breach at the drainage pond at the Annegara field, while the lowest is 70 for the breach in the levee of the SUHgibildu'a canal (see appendix W, table W.11). As is shown in table 6.13 (see for details, see table W.11), reed was also plaited into different types of reed mats and twisted into ropes, suggesting that reed rolls known as *badka* in modern times were also used in ancient times to fix breaches in dikes and dams (Rost and Hamdani 2011: 216). The very limited use of earth (sar) and adobe (kin u_2 sahar-ba) in the repair of these breaches is surprising, as the reed material must have somehow been anchored (see appendix W, tables W.9 and W.12). Also, one would expect more evidence for the blocking of these breaches (uš$_2$) (see table W.14).

Table 6.14

Works performed at the breaches (a-e$_3$-a)

English	Sumerian	# References
stationed at the water outlet	gub-ba	136
reed bundles	sa gi	12
counted reed	sa gi-ŠID	2
carrying reed	gi ga$_2$-ga$_6$	3
twisting reed ropes	^{gi}gilim sur	3
reed mats	KA.GIR$_3$	3
binding reed	gi la$_2$-a	2
making reed mats	ad ak	1
work with adobe mixture only at breaches at flow dividers	kin u$_2$-sahar-ba	3
inserting earth	sahar si.g	2
transporting talents of plant material	gu$_2$ u$_2$ il$_2$	1
restoring the weir at the breach of the flow divider	a-e$_3$-a kab$_2$-ku$_5$ … kun-zi-da gi$_4$-a	3
stationed at the water of the breach	a-da gub	2
blocking the breach	uš$_2$	1
measuring the extend of the breach	gid$_2$	2

The most frequently attested task is that of being stationed at the breach on work duty, with no specification of what the job entailed. However, the high number of references does provide some insight into the strength of the individual work force as well as the amount of time spent at the site. As can be seen in table W.15 (appendix W), the repair of the breach in the embankment of the Adagal field required 1,375 work days over a period of 20+ days in the year SS01. The repair of breach at the Naram-Suen field was equally labor intensive, with 796+ labor days over a period of a month and a half (48+ days). On average, though, the individual work groups consisted of about 14 people working on average for about 5 days (see appendix W, table W.16).

6.5 Summary

Flood control was an integral part of the water management system and consisted of dikes alongside the Tigris and the lower end of fields adjacent to depressions used for drainage. As has been shown, the southeastern part of the Umma province close to the border of Girsu/Lagaš appears to have been very prone to flooding, as most of the protective works (dikes and field embankments) were constructed in this location. Furthermore, breaches in field embankments and dikes occurred primarily in this area, further supporting the conclusion that this was a high-risk area for conducting crop cultivation. Flood control also entailed monitoring the water levels in the river and if necessary maneuvering water masses strategically over the Mesopotamian landscape by diverting the water via fixed diversion points in the river’s levee. Built-in flood-control devices consisted of inundation canals or managed levee breaches that allowed the diversion of water to lower the water level in the river. While much precaution was taken to prevent flood damage, the numerous references to breaches show that flood damage was always a real threat to fields, settlements, and the watercourse system itself.

Chapter 7

Administration of Aspects of the Watercourse Management System

In chapters 4–6, I described how water courses in the Umma province were managed for three functions, river navigation, irrigation and flood control. As has been discussed in chapter 2 and chapters 4–6, the smooth and successful operation of the system depended entirely on the timely performance of all necessary tasks. That is the water control devices needed to be constructed in the first place and later be maintained. Water needed to be allocated to different parts of the irrigation system to ensure the timely watering of the crops. Flood protection devices needed to be in working order prior to the flood and monitored during the flood in order to minimize the risk of damage. The demand for river transportation put an additional strain on the available labor force as massive barrages needed to be maintained to stabilize the fluctuating water levels and keep the river navigable year round. This brief overview shows that the water course management system required a considerable amount of planning and action.

The administrative documents of the Ur III period bear witness to a complex administrative system consisting of a staff of full and part-time administrators and workers employed to plan and schedule the timely execution of required work projects. This was based on computational procedures that allow for assessing the workload, converting it into the labor and the material costs necessary for the recruitment of workers, and gathering construction materials. The recording of the names of officials in charge of supervising and authorizing the various work projects allows us to reconstruct the chain of command and determine the degree of centralized control of the water course management system. In addition, the texts provide an extraordinarily detailed insight into the various computations and quantifications employed in the planning of the execution of water works. More importantly, however, they also provide insight into the skill set that various administrators and officials mastered and help us gauge the level of literacy and numeracy of an ancient society. As shown below, intermediary officials were literate and responsible for both the day-to-day record keeping as well as the data collection (e.g., surveying) and accounting associated with the planning of various work projects.

The variety of tasks recorded indicates that the management of the river for navigation and flood control was handled by state officials under the authority of the governor. The comprehensiveness of the control is very apparent in the management of irrigation as it extended all the way down to the field level. A full reconstruction of the management structure concerned with organizing all tasks related to navigation, irrigation and flood control could not be accomplished in this thesis. The available documents only record the water works carried out by the governor-run sector. There is no information on how water was managed for and by the royal sector that controlled the much larger portion of agricultural land. In addition, there is very limited evidence on how the two sectors cooperated to manage the commonly shared water source –the Tigris and water control facilities (e.g. irrigation systems, flood dikes etc.). Therefore, the available documents describe only a portion of the administrative system in charge of the water course management system. Reconstructing the administrative body planning and organizing the water works for the governor-run sector remains difficult as well. Even though there is clear indication that the majority of water works of the governor-run sector was managed by the agricultural bureau of Umma, there are other officials involved from other economic sectors. Who these officials were and why and in what capacity they participated in the water course management system frequently remains unclear and would require conducting a comprehensive prosopographic analysis of each official involved. In addition we have no comprehensive understanding of the administrative structure of the Umma province under the authority of the governor. So far, only the administrative hierarchies of individual economic sectors are known but it remains unclear how they are integrated into the administrative system as a whole. This chapter will discuss the chain of command and some aspects of the administration based on a few key texts that deal with specific tasks.

7.1 Management of the Agricultural Land in the Umma Province

As has been mentioned above, the agricultural bureau of Umma seems to have been in charge of carrying out most of the work related to the management of water courses. A comprehensive study of the agricultural bureau of the governor-run sector of Umma has recently been provided by Nicolas

Vanderroost (2012i, ii). The size of land holdings of the governor-run sector is recorded in texts YBC 9818 dating to the Year AS02 which amounted to 33,541 iku (= 13,154.76 ha). This included the actual cultivated state land ($gana_2$-gu_4: 14,130 iku), the amount of fallow land ($buru_{14}$-bal: 14,130 iku), and the total amount of sustenance plots ($gana_2$-šuku) for the governor (1,080 iku) and his various personnel (4,201 iku) (Steinkeller 2013a: 358–359; see also Driel 1999/2000, Maekawa 1987a; Vanderroost 2008: 131–132; 2012i: 87–93). The agricultural land of the provincial sector was unevenly distributed between the four geographic districts of the Umma province: Da-Umma (59.3%), Apisal (18.63%), Gu'edena (7.27%), and Mušbiana (13.6%) and various shrines (1.2%, $eš_3$ dil-dil) (Steinkeller 2013a: 359, Vanderroost 2008: 137; 2012i: 78–86).[159]

A highly centralized administrative system was employed for the management of the agricultural land and also appears to have also been primarily in charge of the management of the water courses for river navigation, irrigation and flood control. This administrative body consisted of a permanent staff of laborers and mid- and high-level agricultural administrators (see fig. 7.1). As discussed in chapter 5, the administration of the agricultural operation was based on a unit of 6 bur (ca. 39 ha, with 1 bur_3 = 6.48 ha), which allowed bureaucrats to easily convert a given amount of agricultural land into administrative parcels. These were then assigned to a distinct hierarchy of responsible officials (Pettinato 1967i, ii; Vanderroost 2012i, ii). As discussed in chapter 5, the study of cadastral texts (Liverani 1996; 1990; Maekawa 1992b) indicate that the agricultural landscape in southern Mesopotamia was dominated by elongated rectangular strips of agricultural land varying in size between 90–135 iku (32–49 ha) and 150–450 nindan (900–2700 m) long and 17–50 nindan (100–300 m) wide (Liverani 1990: 7–9, fig. 5). These strips were further sub-divided into plots of 60 m x 60 m to allow for water efficiency. It is fairly certain that what is considered a "field" (a-$ša_3$) in administrative terms described a number of smaller field plots assembled within an elongated strip of agricultural land. Judging from the sizes, field names used usually referred to a larger agricultural domain containing several field strips (Pettinato 1967i, ii).

The administrative hierarchy of the agricultural land rested on the basic unit of a responsible "cultivator" (engar), who was in charge of cultivating one 6 bur_3 (ca. 39 ha) agricultural unit and

[159] This subdivision only existed in the fourth decade of Šulgi's reign. Prior to this, the agricultural land was subdivided into the so-called Menkar (later Gu'edena and Mušbiana) and Lamah-field (later Da-Umma) (Vanderroost 2012i: 119).

supervising three "ox-drivers" (ša$_3$-gu$_4$). According to two texts[160], a total of 104 plow teams were in operation in the governor-run sector of the Umma province in a given year. On the upper ends of the administrative hierarchy usually four to six cultivators (and thus four to six agricultural units) were subsumed under the authority of the so-called "inspector of the (plow-) oxen"[161] (nu-banda$_3$ gu$_4$) (Heimpel 1995; Vanderroost 2012i: 92, 180). The offices are labeled after the number of plow oxens under the supervision of an administrator rather than the plow team itself. The inspectors of the (plow-)oxen then answered either to a scribe of 10, 20 or 30 plow(-oxens) (dub-sar gu4-10/20/30) depending on the district.

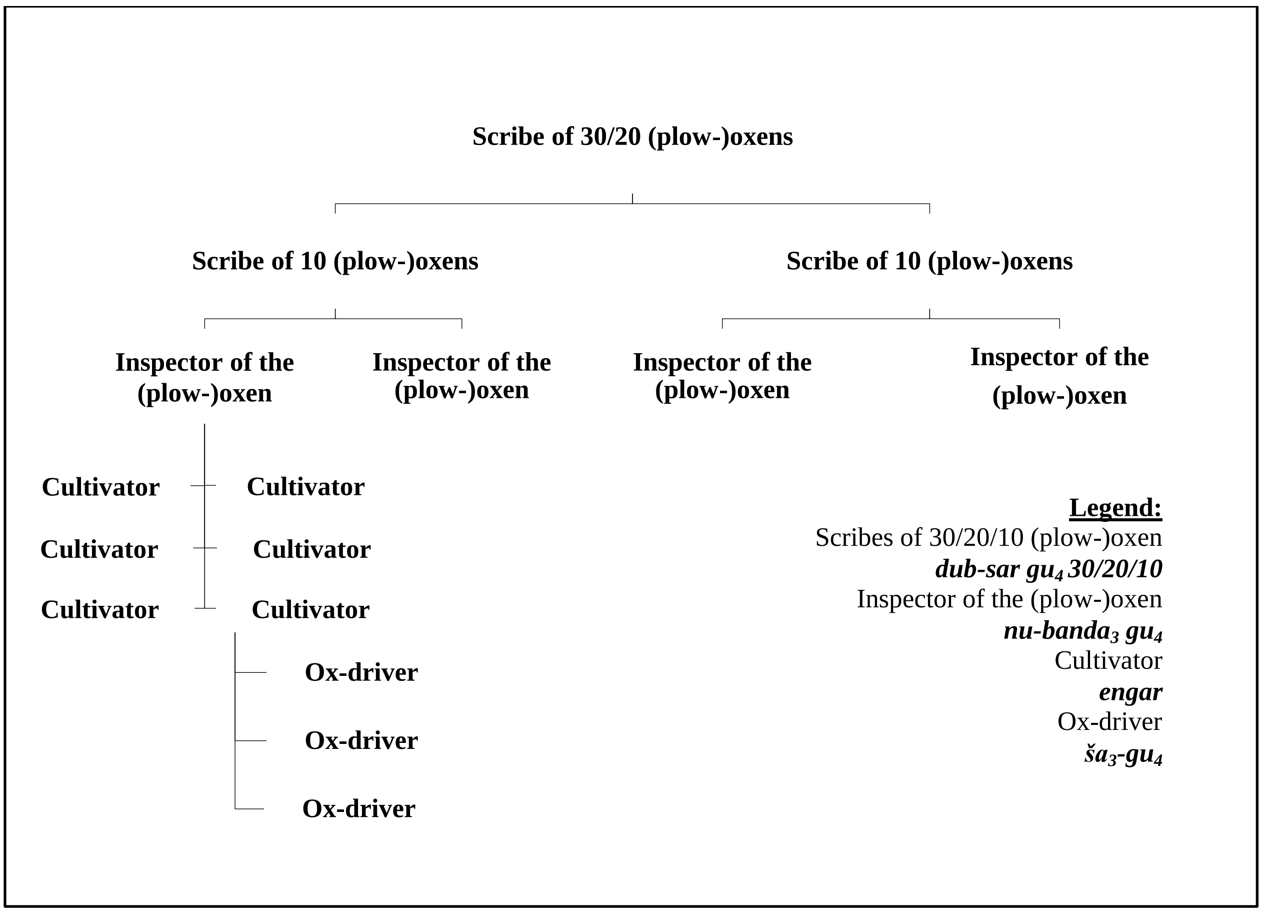


Figure 7.1 Administrative hierarchy of the management of agricultural land in the Umma province, based on Vanderroost (2012i)

[160] According to text AAS 83 (SH35-04-00 –SH36-01-00), 104 plow teams were in operation in the year SH35 and according to MCS 6, 83, BM 105334 (AS02), 101 in the year AS02 (Vanderroost 2012i: 85, 94, 103–108, 178).

[161] This term is related to a set of tablets which document the inspection of plow-oxen, listed under the responsibility of a certain "inspector of the plow-oxen" (nu-banda$_3$ gu$_4$) and their subordinated "cultivators" (engar) (Heimpel 1995). The plows operating in the Da-Umma district amounted to approximately 54, 22 for the Apisal district and around 28 for the Gu'edena and Mušbiana district (Vanderroost 2012i: 85, 94, 103–108, 178).

Vanderrost (2008, 2012i: 98–171) showed that the various offices were controlled by families. There was a clear kinship component to the recruitment to these offices such that the son of an official would frequently "inherit" his farther position. In many instances, officials had more than one son and it remains unclear whether the eldest was recruited to occupy his father position or the most competent son. It also remains unclear who had the authority to decide upon such recruitments. The primary administrative unit of cultivators (engar) and ox-drivers (ša$_3$-gu$_4$) consisted almost always of a father and his two or three sons or close kin, such as a brother or nephew. Once the father retired, a younger brother or his oldest son assumed the position of the cultivator and a nephew or grandson took the vacant position of the ox-driver (Vanderroost 2012i: 158–167).[162] Similar observations have been made by Steinkeller (1987b) on the organization of the "Foresters of Umma". The basic agricultural units were in fact quiet stable and certain cultivators can be attested as having been employed for 22–26 years (Vanderrost 2012i: 169).

High- and mid-level administrative positions were also frequently passed down from father to son. In addition, most of the high level agricultural administrators of scribes of 20 or 30 (plow-)oxen were either members of the gubernatorial family of Umma or derived from prominent families that held other key positions in the socio-economic organization of the Umma province (see chapter 3, 3.2). Ur-E'e[163], for example, a brother of the three governors was in charge of running the agricultural sector of the Apisal district for nearly 33 years (SH33–SH08). He was later succeeded by his son Lu-Haya in the year SH08/09, whose tenure lasted until the end of the Ur III period (Dahl 2007: 85–104; Vanderroost 2012i: 40–41, fn 136, 184).

The largest agricultural sector located in the Da-Umma district, for example, was managed by members of two prominent families of land surveyors (sa$_{12}$-du$_5$); the families of Lugal-kugani and Inim-Šara. Inim-Šara was a royal land surveyor who might have been installed by the crown

[162]As may be shown in text Talon-Vanderroost 1 and 2, children are listed as being provided with barley allotments ranging between 10-30 *sila* (1 sila$_3$ ≈ 1 liter) of grain per month. They were included in the plow team as junior males working between 1/3-2/3 of an adult workload, depending on their age. Once a new team mate was needed, they were promoted to full wages and adult work-loads (Vanderroost 2012: 137–138, 143–145).

[163] Ur-E'e also held the position of chief livestock administrator (šuš$_3$) of the province Umma, a position he inherited from his father Ur-Nigar, the ancestor of the gubernatorial family at Umma. Ur-E'e never referred to his father Ur-Nigar as the previous chief livestock manager, a practice that can also be observed for Lu-Haya, Ur-E'e's son who succeeded him as chief livestock administrator. The same applies to Šara-izu, the son of ARAD2(mu), chief of the granary (Dahl 2007: 86).

in Umma to ensure accurate reports on the province's agricultural potential. Lugalemah(e), the son of Lugal-kugani, and Egalesi, the grandson of Inim-Šara, held key administrative positions in the management of the agricultural sector of the Da-Umma district. Furthermore, the office of the provincial archivist (pisan dub-ba) was in the hands of the family of Lugal-ušur, who also managed the agricultural domain of the temple household of Umma's main deity Šara. It appears that important offices in Umma's administration were also tasked with exercising control over the management of agricultural land (Dahl 2007: 70–72, Vanderroost 2012i: 186–187).

7.1.1 The Agricultural Administrator of the Various Districts

As mentioned above, the agricultural sector of the Apisal was run by Ur-E'e, a brother of the three governors Ur-Lisi, Akala, and Dagada of the Umma province, and later run by his son Lu-Haya. The administrative hierarchy of the agricultural sector of the Apisal district is best known from the tenure of Lu-Haya (see fig. 7.2).

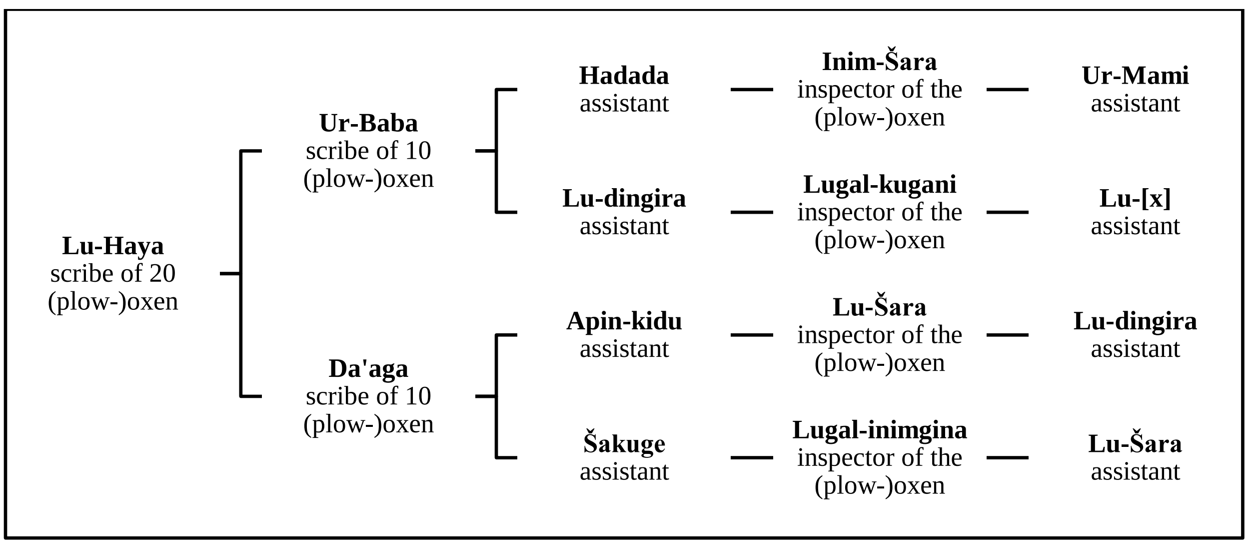


Figure 7.2 Administrative hierarchy of the Apisal district under the direction of Lu-Haya, based on Vanderroost (2012i: 116, 275, table 19)

The administrative body of Apisal's agricultural sector is the most complex one in the Umma province with the highest number of administrators and assistants (šeš-tab-ba). This might be related to the fact that it was managed by members of the gubernatorial family that frequently held other high-level administrative positions and more administrative staff was needed. Ur-E'e, for example, was overseeing livestock production in the Umma province as the chief livestock administrator as well as managing the agricultural sector of Apisal (Vanderroost 2012i: 116, 275 table 19, 2012ii: 140–142). As mentioned earlier, the agricultural sector of the Da-Umma district was run by Lugalemah(e) and Egalesi, both holding the title of scribes of 30 (plow-) oxen, who both derived from two prominent families of land surveyors.[164] The administrative hierarchy was less complex as five inspectors of the (plow-)oxen were subsumed under the authority of the two scribes of 30 (plow-)oxen (dub-sar gu_4-30). Lugalemah(e) had a long career of 27 years (SH35–SS4/5) as did Egalesi (20 years between SH47–SS09) (Vanderroost 2012ii: 81–102).

The administrative body of the Gu'edena and Mušbiana districts is less clear and there is a discrepancy concerning the tenure of Egalesi. Despite being listed as the scribe of 30 (plow-)oxen of the Da-Umma in text Talon-Vanderroost 1 (AS05/06), his activities were mainly associated with the Gu'edenen and Mušbiana district. Vanderroost (2012i: 183) suggested that Egalesi might have been managing the southeastern section of the Da-Umma bordering the Gu'edena and Mušbiana districts, which would explain the discrepancy. It could, however, also indicate the relative mobility of the agricultural staff that worked in more than one given geographic district (Vanderroost 2012i: 60–63, 183, 2012ii: 41–45, 195–198). It is difficult to determine the hierarchy of responsible agricultural officials in the Gu'edena and Mušbiana districts prior to the tenure of Lugal-kuzu, a son of Ur-nigar and brother to the three governors of Umma (Dahl 2007: 125–127; Vanderroost 2012i: 184–185). He took office in the year AS07, and ran the agricultural sector until the year SS09, when he was succeeded by a certain Lu-Šulgi(ra), who was probably not related to the governor's family (Vanderroost 2012i: 185). As we shall see later, these high-level agricultural administrators and their subordinate inspectors of (plow-)oxen were the officials in charge of the planning and execution of projects related to irrigation and water management.

7.1.2 The Labor system in the Ur III State

Labor mobilization for agricultural and water management and other productive sectors (e.g., milling, weaving, etc.) was based primarily on a system of corveé obligations that was

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[164]Note that during Šulgi's reign the more common term for scribe of the (plow-)oxen was šabra gu_4, which is equivalent to dub-sar gu_4-10 but became obsolete during Amar-Suen's reign (Vanderroost 2012i: 111–115).

mainly tied to usufruct rights to agricultural land (Steinkeller 2015: 9; Studevent-Hickman 2006: 7–8; Waetzoldt 1987a: 118). The size of these plots varied greatly depending on the recipient's social status. The sustenance plot of low-class workers amounted to 3 iku (1.08 ha) while the amount granted for example to governor Ur-Lisi from Umma amounted to 60 bur_3 (389 ha) of land (Dahl 2007: 61; Steinkeller 1987a: 27, 2013: 351). Using modern Iraqi yield data, the amount of grain received from a 1.08 ha plot of land could amount to about 1700 kg or 16,500 calories/day, which is clearly an income above the basic subsistence level (p.c. Stone April 4th , 2015). Land allotments for agricultural staff varied between 3 iku for ox-drivers (ša$_3$-gu$_4$) and 6 iku (2.16 ha) for cultivators (engar). The size of plots allotted to inspectors of the plow oxen (nu-banda$_3$-gu$_4$) amounted to 1 bur (6.48 ha) and those allotted to a scribe of 10 plow teams (dub-sar gu$_4$) 3 bur (19.44 ha) (Koslova 2008: 166; Vanderroost 2012i: 126). Since the state was considered the sole owner of all land, the obligation of corveé labor was levied on every person of all levels of the social hierarchy who held usufruct rights to agricultural land.[165] The corveé obligations varied between 100–180 days and were distributed in different installments over the year. What remains somewhat unclear is how many days a person owed to the provincial sectors, or to the crown directly (Steinkeller 2015: 12–13, 2013a: 350–351, 367).

The Sumerian words for male and female workers are guruš and geme, respectively, and are the most commonly terms used to refer to the employed workforce. However, there are specific terms that refer to distinct classes of different socio-economic statuses and incomes.[166] The Ur III work force was composed of the unskilled and "less privileged" group, referred to as UN.IL$_2$/ug$_3$-ga$_6$ ("carrier"/"menial") who were employed year-round by the various state institutions and industries. The size of this working class was relatively small, ranging between 3,000–4,000 individuals of both —male and female workers of roughly equal portions. Menials most likely were impoverished natives who were forced by their life circumstances to become full time employees of the state institutions (Steinkeller 2015: 24–26). These workers received monthly wages consisting mainly of grain and wool but also sometimes of oil, bread or flour, and

[165] For example amongst individuals conscripted to perform corveé labor at the construction site of the palace of Tummal, we even find members of the governor's family of Umma; Ur-e'e, the brother of the governors Ur-Lisi and A'a-kala and Dadaga (Steinkeller 2013a: 350–351). Even though it can be assumed that individuals of such social standing would hire a laborer who would perform the corveé duty on their behalf, they were nevertheless required to contribute the required amount of workdays to the central government (Steinkeller 2013a: 367).
[166] For a detailed discussion of the various working classes, see Englund (1991), Koslova 2008, Nissen (et al.1990), Steinkeller (2015; 2003: 45, 1987a) and Studevent-Hickman (2006).

occasionally of fish, milk products, fruits and vegetables (Koslova 2008: 166–167; Steinkeller 2013a: 365; Waetzoldt 1987a: 119). It appears that carriers/menials hardly ever received sustenance land[167] and are recorded as receiving low-quality grain (Vanderroost 2012i: 124). Unskilled labor was not assigned to particular occupations; however as part of work teams under specific supervisors (ugula), they usually performed a narrow range of tasks (Englund 1991: 257).

The more privileged group of the workforce was referred to as $eren_2$ (worker/soldier). Alternatively referred to also as dumu-gi_7 (native born/ citizen) which suggests that the Sumerian concept of "native born" was indicative of a person's socio-economic status and determined a person's obligation to the state and/or its provincial governments as well as his/her position in the a particular work force (Kraus 1970: 376; Studevent-Hickman 2006: 15). The population of $eren_2$ workers was further divided into a more privileged group consisting of higher officials and craftsmen supervisors or managers who received sustenance field allotments in return for service/corveé labor, as discussed above. For the rest of the year they were free to engage in other business or ply their trade (Steinkeller 1996: 239–241). Note that most attested 'cultivator' (engar) and ox-drivers ($ša_3$-gu_4) were in fact native born (dumu-gi_7) and/or $erin_2$-workers, who were in possession of sustenance fields (see for example SAT 2, 77 [SH33-06-00]; Koslova 2008: 165; Vanderroost 2012i: 68–69; 189–190).

The other group of $eren_2$ workers did not hold sustenance fields and worked for the state institutions and industries year round. After fulfilling their part-time work obligations they remained employed by the same state institutions and industries. However, they changed status from $eren_2$ worker to hired laborer (lu_2-hun-ga_2) for which they received wages (mainly grain) that were generally higher than the grain allotments they received during their work obligation (Steinkeller 2003: 45; Studevent-Hickman 2006: Studevent-Hickman 2006: 12 ff). The difference in employment is specified by the terms "performing duty" (bala gub-ba) during which period the $eren_2$ laborers were alimented with food. $Eren_2$ laborers in the hired period are referred to as "sitting out of the duty" (bala tuš-a) during which they were paid wages. Studevent-Hickman (2006: 326) notes, however, that the hired labor force consisted of members

[167] Studevent-Hickman 2006: 325, fn 303) showed that some menials did indeed receive sustenance land and were only obliged to work half-time for the state. This arrangement was usually restricted to the higher status working class of $eren_2$ laborers.

of a great variety of social groups of Ur III society. While $eren_2$ workers were recruited, members of their households such as their wives and children were hired as well. In addition, the urban population of cities and towns appeared to have been an additional source of hirable labor.

Laborers were assigned to specific work crews that could vary between 10–50 workmen, headed by a supervisor (ugula)(Koslova 2008; Maekawa 1987b).[168] Individual supervisors had to fulfill specific labor performance quotas in a given year with the assigned work force. Year-end or balanced accounts (based on individual receipts collected throughout the year) kept track of quota fulfillment; while surplus (diri) labor days (rare) were recorded as credit, deficits in performed labor days (frequent) were recorded as a debit (LA_2+NI) and carried over to the following year (Englund 1991; Nissen et al. 1993; Steinkeller 2003: 38–39). The work gangs undertaking projects related to the management of water courses for the three core functions frequently consisted of cultivators and their respective ox-drivers subsumed under one inspector of (plow-)oxen. They would work on the irrigation and river systems frequently between late November to March when only irrigation needed to be done or during the agricultural off-season in the summer.

7.1.2.1 Sustenance Land and Irrigation Fee

Sustenance land ($gana_2$ šuku) allotted to the governor and his administrative personal and workers was part of the larger agricultural domain. These field plots were not cultivated by the individual sustenance holder but all agricultural land was cultivated en masse by the agricultural personal of the governor-run sector of the Umma province (Vanderroost 2012i: 59). In that regards, the sustenance fields are more of an abstract measure of an income, rather than a physical entity. According to Steinkeller (1999: 303) plots assigned would shift location from year to year, possibly to account for differences in soil quality and the resulting yields and income. Whether or not this arrangement also applied to land leased out to tenants is less clear.

[168] The term ugula simply means "being in charge" and did not designate a specific position in the administrative hierarchy (Maekawa 1987b: 39; Vanderroost (2012i: 34, fn. 111. If an inspector of the (plow-)oxen (nu_2-bada gu_4) supervised his subordinated cultivators and ox-drivers at a work project, he is listed by the title ugula and not by his administrative position of a nu-banda3 gu4.

In addition, as shown by Ouyang (2010), the allotment of sustenance land was an important source of silver revenues in the form of an irrigation fee (maš/maš$_2$ [a-ša$_3$-ga]). The irrigation fee was a tax levied on sustenance land (probably also on leased land) for the initial irrigation of fields (ade2-a) and possibly for other agricultural work performed by the agricultural office of the governor-run sector of Umma (Steinkeller 1981: 126–129). According to Ouyang (2010: 334), the attested rates amounted to 0.083 shekel of silver per iku (0.36 ha) of land which equals 1.50 shekels of silver per bur$_3$ (6.48 ha) of land. Other texts record 2 shekel per 6.48 ha of land, a rate that is also attested to for Ur III Lagaš and Nippur. The amount recorded corresponds well to the amount of silver stipulated in the Ur-Namma law code for leased land that should be paid for access to water. The four major recipients who received large shares of these silver payments at various points in time were all member of the gubernatorial family of Umma. Amongst them we find the later governors Akala and Dadaga, and his son Gududu as well as Lukala the son of Ur-E'e (Ouyang 2010: 318–322). The silver payments were used by these individuals to meet the financial obligations of the provincial government to the crown in form of tribute (maš-da-ri-a and kaš-de$_2$-a). They were not used to finance the upkeep of the irrigation systems and other water control devices Ouyang (2010: 334). It is possible though that silver from this tax was used to finance projects related to water management carried out by the central government (Steinkeller p.c. M arch 23, 2015).

7.1.2.2 Size of the Agricultural Workforce of the Province Umma

The cultivation of government-owned agricultural land was based on a labor organization that showed a fairly high degree of labor division. Plowing and harrowing was only done by working the cultivators (engar) who belonged to a class of higher income and status (eren$_2$). Hoeing and weeding and various reed work was done almost exclusively by ox-drivers (ša$_3$-gu$_4$), hired labor (lu$_2$-hun-ga$_2$) and menials (UN-il$_2$/ug$_3$-ga$_6$). As will be discussed below, menials appear to have been the most flexible and mobile workforce deployed wherever shortage of labor occurred. There are cases of supervisors (ugula) whose work crews consisted exclusively of menials (Studevent-Hickman 2006: 76, see appendix M) and might have functioned as a standing labor reserve pool.

The permanent agricultural staff was by no means capable of handling the required workload alone. There are 265 cultivators (engar) known by name, however according text SAT 2, 695 (AS02) probably 95–114 cultivators were operating at one time (Vanderroost 2012i: 96). A total of 85 agricultural administrators are known. A number of texts[169] indicate that about 20 inspectors of (plow-)oxen operated at one given time (Vanderroost 2012i: 180). Assuming that each plow-team consisted of one cultivator and three ox-drivers the total agricultural workforce would have amounted to 380–456 individuals (95–114 cultivators and 285–342 ox-drivers) and seem to represent the strength of the agricultural workforce for the governor-run sector in the province Umma.

Table 7.3

Seasonal labor requirements based on (Adams 1965: 15, table 4)

Month	**1st and 2nd half**	**# workday per 12 ha**	**# workdays for 13,155.76ha**
Aug.	1 2	13 18	14252 19734
Sept.	1 2	15 14	16445 15348
Oct.	1 2	10 11	10963 12059
Nov.	1 2	18 13	19734 14252
Dec.	1 2	8 4	8770 4385
Jan.	1 2	2 3	2193 3289
Feb.	1 2	2 3	2193 3289
Mar.	1 2	4 4	4385 4385
Apr.	1 2	4 2	4385 2193
May	1 2	14 25	15348 27408
Jun.	1 2	16 19	17541 20830
Jul.	1 2	13 14	14252 15348
Total			**272,981**

[169] A total of 22 inspectors of (plow-)oxen for the province Umma is given in SAT 3, 2167 (no date), 17 in Syracuse 346 (SH46), 17 in Nisaba 6 5 (SH47) and 19 in MCS 1 54, BM 10604 and MCS 6 10, BM106041 (SS 3-5) (Vanderroost 2012i: 180).

Adams (1965: 15, table 4) has provided quantitative data from ethnographic sources on labor requirements for the cultivation of 12 ha land which includes fallowing one third to one half of the land. It shows that labor demand peaks twice in one season, once during sowing but even more drastically during harvest time. These data do not include work related to the management of water courses for irrigation and flood control. As indicated by the grain cultivation calendar discussed in chapter 2, large amounts of labor are needed for flood control adding to the already tight labor bottleneck. Applying these numbers to ancient Umma, the amount of labor days needed to cultivate 13,154.76 ha of land would have amounted to roughly 272,981 per year. A rough estimate shows that a workforce of 114 cultivators, usually working only half-time with the respective ox-driver working full time could have provided 143,640 work days, only roughly half the required amount.

7.1.2.3 Seasonal Labor

At least half if not more labor had to be drawn from other sources. Seasonal labor was one source which the agricultural administration of the four districts could tap into. Much of the seasonal labor employed in the agricultural sector was drawn from various workshops (e.g., mills, weaving establishments) but as shown by Steinkeller (2013a: 381) was also drawn from the royal sector. Recurring interest of grain loans given by the governor-run sector to the royal sector of the Umma province was repaid in harvest labor. Thus, for 60 l of loaned grain, the interest paid equaled reaping a plot of a grain field the size of 1–2iku (0.36–0.72ha).

A. Female Workers (geme$_2$)

Seasonal labor was frequently drawn from the weaving establishments[170] and the mill houses and therefore female workers (geme$_2$) were regularly employed in agriculture and water management (Verderame 2013: 439–441). They were frequently (but not exclusively)[171]

[170] See for example SAT 2 0704: o. 1 – r. 1 and BPOA 6 1420: o. 1–3. Note that the weavers (uš-bar) employed in this case at the barrage/weir of the Amara-canal were working under Adu, a supervisor (ugula) of millers. Studevent-Hickman (2006: 74) notes that "weavers were tightly integrated with the millers, their supervisors transferred labor routinely across the two industries". Labor exchange appears to have been practiced across all industries and trade and was not restricted to supplying seasonal labor to the agricultural sector by various workshops.

[171] See for example Princeton 2 476: o. 1-8, SAT 3 1488: o. 1–4, both times employed during October (month VII).

employed during the harvest/flood season, as the labor bottleneck would have been tightest during that period.[172] However, as can be seen in table 7.3[173] seasonal labor was not deployed indiscriminately. Female workers were predominately employed for the construction and upkeep of barrages and weirs (kun-zi-da) but most importantly in the repair of breaches (a-e_3-a). The latter is not surprising as breaches in canal and river levees would have occurred around the flood season when the labor bottleneck was particularly tight. As immediate response was needed, labor would have been drawn from any establishment that could spare it. The same applies to the upkeep of barrages and weirs. As shown in Chapter 4, 4.1.3 the large barrages appear to have been restored (kun-zi-da gi_4) shortly after the flood when most of the permanent agricultural labor force was still tied up in completing the harvest. In addition, given their considerable size the labor needed for their construction and repair would have been too high to have been met by the available permanent staff of the agricultural sector. Furthermore, it is also possible that the "unskilled" seasonal labor force was most efficiently deployed in such tasks. Female workers were also employed in the construction of the inlet (ka i_7) dam of the Amar-Suen-kegara-canal (see appendix B) in the year SS01/02. They carried out the final steps, such as blocking ($uš_2$) and inserting earth (sahar si.g) into the inlet that took place in March/April and coincided with the beginning of the harvest and the flood season. It appears that the completion of the project depended on the employment of seasonal labor.

Female/seasonal workers are not recorded having carried out tasks related to the upkeep and operation of the irrigation system, such as digging or cleaning irrigation canals, irrigating and flooding fields, or maintaining river levees and canal and field embankments. The emerging pattern might also be explained by the timing of when these tasks were carried out. Works on the levees, canal and field embankments were frequently done during the growing season, when little work, besides irrigation, needed to be done in the fields. A number of female work crews were however employed in performing the flood watch.

[172] See for example the record of the barrage/weir at the Dubla-Utu- or the Magur-canal in appendix A.

[173] The quantitative data presented in this table is obviously a broad brush of the actual underlying Ur III labor organization. Most of the references that use the more generic term "worker" (guruš) have not been considered here as they don't allow the assignment of the recorded laborers to different working classes. Such a distinction could only be made based on a thorough prosopographic study of their supervisors; a study that would go far beyond the scope of this dissertation. Furthermore, it is not always clear why certain receipts do indicate the status of the deployed workers, while others don't. The overall picture that can be drawn from these numbers is very much in line with the labor organization system described by Studevent-Hickman (2006) and others.

B. Cultivators (engar) and ox-drivers (ša$_3$-gu$_4$)

The more permanent agricultural staff appears to have carried out most tasks related to irrigation and cultivation, such as digging, cleaning and operating the inlets of canals, and irrigating and flooding fields. Cultivators (engar) are rarely attested to as having carried out tasks related to irrigation and water management. They were primarily responsible for the plowing and cultivation of the fields (Maekawa 1990: 118). Ox-drivers (ša$_3$-gu$_4$) on the other hand are regularly attested as carrying out irrigation or jobs related to the construction and upkeep of the irrigation system. As cultivators were usually the fathers of ox-drivers, this suggests that seniority might have played an important role in the division of labor in the agricultural sector. The predominance of ox-drivers suggests that the irrigation of fields was the responsibility of the cultivator's family. This finding is not all that surprising as the irrigation of fields would have required some knowledge of the crop's water demand in order to prevent damage due to over irrigating.

C. Menials (UN-ga$_6$)

The wide range of tasks for which menials were employed suggests they might have formed a permanent reserve pool from which workers could be recruited whenever and wherever a shortage of labor occurred (Steinkeller 2015: 26). The "work diary" of Lu-Nanna and Šara-Nirgal (appendix M), who were both supervisors to about 30 menials, each provides insight into the high degree of mobility of these work crews. As can be seen in table 7.4 they appear to have been primarily employed in the operation and upkeep of flow dividers. As discussed in Chapter 5, section 5.2.4, these devices were crucial to the functioning of the irrigation system and their operation and upkeep must have required a considerable amount of labor. One third of all the work projects carried out within a five-month period (April through August) under the supervision of Lu-Nanna and Šara-Nirgal were assignments at flow dividers. As the operation of flow dividers was related to the irrigation of fields, it is not surprising that menials were also very frequently employed for that task. They were also frequently deployed at barrages and weirs and performed water duty at various locations.

D. Hired labor (lu$_2$-hun-ga$_2$)

Another source of labor the administration could tap into was hired labor. According to Studevent-Hickman (2006: 325), "hired labor formed the fundamental component of provincial management and its economic planning". Where the hired labor came from is not easy to answer though a few sources can be identified with certainty. The key component of hired labor was the half-time work arrangement, which as discussed above primarily applied to the eren$_2$ working class but was not restricted to them. The half-time arrangement, for example, also applied to female workers (geme$_2$) in the textile industry, who might have been wives of eren$_2$ workers They were frequently hired as wage laborers after fulfilling their corveé duty, as were their children and other members of the families of eren$_2$-workers (Steinkeller 2015: 19–24; Studevent-Hickman 2006: 325–326). Studevent-Hickman (2006: 326) argues that hired labor was also recruited from the urban population of cities and towns. Steinkeller (2015: 22) showed that hired labor was recruited amongst the free population of other provinces of the royal or governor-run sectors.

The removal of dirt clods from irrigation furrows was primarily done by hired laborers that might have consisted of such a mixed crowd.[174] These tasks were done primarily in late fall (Oct/Nov) at the beginning of the agricultural cycle (see Chapter 5, 5.3.1). The permanent agricultural staff was at that time fully engaged in tasks related to the cultivation of fields. As indicated in table 7.3, the beginning of the agricultural season represents the second tightest labor bottleneck in the agricultural year, as a whole array of tasks had to be accomplished in a relatively short period of time (see Chapter 2, 2.3.3). As indicated in table 7.3, a considerable amount of work, including the cleaning of canals and construction/repair of field embankments and field paths had to be outsourced. Given that all these tasks were done during the agricultural season, this suggests that hired labor were frequently recruited from establishments and places other than the local and more permanent agricultural work force (Studevent-Hickman 2006: 326).

[174] Civil (1994: 76–78, 167–170) and Studevent-Hickman (2006: 29–30) claimed that the removal of dirt clods from irrigation furrows (ab-sin2-ta la-ag ri-ri-ga) was exclusively done by the lower class of menials (UN-il2/ug3-ga6). However, as seen in table 7.4 this work was actually done primarily by hired laborers.

E. Half-time arrangement for administrators

The Ur III texts indicated that hired labor was even recruited in the administration. Hired labor at the administrative level, however, were virtually always members of the more privileged $eren_2$ working class whose work obligation towards the state was only half a year. As Studevent-Hickman (2006: 324) notes "the half-time arrangement" had also a very practical effect, as the extent and complexity of accounting and record keeping, created a need for additional administrators during times when the agricultural sector had to rely on large amounts of hired and seasonal labor. Officials "off corveé duty" could be hired and put in charge of a number of supervisors and their respective work crews (Studevent-Hickman 2006: 324).This arrangement has been observed for many administrators in the agricultural sector, for example, with the inspector of the plow-oxen Ipa'e, son of Lu-Šara the land surveyor and a brother to Egalesi, the scribe of 30 (plow-)oxen. He is for the most part recorded as a supervisor (ugula) but in a few instances also as the sealing party and in the position of authorizing and overseeing a number of work projects simultaneously (compare appendix L, Muru-field and Šara-hegal-canal). His example shows that the administrative hierarchy was kept flexible enough that officials could move in and out of these positions as needed. It is also possible that even laborers (most likely cultivators) might have been hired to oversee hired laborers. A certain Lalil, for example, a cultivator of sesame, supplied 75 work days for the restoration (gi4) of the barrage of the Ubada-canal and work at the flow divider of the Naram-Suen-[canal] (Syracuse 180).

In sum, the Ur III labor organization had a well-integrated mechanism that mitigated the various labor bottlenecks arising from the agricultural calendar. As demonstrated, this system applied even to the managerial level of the administration. Further, as will be shown in more detail below, this provides insight into the level of numeracy and literacy of Ur III society.

Table 7.4

The employment of seasonal labor in irrigation and water management

Location according to appendix nr.	**# ref. Total**	**# of References in %**				
		f. worker (geme2)	**menial (UN-ga6)**	**hireling (lu2-hun-ga2)**	**ox-driver (ša3-gu4)**	**cultivator (engar)**
A. Barrage/weir (kun-zi-da)	440	11	22	4	3	0

B. Amar-Suen-kegara-canal	69	17	0	3	0	0
C. Inlets of canal (ka i$_7$/ka i$_7$-da)	188	4	6	0	6	1
D. Tigris (Idigna)	108	3	13	0	4	3
E. Levee/bank of rivers, tributaries and canals (gu$_2$ i$_7$)	80	0	15	0	3	3
F. Maintaining pathways (gi giri$_3$-še$_3$ nu$_2$)	13	8	0	23	0	0
G. Canal embankment/spoilbank (eg$_2$ i$_7$)	27	0	0	0	0	0
H. Outlets of canals (kun i$_7$)	60	12	5	10	8	0
I. Cleaning canals (šu luh-ak)	88	0	3	22	5	3
J. Digging/excavating canals (ba-al)	128	1	2	17	8	0
K. Device in canal (bar-la$_2$)	90	8	2	3	6	2
L. Flow divider (kab$_2$-ku$_5$)	590	6	58	5	4	0
N. Removing clods from irrigation furrows (ab-sin$_2$-ta la-ag ri-ri.g)	98	6	7	51	4	0
O. Irrigating fields (a—du$_{11}$.g)	164	0	27	1	25	0
P. Flooding fields (a—de$_2$)	37	0	9	0	5	3
Q. Drainage-canal/pond (a-ga-am/am$_3$)	85	7	7	8	2	0
S. Flood dike (eg$_2$-zi-DU)	41	0	3	15	2	0
T. Field embankments (eg$_2$ a-ša$_3$)	59	0	0	12	0	0
U. Water duty / flood watch (a-da gub)	425	5	18	0	5	1
V. Stationed at rising waters (a zi.g gub)	38	0	3	0	3	0
W. Breaches (a-e$_3$-a)	177	18	3	2	1	0

7.2 Administrative Steps of the Organization of Water Management Tasks

Administering an economy and labor organization as complex as that required by the Ur III state led to the development of mathematical procedures and scientific methods. Mesopotamians were the first to use a system of sexagesimal place value notation (SPVN). However, administratively speaking, the most important innovation during the Ur III period was the usage of standardized work norms that allowed for the conversion of specific workloads (i.e. earth volumes) into individual workloads (i.e. 10 gin$_2$ or 7½ gin$_2$ $\approx 2.25m^3$ or $3m^3$ per workman per day) and into workdays that were then assigned to (and later accounted for) different supervisors. The standardized work norms or performance expectations were defined for each kind of work—the amount of pots a potter had to produce in a given period, the amount of surface a workman had to harrow in on day, or the amount of fish a fishermen had to deliver (Nissen, et al. 1993: 47–54).

The Ur III records on the management of water courses consist primarily of construction and maintenance work, as these types of tasks required the expenditure of labor and construction materials. There is little but sufficient evidence on managerial tasks that allows us to trace the different administrative steps associated with the organization of certain water works. In the following section, I will focus on construction and maintenance works at canals and associated devices, and in particular on "flow dividers" (kab_2-ku_5).

My analysis of texts suggests the following steps in the administrative process:

1. Inspection of the devices in different locations
2. Surveying and computing the amount of work needed to be done
3. Dividing and assigning work to different supervisors
4. Execution of the work by the supervisors and their work crew
5. Payment of employed workers and their supervisors.

Here, I will only touch on the remuneration (Step 5) of workers and supervisor as the Ur III grain allotment and wage system is very complex and goes beyond the scope of this dissertation. The texts used as examples of the different administrative steps describe work projects in different geographical locations and from different dates. The available evidence is too fragmentary to provide textual evidence of all administrative steps of a work project carried out at a single location. When possible, geographic consistency was maintained.

7.2.1 Initial Inspection of the Condition of Water Control Devices

As already discussed in chapter 5, 5.2.4.5, there is evidence that the initial step in the administrative process was the inspection of the canals' sections and devices. Text YOS 04 235 text is not an administrative document per se but more a memo stating that Erdingir was supposed to inspect all flow dividers in the Da-Umma district.

YOS 04 235 ***obverse*** 1. kab_2-ku_5 da $Umma^{ki}$-ka a-na gal_2-la 2. Er_2-dingir-e igi kar_2-kar_2-dam ***reverse*** ============ 1. mu ^{d}Amar-^{d}Suen lugal ***seal*** 1. Er_2-dingir 2. $arad_2$ $^{d}Šara_2$ 3. dumu Lugal-sa_6-ga	***o. 1-2*** flow dividers – as many as they are in the Da-$Umma^{ki}$ district – are to be inspected by Erdingir. ***r. 1*** Year: ^{d}Amar-^{d}Suen is king (AS01) Seal: Erdingir, servant of god Šara, son of Lugal-saga

Erdingir deposited his seal on the tablet verifying that he had carried out the assigned task. It is conceivable, although not explicitly stated in the text, that the devices were inspected for possible damage, allowing for prioritization of repair work needed to the various irrigation systems. Erdingir probably reported back to an officer in charge for sending the survey personnel to collect the measurements that allowed for the quantification of the workload required (i.e. SAT 2 0210 and OrSp 47-49 511, see below).

7.2.2 Surveying Text

Text SAT 2 0210 and OrSP 47-49 511 discussed in Chapter 5, section 5.2.4.1, are examples of such a surveying text that records all relevant linear dimensions needed to calculate the amount of work to be accomplished (kin-bi *n* sar). As discussed in Chapter 5, texts that provide all relevant dimensions of water control devices are very rare. Much more common are texts such as MVN 16 1594 which only list the volume of a type of reinforcement work at canals and water control devices with an adobe mixture (kin u_2-sahar-ba). As shown in the summary table 5.1, most of the reinforcement work with adobe was done at various types of dikes and dams and flow dividers located in the Ganamah field domain in the Apisal district (see Map 2).

MVN 16 1594 ***obverse*** 1. 11 2/3 sar kin u_2 sahar-ba 2. eg_2-zi-DU a_2-sukkal-mah 3. 10 2/3 sar 3 1/3 gin_2 kin u_2 sahar-ba 4. eg_2-sa-dur_2-ra 5. 44 1/2 sar 3 1/3 gin_2 u_2 sahar-ba 6. kab_2-ku_5 gu-la 7. [x] 2/3 sar u_2 sahar-ba kab_2-ku_5 / Gu-til da E_2-$duru_5$ 9. 13 1/3 sar 3 gin_2 u_2 sahar-ba 10. sa-du_8 ak da E_2-$duru_5$ ***reverse*** 1. 19 sar 3 2/3 gin_2 u_2 sahar-ba 2. kab_2-ku_5 da E_2-$duru_5$-^{d}Amar-^{d}Suen 3. 38 1/2 sar u_2 sahar-ba 4. eg_2-zi-DU gu_2 a-ga-am_3 5. 8 2/3 sar u_2 sahar-ba 6. eg_2-zi-DU gu_2 a-ga-am_3 a egir za_3 5 7. a_2 lu_2 hun-ga_2 kin gid_2-da 8. a-$ša_3$-GAN_2-mah 9. kišib Lugal-ku_3-ga-ni 10. mu ma_2 ^{d}En-ki ba-ab-du_8	***o. 1-2*** work with 210m^3 adobe mixture (at) the flood dike at the side of the [field] of the grand vizier ***o. 3-4*** work with 193m^3 adobe mixture at the dike at the bottom of the field ***o. 5-6*** work with 802m^3 adobe mixture (at) the large 'flow divider' ***o. 7-8*** work with [...]m^3 adobe mixture at the Gutil flow divider on the on the side of the village ***o. 9-10*** work with 240m^3 adobe mixture at the […] on the side of the village ***r. 1-2*** work with 343.1m^3 adobe mixture (at) the flow divider on the side of the village Eduru-Amar-Suen village ***r. 3-4*** work with 693m^3 adobe work at the dike (alongside) the bank of the drainage canal/pond ***r. 5-6***

seal 1. Lugal-ku$_3$-ga-ni 2. dumu Ur-´mes`	work with 156m^3 adobe mixture of the dike alongside its five sides of the drainage area (containing) the water in the back ***r. 7-9*** surveying work of the workload of hired laborers in the field Ganamah-field ***r. 9-10*** sealed (by) Lugal-kugani **Year:** the boat of Enki was caulked **Seal:** Lugalkugani, son of Ur-´mes`

Table 7.5

List of measurement values presented in MVN 16 1594

Ref.	**Device**	**Sumerian Transliteration**	**Volume in m^3**
o. 1-2	the flood dike at the side of the [field] of the grand vizier	eg$_2$-zi-DU a$_2$-sukkal-mah	210
o. 3-4	dam at the bottom of the field	eg$_2$-sa-dur-ra	193
o. 5-6	the big flow divider	kab$_2$-ku$_5$ gu-la	802
o. 7-8	the Gutil flow-divider on the side of the village	kab$_2$-ku$_5$ Gu-til da E$_2$-duru$_5$	[...]
o. 9-10	(type of device) on the side of the village	sa-du$_8$-ak da E$_2$-duru$_5$	240
r. 1-2	the flow-divider on the side of the village Eduru-^{d}Amar-^{d}Suen	kab$_2$-ku$_5$ da E$_2$-duru$_5$-Amar-Suen	343.1
r. 3-4	dike at the bank of the pond/marsh area	eg$_2$-zi-DU gu$_2$ a-ga-am$_3$	693
r. 5-6	of the dike alongside its five sides of the drainage area (containing) the water in the back	eg$_2$-zi-DU gu$_2$ a-ga-am$_3$ a egir za$_3$-5	156
r. 7-8	work surveyed to be done by hired laborers in the Ganamah-field		

7.2.2.1 Survey Methods and Tools used to Compute Workloads

The scarcity of texts recording all relevant dimensions of water control facilities might be related to the fact that ancient surveying techniques were probably very time-consuming and only performed for the planning of new construction projects. Unfortunately, very little is known of the surveying methods employed and the kind of tools used, since only measuring weights (i.e. in Ur III often in the shape of a duck) have been preserved in the archaeological record (Roaf 1990: 103).[175] Textual evidence indicates that measuring instruments used consisted of measuring rods and ropes (Nissen, et al. 1993: 68, Powell 1987–1990, Waetzoldt 1992).

[175] The only evidence of measuring tools for linear dimensions is a depiction of a graded ruler on the statue B (fragmentary) and F of the ruler Gudea of the city state Lagaš (2200 BCE), which implies a cubit in the 50cm range. Further, a notched bronze bar was found in the ancient city of Nippur, probably predating the standard cubit found from Gudeas' time, measuring 5.18cm (Powell, M. A. 1987-1990: 462).

Surveying land with ropes and rods not only required skilled laborers but must have been very time consuming. It is unlikely that a full-fledged survey of the canals or hydraulic devices in question was conducted for the computation of the amounts of maintenance work every year. I argue that the survey work documented in text MVN 16 1594 consisted simply of measurements, for example, of the height of accumulated silt or the extent of eroded parts that required repair. The measurements taken in the field might have been recorded on wax-coated wooden boards (li-um), known from the first millennium B.C. Other para-writing accounting and recording devices are conceivable, such as stone calculi and counting sticks that would aid the memorization of the measured dimensions (Steinkeller 2004: 75). The tablet would have then been prepared in an office setting in which the workloads were calculated based on the dimensions measured in the field and those recorded in a pre-existing tablet such as the type of SAT 2 0210 and OrSP 47-49 511.

7.2.2.2 Computation of Workloads

The following computation of labor demands and material costs for construction and maintenance works at the irrigation system was done by means of dividing the volumes measured in sar (see table 3) by fixed work-norms of 7½ gin2 (≈ 2.25 m^3) or 10 gin2 (≈ 3m^3) of earth that could be moved by a single worker in one day (Civil 1994: 115, 123–124; Nissen et al. 1993: 83, see table 7.6).

Table 7.6

Sumerian number and meterological units

Numerical Values										
šar'u		**šar$_2$**		**geš'u**		**geš**		**u**		**diš**
	× 10		× 6		× 10		× 6		×10	
36000		**3600**		**600**		**60**		**10**		**1**
Units of lenght										
uš		**eš$_2$**		**nindan**		**gi**		**kuš$_3$**		**šu-si**
	× 6		× 10		× 2		× 6		× 30	
360m		**60m**		**6m**		**3m**		**0.5m**		**0.016m**
Units of surface										
bur$_3$		**eše$_3$**		**iku**		**sar**		**gin$_2$**		**še**
	× 3		× 6		× 100		× 60		× 3	
64800 m^2		21600 m^2		3600 m^2		36m^2		0.6m^2		0.2m^2

Units of volume											
bur_3		$eše_3$		iku		sar		gin_2		še
	× 3		× 6		× 100		× 60		× 180	
32400 m^3		10800 m^3		1800 m^3		18 m^3		0.3 m^3		0.33 m^3

Even both work norms are attested for the same task, the most frequently attested work norm for the cleaning of a canal (i_7 šu/$šu_2$ luh-ak) is 10 gin_2, while the work norm of 7½ gin2 is more prominent in canal digging (i_7 ba-al). This suggests that in general terms, digging a canal was more strenuous than the removal of accumulated sediments. However, a lower work norm might have been adopted if the to-be-removed sediments had to be hauled over a considerable distance (compare appendix I, table I. 1.2; appendix J. J.1.1). In computational terms, canals as well as flow dividers have been perceived as a rectangular prism – even though it is more likely that canals had a trapezoidal cross section. The term sar serves as a measure of surface as well as of volume. The metrological system used to describe volume is sar, which is a bridge between the metrological unit of surface measures gan and the linear measures nindan. In the metrological system of surface measurements, sar (1 sar = ca. 36m^2) usually describes a square of the basic linear measure nindan (1 nindan = ca. 6 m) squared.

1 nindan × 1 nindan = 1 sar (surface)

The metrological unit of sar, describing the volume, consists of the surface measure sar multiplied by the linear measure of kuš.

1 sar × 1 $kuš_3$ = 1 sar (volume)

The next smaller unit of sar is gin_2 (1 gin_2= 1/60 sar = ca. 0.3 m^3) (Civil 1994: 116).

There are two ways in which workloads are reported in the ancient administrative documents (see Civil 1994: 116). In some cases, work volumes are simply listed without providing the dimensions of the device or canal in question on which the quantifications were based (see for example text MVN 16 1594). In other cases all the dimensions are given, as in text SAT 2 0210: o.i 1-2 “1 nindan gid$_2$ 2(diš) nindan dagal 4(diš) kuš$_3$ bur$_3$ kin-bi 8(diš) sar” = **1 nindan length, 2 nindan width, 4 kuš depth; its volume is 8 sar**.

Calculation of the work volumes was based on two computational steps. The first step **(A)** is calculating the surface of the cross-section of the canal that is later multiplied by the depth **(B)** to calculate the work volume. The first calculation **(A)** is using the formula length × width = s (surface of the cross –section), also called the base. The computation of the volume **(B)** uses a metrological calculation that multiplies two different measuring units. The base/surface of the cross-section measured in sar is multiplied by the depth measured in kuš$_3$. Therefore, the formula used is sar × kuš$_3$= sar-volume.

7.2.3 Assignment of Work Projects

Once the workloads were established, they would be divided and assigned to different supervisors and their work crews. The assignment of work is illustrated in MVN 16 0757 and text BPOA 2 2547. Text MVN 16 0757 does not provide any metrological information except for the flow divider (kab$_2$-ku$_5$) but records which mid- to high-level agricultural administrators of the Gu’edena district assume responsibility for which part of the irrigation system. BPOA 2 2547, on the other hand, provides specific work volumes assigned to various mid-level agricultural administrators of the Da-Umma district for the cleaning of an irrigation canal.

MVN 16 0757	
obverse	***o. 1-3***
1. ka i$_7$-Lugal-gu-la-ta	(The responsibility for the section the inlet of the Lugal-canal to
2. i$_7$-An-^{d}En-lil$_2$-la$_2$-še$_3$	the An-Enlil-canal was assumed by Ur-Enuna, Gutar, Utu-bara,
3. Ur-e$_2$-nun-na Gu$_2$-TAR	Lu-^{d}Šara and Egalesi.
4. ^{d}Utu-bar-ra Lu$_2$-^{d}Šara$_2$	***o. 6-7***
5. u$_3$ E$_2$-gal-e-si ib$_2$-dab$_5$	(The responsibility for) the flow-dividers of an area of 6 *bur* was
6. kab$_2$-ku$_5$-ka 6 bur$_3$ GAN$_2$	assumed by Ur-Šulpa’e.
7. Ur-^{d}Šul-pa-e$_3$ i$_3$-dab$_5$	***o. 8-9***
8. i$_7$- ^{d}IM.MI^{mušen}-bar$_6$-bar$_6$	(The responsibility for) the IM.MI^{mušen}barbar canal was assumed
9. Lugal-ušum-gal ib$_2$-dab$_5$	by Lugal-ušumgal.
10. ^{d}IM.MI^{mušen}-bar$_6$-bar$_6$-ta	***o. 10-r.3***
11. ka i$_7$-Šara$_2$-he$_2$-gal$_2$-še$_3$	(The responsibility for the section stretching) from the
reverse	IM.MI^{mušen}barbar-(canal) to the inlet of the Šara-hegal-canal was
1. Ur-^{d}Nin-su Da-da	assumed by Ur-Ninsu, Dada, Lugal-nesage, Kuli, A’akala (and)
2. Lugal-nesag-e Ku-li	Ipa’e.
3. A-a-kal-la I$_7$-pa-e$_3$ ib$_2$-dab$_5$	***r. 4-8***
4. Lu$_2$-dingir-ra nu-banda$_3$-gu$_4$	Lu-dingira, the inspector of the (plow-)oxen (and) Lugal-kuzu, the
5. Lugal-ku$_3$-zu egir ensi$_2$-ka	follower of the governor [...] stayed outside (?)
6. [...]-tu u$_3$-bar-ra-me	These are the distributed [flow] dividers in the Gu’edena district

------------ 7. [kab2]-ku5 ha-la-a 8. [ša$_3$] ´Gu2`-de$_3$-na[176] 9. [iti] ^{d}Li$_9$-si$_4$ 10. [mu] bad$_3$ mar-tu ba-du$_3$	**Month XI** (December) **Year:** SS04-09-00

Text BPOA 2 2547 is a rare text but shows neatly the administrative step of assigning responsibility for cleaning work of a specific canal.

BPOA 2 2547 (SS 02) ***obverse*** 1. 59 1/3 sar sahar 2. I$_7$-pa-e$_3$ nu-banda$_3$-gu$_4$ 3. 60 sar Ab-ba-saga 4. 60 sar 1 2/3(diš) gin$_2$ [Ur]-mes 5. 64 1/2 sar 5 [gin$_2$] 6. Lugal-nesag-e 7. 90 sar Ab-ba-[...] 8. 20 sar Ur-^{giš}[gigir] 9. 20 sar Ur-am$_3$-[ma] 10. 60 sar Šeš-kal-la 11. 60 sar Lugal-iti-da 12. 61 sar 6 gin$_2$ Ba-sa$_6$ 13. 60 sar 10 gin$_2$ Lugal-e$_2$-mah-e 14. 30 sar Ur-^{geš}gigir nu-banda$_3$-gu$_4$ 15. 60 sar Ur-mes ***reverse*** 1. 69 sar 15 gin$_2$ 2. Lugal-ku$_3$-zu 3. 63 2/3 sar 6 2/3 gin$_2$ 4. Ur-^{d}Ur$_3$-bar-tab 5. 21 2/3(diš) sar 8 5/6 gin$_2$ 6. Ur-lugal 7. 20 sar 1 2/3 gin$_2$ Nimgir-an-ne$_2$ 8. šu-nigin$_2$ 870 ½ sar 4 5/6(diš) gin$_2$ 9. kin sahar-ra a$_2$ lu$_2$ hun-ga$_2$ 10. a$_2$ 6 sila$_3$-ta 11. i$_7$-^{d}Šara$_2$-gu$_2$-gal-e šu luh-ak 12. Da-da-ga u$_3$ Gu-u$_2$-gu-a ib$_2$-gid$_2$ 13. kišib$_3$ Da-da-ga 14. mu ma$_2$ ^{d}En-ki ba-ab-du$_8$ ***left*** 1. i$_7$-En-gaba-ra$_2$ ***seal* 1** 1. Da-da-ga 2. dub-sar 3. dumu Ur-nigar^{gar} šuš$_3$	***o. 1-2*** 1068m^3 of (earth assigned to) the inspector of the (plow-)oxen Ipa'e ***o. 3*** 1080m^3 (of earth assigned to) Abba-saga ***o. 4*** 1080.5m^3 (of earth assigned to) [Ur]-mes ***o. 5-6*** 1153.5m^3 (of earth assigned to) Lugal-nesage ***o. 7*** 1620m^3 (of earth assigned to) Abba-[...] ***o. 8*** 360m^3 (of earth assigned to) Ur-[gigir] ***o. 9*** 360m^3 (of earth assigned to) Ur-am[ma] ***o. 10*** 1080m^3 (of earth assigned to) Šeš-kala ***o. 11*** 1080m^3 (of earth assigned to) Lugal-itida ***o. 12*** 1099.8m^3 (of earth assigned to) Basa ***o. 13*** 1083m^3 (of earth assigned to) Lugalemah(e) ***o. 14*** 540m^3 (of earth assigned to) Ur-gigir, the inspector of the (plow-)oxen ***o. 15*** 1080m^3 (of earth assigned to) Ur-mes ***reverse*** ***r. 1-2*** 1246.5m^3 (of earth assigned to) Lugal-kuzu ***r. 3-4*** 1148m^3 (of earth assigned to) Ur-Urbartab ***r. 5-6*** 392.65m^3 (of earth assigned to) Ur-Lugal ***r. 7*** 360.5m^3 (assigned to) Nimgirane ***r. 8*** Total is 15832.45m^3 (written 15670.45m^3 but it is wrong).

[176]Note that there is sufficient evidence now that Gu-de$_3$-na is an unorthographic writing ofthe Gu$_2$-eden-na-District.

	r. 9-10 earth work – the job of hired laborers with a wage of 6 liter of grain ***r. 11*** (the work project concerns): The cleaning of the Šara-gugal–canal ***r. 12*** Dadaga and Gugua surveyed it ***r. 13 -14*** sealed (by) Dadaga **Year:** The boat of god Enki was chaulked. I.e. 1 The Engabra-canal **Seal:** Dadaga, scribe, son of Ur-nigar, the chief livestock administrator

I argue here as well that the linear dimensions that served as the base for calculated workloads were obtained from various written records similar to SAT 2 02010, even though no such tablet has not been found. Despite the extraordinary abundance of quantitative data, we are frequently not able to determine the size of the water control devices that were constructed or maintained.

7.2.3.1 Individuals Mentioned in MVN 16 0757 (S04-09-00) District Gu'edena

The text records the division of responsibility for the various flow dividers in the Gu'eden Mušbiana district among the agricultural staff. While it is possible that this text records one work event (e.g. the repair of the flow dividers), it is more likely that this text records the assignment of responsibility for different sections of the irrigation systems to the individual inspectors of the plow(-oxen). It is possible that an irrigation system was subdivided in administrative terms from flow divider to flow divider. It is possible that Lugal-kuzu himself, who directed the agricultural sector of Gu'edena and Mušbiana (see above) made the assignments. The role of Lu-dingira, the inspector of the (plow-)oxen who is mentioned alongside Lugal-kuzu remains unclear. A specific section of the agricultural area of the Gu'edena and Mušbiana district to was assigned to Egalesi, the high-level administrator of the Da-Umma district. This shows again that Egalesi had some sections of the Gu'edena and Mušbiana district under his jurisdiction.

The crew of inspectors of the (plow-)oxen that operated in Gu'edena and Mušbiana district at a given time consisted of a remarkably stable group of 5–6 individuals comprising Ipa'e[177], Ur-Ninsu GuTAR, Urenuna, Dada, and Lu-dingir, and sometimes Kuli and Akala[178] (Vanderrost 2012: 98–99, 153, 183). Most of these known inspectors of the (plow-)oxen are represented in this text, with the exception of Lugal-nesag(e) and possible Ur-Šulpa'e[179] who were inspectors of the (plow-)oxen from the Da-Umma district. As all inspectors of the Gu'edena and Mušbiana district are represented here, this further supports the conclusion that we are dealing with the subdivision of responsibilities, rather than a portion of an individual work project. Three individuals (Lu-Šara, Lugal-ušumg, Utu-bara) stand out as they cannot be associated with the agricultural bureau of Umma. Even though it is tempting to argue that this is one of the very few indications of irrigations systems operated by social groups other than the provincial government under the authority of the governor, such claims cannot be made on such scant evidence.

7.2.3.2 Individuals Appearing in BPOA 2 2547 (SS02-00-00)

The work project documented in text BPOA 2 2547 concerned the annual removal of sediments of the Šara-gugal canal. Most of the individuals mentioned are the various inspectors of the (plow-)oxen that operated in the Da-Umma district, where this canal was probably located (Vanderroost 2012i: 99–105, 260–270, table 6, 8–14, 2012ii). The projects, with that mentioned above, appeared to have been large enough that it required the participation of the agricultural staff of the entire Da-Umma district and their respective work crews. Though the text indicates that the workforce consisted of hired laborers (a_2 lu_2 hun-ga_2), we can assume that workers were

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[177] Ipa'e was the brother of Egalesi and usually appears in the capacity of an inspector of (plow-)oxen in the textual record. However, he seemed to have occupied a slightly higher position in the administrative hierarchy of the Gu'eden and Mušbiana district, as he supervised eight instead of the typical five or six cultivators as well as authorized many work projects supervised by his colleagues (Vanderroost 2012i: 152, 2012ii: 54–57)

[178] Akala and Kuli are quiet common Sumerian names and it is difficult to know which individual is mentioned in the text. There is an Akala and Kuli known as inspectors of (plow-)oxen for the Gu'edena and Mušbiana, however, there is too little evidence to identify them any further (Vanderroost 2012ii: 62, 286, 2012ii: 249–252).

[179] To my knowledge, the dimensions of flow-dividers are never given in surface units, but always in units of volume. I argue that this line refers to the number of flow dividers located within an area of 6 bur_3, which corresponds to the standardized size of one unit of agricultural land. This might be an indication that we are dealing with Ur-Šulpa'e, the cultivator, under the supervision of the inspector of the (plow-)oxen GuTAR, who was in charge of this particular agricultural unit. However, it is also possible we are dealing with the inspector of the (plow-)oxen Ur-Šulpa'e who operated in the Da-Umma district (Vanderroost 2012i: 183–184, 270, table 14).The tablet was written at a time when Lugalemah(e), the scribe of 30 (plow-)oxen of the Da-Umma had already been succeeded (around ŠS03–05) by three scribes of 10 (plow-)oxen, Lugalnesag(e), Abbagina and Kaš. Therefor, Lugalemah(e) would have been the superiors to Ur-Šulpa'e if we are dealing with the inspector of the (plow-)oxen of the Da-Umma district.

recruited among the labor force under the authority of the individual inspectors of the (plow-)oxen (see above). Each of them had approximately 18 ox-drivers under their jurisdiction, and the workforce amounted to about 252 individuals. A labor force of 252 individuals at a daily work rate of 2.25– 3m^3 per worker would have been able to move the amount of 15670 m^3 earth in 20–28 days. Even though the dimensions of this particular canal is unknown, assuming a width of 6 and 12 m and a height of 0.3 m accumulation of silt, the total length dredged would amount to either 4.397 km or 8.795 km.

Indicative of the management structure is the fact that the surveying, planning, and assignment of the workload was done by Dadaga, who became governor of the Umma province in the year SS07. Lugalemah(e), who was in charge of the agricultural sector of the Da-Umma district, appears in this text in a subordinated position. As will be discussed in chapter 8, 8.3.2 Dadaga alongside with his brother Akala appear frequently in documents pertaining to agricultural or water works in the Da-Umma district. It is clear that the gubernatorial family of Umma ultimately retained oversight over the entire agricultural operation of the province. Gugua, the son of Mansun appears frequently in relation to projects related to irrigation, flood control and river management and might have functioned as an assistant to Dadaga in this surveying project (Vanderroost 2012ii: 41).

7.2.4 Execution of Projects

Text MVN 16 0993 is an example of a receipt for the execution of the assigned work project to an individual inspector of the (plow-)oxen and his subordinated workforce of cultivators and ox-drivers. The project at hand consisted mainly of repair work at several flow dividers in the Gu’edena and Mušbiana district under the supervision of Lu-dingira. Lu-dingir, the son of Hemadu, was an inspector of the (plow-)oxen operating in the Gu’edena and Mušbiana district, frequently working under the supervision of Egalesi, who in this instance sealed the tablet to confirm that the work had been completed. He supervised a work crew consisting of 5 cultivators and 8 ox-drivers (Vanderroost 2012i: 97–98, 152, 2012ii: 64–65). The job would have been completed in about a week, with a work crew of 13 individuals.

MVN 16 0993 ***obverse*** 1. 5 sar kin u$_2$ sahar-ba 2. kab$_2$-ku$_5$ i$_7$-Lugal igi E$_2$-duru$_5$ 3. 4 sar kab$_2$-ku$_5$ i$_7$-Nin-he$_2$-gal$_2$ 4. 9 sar 10 gin$_2$ kab$_2$-ku$_5$ i$_7$-Sag-du$_3$ 5. šu-nigin$_2$ 18 sar 10 gin2 kin u$_2$ sahar-ba 6. guruš-e 10 gin$_2$-ta ***reverse*** 1. a2-bi u4 109-kam 2. kab2-ku$_5$-ta sahar šu ti-a 3. u3 kab$_2$-ku$_5$ sahar si-ga 4. ugula Lu$_2$-dingir-ra 5. kišib$_3$ E$_2$-gal-e-si 6. mu bad$_3$ mar-tu ba-du$_3$ ***seal*** 1. E$_2$-gal-e-si 2. dub-sar 3. dumu Lu$_2$-^{d}Šara$_2$ 4. sa$_{12}$-du$_5$-ka	***o. 1-2*** 90m^3 reinforcement work with an adobe mixture at the flow divider of the Lugal-canal facing the village ***o. 3*** 72m^3 reinforcement work with an adobe mixture (at) the flow divider of the Nin-hegal-canal ***o. 4*** 165m^3 reinforcement work with an adobe mixture (at) the Sagdu-canal ***o. 5*** The total is 327m^3 of reinforcement work with an adobe mixture ***o. 6 – r. 3*** (the workload) per worker is 3m^3 (equals) 109 workdays; (the tasks involved): collecting earth from the flow-divider, and filling in earth at the flow divider ***r. 4-5*** the supervisor (was) Lu-dingira sealed (by) Egalesi **Year:** The Amurru wall was built (SS04-00-00) **Seal:** Egalesi, scribe, son of Lu-Šara, the land surveyor

7.2.5 Remuneration of Workmen

Once the work was completed, hired laborers or workmen on corveé duty were remunerated, of which OrSp 47–49 151 is an example. As mentioned earlier, depending on the employment status, workers received grain allotments (šag$_4$-gal) when on corveé duty and wages (a$_2$) when contracted as hired laborers (lu$_2$-hun-ga$_2$). Wages are usually listed in daily payments varying between 4–6 *sila* (liter) (Nissen et al. 1993; Koslova 2006). The wages were usually three times higher than the grain allottments received during corveé duty (Steinkeller 2003: 45). However, depending on the status of workmen the grain allotment /wage could vary considerably (Koslova 2008). This text also provides a neat summary of the work-norm as well as daily wages for hired labor (lu$_2$-hun-ga$_2$) and the equivalent amount of grain that was spent. This tablet shows the conversion of the equivalents:

The amount of repair work was surveyed by Erdingir, who appears to have been in charge of the management of the flow divider of the I-sala-canal in the capacity of a watcher of water. As discussed in chapter 5, 5.2.4, flow dividers needed to be maintained regularly to ensure that the proportional division of the water was retained. The authorization for withdrawing the 240 liters of grain to pay the hired laborers was given by Akala, the later governor of Umma. The office of the chief of the granary (ka-guru$_7$) was held around the time the text was written by ARAD$_2$(mu), the brother of Akala (Dahl 2007: 115–121). Akala never held the position of chief of the granary, but he might have had the authority to authorize withdrawals.

OrSP 47–49 151	
obverse 1. 6 2/3 sar kin u$_2$ sahar-ba 2. guruš-e 10 gin$_2$-ta 3. a$_2$ 6 sila$_3$-ta 4. še-bi 240 sila$_3$ 5. kab$_2$-ku$_5$ i$_7$-Sal$_4$-la si-ga ***reverse*** 1. sahar-bi Er$_2$-dingir in-gid$_2$ 2. ki ka-guru$_7$-ta 3. kišib$_3$ A-kal-la 4. mu a-ra$_2$ 2(diš)-kam Ša-aš-ru-um^{ki} ba-hul ***seal*** 1. A-[kal-la] 2. dub-[sar] 3. dumu Ur-nigar$^{[gar]}$	***o. 1*** 108 $^2/_3$m^3 reinforcement work with an adobe mixture ***o. 2*** (the workload) per workmen per day is 3 m^3 ***o. 3*** the wage (paid per day): 6 liters of grain ***o. 4*** the (total) grain expenditure is 240 liters of grain. ***o. 5*** (the task): applying (the adobe mixture) to the flow divider of the I-sala canal ***o. 6 – r. 1*** its (work) volume was surveyed by Erdingir ***r. 2*** (the grain was received) from the chief of the granary ***r. 3*** sealed by Akala **Year:** AS-06-00 **Seal:** Akala, scribe, son of Ur-nigar

7.2.6 Numeracy and Literacy in Ur III Society

In, sum the ancient documentation of Umma shows that an elaborate bureaucratic system was employed to manage state land and organize projects related to irrigation, flood control and river management. The mathematical methods involved consisted of surveying the construction and repair work to acquire quantitative data that allowed for calculating the labor demand as well as the amount of construction materials needed. The mathematical procedures further consisted of dividing and assigning the respective workload to various administrators and their work crews. The final step involved the quantification of the expenditure of grain for paying the wages for staff and laborers. The texts remain completely silent on the science of hydraulic engineering, which must have existed even if in a very rudimentary form and which are well attested for later periods (Bagg 2000). The only direct evidence of this are the linear dimensions given in a blueprint fashion as seen in SAT 2 0210. Unfortunately, such documents are rare and it is difficult to draw any conclusion on the understanding of hydraulic engineering in Ancient Mesopotamia.

The quantitative and qualitative details recorded in the texts raises the questions of how accurately they represent day-to-day agricultural operations. Steinkeller (2004: 73–75) has argued that most of the administrative records were composed *post factum*, most likely in an office setting. He argues that the administrator drawing up the record was not necessarily supervising the described work project. Based on Steinkeller's observations, (Adams 2006: 3) also questions the practicality of "farmers having to follow superimposed, largely unchanging rules under close supervision by notaries without practical experience" when insufficient water supply, changing weather, and soil conditions call for skill and experience to respond adequately. In his view, cultivators on site must have had some leeway to make day-to-day decisions on their own that were later recorded but not necessarily predetermined. The underlying assumption in Adam's (2006) interpretation is that there was a high degree of labor division between the administrators, who produced the written record, and the laborers and supervisors on onsite. However, the evidence presented here suggests a different scenario.

As shown above, the records do not only record labor and material expenditures of completed jobs but also different planning stages of the organization of work projects. In particular, the texts recording the survey of various work projects were drawn up to aid the planning, scheduling, and timely execution of irrigation works. In addition, several of these documents also suggest that the labor division was not as great as had been thought earlier. Rather, the skill sets mastered by even mid-level administrators, such as Lugal-kugani the inspector of the (plow-)oxen mentioned in MVN 16 1594 is broader than assumed. It is not uncommon that mid-level agricultural administrators used seals identifying them as scribes. For example, all his colleagues (Lugal-kugani, Inim-Šara, Lugal-inimgina, and Lu-Šara) who worked as inspectors of the (plow-)oxen in the Apisal district (see Vanderroost 2012ii: 47–50, 125–130, 174–176) used seals identifying them as scribes as well. It appears that agricultural administrators not only planned and supervised agricultural and irrigation projects but also handled the required accounting for their sphere of action. This suggests a much higher level of literacy and numeracy in Ur III society (see also Steinkeller 1987b: 100), than has often been proposed.

7.2.7 The Watchers of Water - Erdingir

As has been discussed above, most of the tasks related to the management of water courses for river navigation, irrigation and flood control were carried out by the staff of the agricultural bureau and seasonally hired labor. As far as I can tell, there was no separate administrative hierarchy only concerned with water course management. Work projects at the Tigris barrages at Apisal and Eduru-Šulpa'e were frequently authorized by the high-level agricultural administrators, Lugal-kuzu from the Gu'edena and Mušbina district and Lugalemah(e) for the Da-Umma district (see appendix A). In addition, the work projects were frequently supervised by the various inspectors of the plow(-oxen), most likely carrying out the project with ox-drivers under their jurisdiction.

The only "water official" who could be identified so far is Erdingir, the official who was put in charge of the inspection of all flow dividers in the Da-Umma district. Erdingir is listed in the employment roster of the agricultural personnel of the Da-Umma district in text Talon-Vanderroost 1 xvii: 29–42 (AS05-06-00– AS06-06-00). He headed a list of ten individuals qualified as water officials (a-igi-du_8-me – "they are watchers of water") (Steinkeller 1988: 79, fn 48: Vanderroost 2012i: 54, fn 172, 100, 179)[180]. Erdingir is well attested in the historical record of Umma from the 36^{th} year of reign of king Šulgi until the fourth (and possibly the sixth) year of Šu-Suen's reign with a tenure of 27 years. The other water officials are rarely attested for some unknown reason.[181] Erdingir is listed as „old" (šu(-gi_4)) in text Talon-Vanderroost 1, suggesting that he might have already retired from his position as a water official and been

[180] The individuals mentioned are, Šara-kam, son of Erdingir; Dada, son of Amar-Suen-Utu-mu, […]kugani, son of Gu'dea and his son Lubalsaga; […]lu-^{d}[…] and his son Lu-dingira; Ur-mes, son of Nabalu and his son Lugal-gigire; Lusaga, the smith, son of La'amu and Šeš-kala son of Akadul. Hardly any of these officials appears in the Umma records except for Erdingir and Ur-mes. The reason for the lack of attestation in the Umma record remains unclear.

[181] Ur-mes, the son of Nagalu (also attested as Na-ba-lu_5) and Rubati, are the only other attested watchers of water. The number of attestations of these two officials is very scant in the Umma record. Ur-mes (14x), appears to have operated in the Apisal district, authorizing work projects at flow dividers (BPOA 1 0788: o. 1–3, Princeton 1 438: o. 5 – r. 1, and UTI 3 1969: o. 1–2), barrages/weirs (BPOA 6 1286: r. 6, Princeton 1 438: o.2, r. 2) and canals (UTI 4 2400: o. 2–4) and sending work crews out to perform water duty at fields and other devices (BPOA 1 0788: o. 4–r. 2, BPOA 6 1286: o. 1–r. 4, BPOA 6 1284: , UTI 4 2400: o. 9–10, UTI 5 3141: o. 1–4). He is attested in a requisition list (Nisaba 24 18: r.i 1–2, see also OrSP 47–49 235) as having received 2035 bundles of reed. Rubati (7x) on the other hand is exclusively recorded as the conveyor of animal deliveries (SAT 3 1640 and SAT 3 1646) many of which were offerings (BPOA 7 2049 and SAT 3 1640), in two cases made out to goddess Inanna (SAT 3 1773 and UTI 3 1884. He is also recorded in conveying animal and animal hides (BPOA 1 0517). Text SAT 3 1767 records him making an offering of 1 liter of grain in the city Zabalam, which was known as a royal town. The delivery of sheep offerings by the watcher of water Rubati might indicate that rituals were performed in relation to water management.

succeeded by his son Šara-kam around the fifth or sixth year of Amar-Suens' reign.[182] However, there is no visible change in Erdingir's sphere of action in records dating to a period after the year AS05/06. Quite to the contrary, he appears to be fully active until the middle of king Šu-Suen's reign.

The records suggest that early in his career, Erdingir[183] only occupied the position of a regular supervisor (ugula) overseeing a work crew carrying out agricultural work assignments.[184] He might have assumed the position of a water official around the 46th year of Šulgi's reign, when he started using a new seal that denoted him as "servant of god Šara"[185] in addition to the patronym, "son of Lugal-saga" (Mayr 1997: 208–209). The use of a more elaborate seal might have accompanied his promotion to a considerably higher position in the administrative hierarchy. From this date forward Erdingir is always recorded in the capacity of commissioning and verifying the completion of work projects by sealing on individual receipts. In all the other instances, he appears in the capacity of the "conveyor", (gir_3/$giri_3$)[186] probably indicating that

[182] Erdingir had two sons, Ur-E'e (Nisaba 23 053, BM 110135: o.i 4) and Šara-kam (Nisaba 11 15 BM 104749: o.ii 2–7) as well as a daughter who was a gardener (text PPAC 4 227: o. 3–4). Ur-E'e is only attested in two documents related to agricultural work (BPOA 2 2037, SAT 2 1028). There is a supervisor (ugula) with the name Šara-kam, who is attested as having supervised work at flow dividers (see BPOA 7 2282, BPOA 7 2335 and Princeton 1 512) and more importantly overseeing workers on water duty, predominately at Ganamah, Igi-emahše, Ninura and Šara-gugal-fields (see appendix U). Text BPOA 7 1610: o.7–r. 2 even identifies him as the watcher of water. Furthermore, this supervisor is attested primarily for the last years of Amar-Suen's reign (AS08–09) and the beginning of Šu-Suen's reign (SS01–03). This time period corresponds to the end of Erdingir's career and could be an indication that this individual was indeed his son.

[183] There are at least one and possibly two other individuals bearing that name. There is a supervisor (ugula) Erdingir, whose tenure overlapped with that of Erdingir the watcher of water (Nisaba 06 26 (AS04-09-00): lo.ed.ii 12–13; BPOA 7 1611 (AS08-05-00); MVN 14 0346 (SS02-06-00 – SS02-11-00); BPOA 1 0168: o. 1–2 (IS03-00-00)). Another individual called Erdingir might have been employed in the textile workshops as a supervisor as he is attested in providing garments (Nisaba 11 57 BM 104799: o. 9 o. 19; Nisaba 24 05 BM 104800: r.i 9, SAT 2 1000).

[184] See e.g. MVN 08 175 (SH36-00-01–SH36-00-16) which shows that he was a supervisor (ugula) in charge of 14–20 workers for consecutive days for a period of about two weeks making sheaves in the field Kamari. Text MVN 05 007 (SH41-00-00) also lists him as a supervisor (ugula) in charge of 20 hired laborers performing water duty at a certain location (tablet is illegible) (see also text BCT 2 250: o. 6 (SH45-00-00) and MVN 15 255 (SH48-03-00): o.iii 18). He is also listed in text MVN 15 390: o.ii 51–52, o. ix 43-44, r. v 51–54 (SH37-03-00 – SH37-07-00) as having to contribute 100 workdays as a supervisor (ugula) to the national building project at the palace of Tummal (Steinkeller 2013a: 362–372). This amount corresponds to the number of workdays an individual owed to the state in corveé labor in exchange for usufruct rights to land parcels (Steinkeller 2013a: 351).

[185] He is listed with as a priest of god Šara in Text OLP 08 24 21 (SS04-00-00): r.iii 33-34 (1 Er_2-dingir $gudu_4$ $^{d}Šara_2$ $Umma^{ki}$-me "…. Erdingir, they are priest of god Šara of Umma").

[186] The function of the official identified as the "conveyor" (gir_3/$giri_3$) in economic transactions is not yet fully understood and might have even varied, depending on the context. It has been suggested that in tablets recording deliveries this particular official was in charge of the actual transfer of the goods or animals in question from one place to another. Others have suggested that the $giri_3$ official was in charge of verifying a transaction and the accuracy of the respective account (Molina 2013: 127, fn26, Sallaberger 1999: 49–50, Steinkeller 1977: 42, fn. 12).

certain supervisors (ugula), who were for the most part inspectors of the (plow-)oxen (nu-banda$_3$) worked in that particular instance under his authority. The fact that most of these tablets are sealed by officials at the top of the administrative hierarchy, such as Lugalemah(e), or even Akala suggest that Erdingir was at the top of the administrative hierarchy of the agricultural bureau of Umma (see appendix X, table X.1).[187] This is further supported by the fact that Erdingir seals a number of receipts with the socalled nam-šatam seal (kišib$_2$ nam-ša$_3$-tam)[188]. This seal was restricted to a specific number of officials[189], most of whom were located at the apex of the administrative hierarchy.

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[187] There is other evidence that substantiates this argument. There are several records on Erdingir authorizing the withdrawal/expenditure of grain wages for various workers (e.g. ASJ 19 226 72: r.i 10'–12', DoCu EPHE 076: r. 1–2, MVN 13 190, SAT 2 0698, SAT 3 1192), including bird catchers and animal drivers (see AAICAB 1/1, Ashm. 1912–1146: r. 3–6) and leather workers (BPOA 7 1607). He is also attested in taking out grain loans MVN 13 619: r.i 19–20 and making payments in silver (SAT 3 1238: 0. 1, SAT 3 1849: o.ii 19). Even though the texts do not state what the silver payment was for, it is likely it represents an "irrigation fee" levied on all landholdings (Ouyang 2010). The amount paid of 1 Shekel (1gin$_2$) would have corresponded to 12 iku (4.32 ha) of land (Ouyang 2010: 334), while other texts suggest that Erdingir's sustenance holdings were smaller (6 iku, see Orient 21 6: o.i 16). In any event, the size of his landholding would have been in both cases smaller than that of an inspector of the (plow-)oxen (18 iku = 1 bur$_3$). He is also listed in CDLJ 2009: 2 FSU 12: o. 5 amongst other senior officials of the Umma province as being eligible for receiving livestock; a goat in his case (Robson and Clark 2009: §3.4).

[188] The prefix "nam" is used to create an abstract, such as nam-lugal = kingship. The nam-šatam seal might indicate an affiliation with a particular office in the administration of the provincial sector of Umma (Gallery 1980: 5). It is only used in the Umma province. Gallery (1980: 1–3) argues that the prime function of those officials was that of a controller, ensuring the accuracy of an account. Dahl (2007: 65, fn 248), on the other hand, suggests that "the term referred to the seal rolled on documents relating to a larger agricultural unit." However, the seal was also used on ordinary administrative documents. Gallery (1980: 4) argues that the use of regular seals "kišib PN is merely an abbreviated formula implicitly understood by the administrators to mean kišib (nam-ša$_3$-tam)". I am hesitant to subscribe to her final conclusion, given that the use of this seal was restricted to a number of officials only (see fn above).

[189] The list compiled by Gallery (1980: 30–32, table 1) of those officials is fairly comprehensive despite the fact that she had a much smaller sample at her disposal at that time. Amongst those officials, we find Akala, the later governor of Umma, his brothers Lugal-kuzu and Ur-E'e each in charge of running the agricultural sectors of the Gu'eden/Mušbina and Apisal districts respectively. The list contains other members of the gubernatorial family such as the sons of the governor Dadaga, Lugal-azida, Lu-Šulgira as well as members of other notable families of the Umma Province. Amongst these, we find members of the family of Lugal-kugani, the land surveyor, father of Lugalemah(e), who was in charge of running the agricultural sector of the Da-Umma district. Also represented were his brothers, Ur-Enlila and Ur-Šulpa'e, who were also high ranking agricultural administrators. The same applies to the family of Lu-Šara, the royal land surveyor, whose son Egalesi frequently signs records with the nam-šatam seal, as does his brother Ipa'e. In sum, the officials making use of the nam-šatam seal are high ranking officials primarily engaged in the management of agricultural land. Based on my analysis of administrative documents dealing with irrigation and water management, some officials to be added are Akala, the son of Ur-nigar, the later governor (Princeton 2 497 (SH47)), Abaginga alias Lu-Šara2, son of Ursaga (Syracuse 193); Lu-dingira, son of Lugalemah(e) (BPOA 6 0253) and Lu-dingira, son of Habaluge (SAT 3 1626); Lugalkugani, son of Ala, the sukkal (SAT 2 0390); Lu-Šukkalanka, son of Lugalkugani (MVN 03 202); Lumma, son of Lu-Ninšubur (BPOA 6 1186); Lugalnesag(e), son of Lu-banda (BPOA 7 2221); Šeš-kala, son of NaDI (BPOA 1 0514), Urdun, son of Dada (SAT 3 1387); Ur-lugal, son of Da'agi (SNAT 336); Ur-emah, son of Dada (MVN 16 0814) and Ur-gigir, son of Baran (Nisaba 23 017).

Of particular interest in this respect is the fact, that Erdingir is listed as an UN.IL$_2$/ug$_3$-ga$_6$ (“carrier”/”menial”) in particular when listed as the watcher of water (a-igi-du8). Menials usually belonged to the group of unskilled and thus “less privileged” worker, who worked for various state institutions and industries year-round.[190] The example of Erdingir, indicates that certain menials not only occupied administrative positions but could also be owners of an official cylinder seals.[191] It is certain that Erdingir, the menial and watcher of water is identical with Erdingir, son of Lugal-saga, servant of god Šara. The proof is given by the mentioning of his sons, Ur-E’e and Šara-kam. They are listed as the sons of Erdingir, the menial and the watcher of water[192] and both use a seal with the patronym “son of Erdingir, servant of Šara”.[193]

7.2.7.1 Erdingir’s Sphere of Action

Erdingir’s sphere of action was concentrated in the Da-Umma district (see appendix X, table X.1). Very rarely, he would authorize work in other districts (e.g. Ninudu-field, barrage of the Sisa-canal, both located in Apisal). As can be seen in table 7.7, Erdingir commissioned a broad variety of work projects that were primarily concerned with irrigation, and less so with flood control or river management. Furthermore, he is mainly engaged in the operating of flow dividers, whose prime function (as discussed in Chapter 5, 5.2.4) was the spatial distribution of specific quantities of water within the irrigation system. The operation of flow dividers might pertain to his position as the “watcher of water” to ensure the accurate division of water within the system. There is a disproportionately high number of texts recording that Erdingir commissioned the making of reed ropes under the supervision of Agu, who was most likely the chief of the basketry workshop in Umma (Dahl 2007: 41, fn 175 and 108, fn 385). It is tempting to argue that these ropes were used to operate the flow dividers, since text BPOA 1 1143 indicates that they were an integral element of the construction design of these devices.

Within the Da-Umma district he primarily commissioned work for I-sala canal and the Dubla-Utu canal as well as their respective control devices. As discussed in Chapter 5, 5.2.1, the

[190] See text Nisaba 11 15 BM 104749: ii 4–7, where he is listed alongside his two sons, Ur-E’e and Šara-kam and Talon-Vanderroost 1 xvii: 29–42.
[191] See also Studevent-Hickman (2006: 325, fn 303) who made a similar observation that certain UN.IL2 held sustenance land and occupied managerial positions.
[192] Nisaba 11 15 BM 104749: o. ii 4–7; Nisaba 23 053 BM 110334: o.i 4 (just Ur-E’e), Talon-Vanderroost 1 xvii: 29–42 (only Šara-kam).
[193] Ur-E’e (BPOA 2 2037; SAT 2 1028); Šara-kam (SAT 3 1192).

I-sala-canal in particular appears to have been the primary canal of the most important irrigation system in the Da-Umma district, closely followed by that of the Dubla-Utu-canal.

Table 7.7

Work projects commissioned by Erdingir

Location	**Task**	**Sumerian**	**# Ref**
Flow divider	making the flow divider	kab$_2$-ku$_5$ ak	1
	carrying plant material to it	kab$_2$-ku$_4$-še$_3$ u$_2$ ga$_6$-ga$_2$	5
	insert earth into it	sahar si.g	15
	manually remove earth from it	sahar šu--ti	3
	work duty	kab$_2$-ku$_5$ gub	4
Barrage/weir	work duty	kun-zi-da gub	7
	cover/coat with earth	kun-zi-da sahar si.g	3
	restoring it	kun-zi-da gi$_4$	1
Canal	digging a canal	i$_7$-CN ba-al	2
	inserting earth into it	i$_7$-CN sahar si.g	1
	cleaning the inlet	ka i$_7$-CN šu luh-ak	3
	removing earth from the inlet	ka i$_7$-CN sahar zi.g	1
	reed bundles for the inlet	sa gi ka i$_7$-CN	1
	profiling/leveling its levee (?)	i$_7$-da šu--ur$_3$	1
Tigris	water duty	a-da gub Idigna	1
Dike	water duty	a-da gub eg$_2$ DN	2
	work duty at a dike	eg$_2$ gub	1
Place	water duty	a-da gub PN	1
Field	irrigating	a du$_{11}$-ga	3
	water duty and flooding a field	a-da gub a-de$_2$	1
	water duty	a-da gub a-ša$_3$ FN	7
	work duty at the fields	a-ša$_3$-FN gub	1
Varia	carrying reed from A to B	gi ga$_6$-ga$_2$	3
	carrying plant material from A to B	u$_2$ ga$_6$-ga$_2$	5
	plaiting reed mats	kid sur	1
	twisting ropes	^{gi}gilim sur	10
	unspecified		3

7.2.7.2 Staff of Erdingir

It remains somewhat uncertain whether Erdingir had permanent staff under his jurisdiction, even though several texts record the transfer of one workman from another supervisor into his work gang.[194] Judging from the names of the supervisors (ugula PN), however, who carried out the work projects he commissioned, it is more likely that he made use of the existing agricultural staff of the Da-Umma district, nominally subordinated to Lugalemah(e) and Egalesi (see table 7.8). The lack of patronyms does not allow these supervisors to be identified with absolute certainty. However, out of the 29 attested supervisors names under the authority of Erdingir during his tenure, 19 are names that are also attested as inspectors of the (plow-)oxen employed in the Da-Umma district (see appendix X, table X.2, for prosopographic data see Vanderroost 2012ii). Erdingir was not the only one authorizing work projects at flow dividers in general and that of the I-sala-canal in particular. As seen in table 7.8, in the span of 19 years for which records are attested, 14 different officials authorized and verified work projects at the flow divider of the I-sala-canal (see table GH and appendix X, table X.2).

Table 7.8

Officials authorizing work at the flow divider of the I-sala-canal

Authorizing official	**# years attested**
Akala, scribe, son of Ur-nigar, the chief livestock administrator	2
Da'agi, scribe…	1
Dadaga, scribe, son of Ur-nigar, the chief livestock administrator	2
Šara-hegal, scribe, son of Ur-mes	4
Erdingir, servant of Šara, son of Lugal-sasa	7
Gugu'a, scribe, son of Mansum	3
Lu-Šulgia, scribe, son of Dadaga	1
Lugalemah(e), scribe, son of Lugalkugani	4
Šešani, scribe, son of Dada	1
Ur-Šara, scribe, son of Šeškala	3
Ur-dun, scribe, son of Dada	1
Ur-lugal, scribe, son of Da'agi	4
Ur-mes, scribe, son of Ur-Ašnan	1
Ur-mes, son of Ur-Nisaba	1
Total: 14	AS03–SS08 = 17

[194] He took on the worker Genamu on AS05-06-15, who was prior to this under the jurisdiction of Ur-gigir (Syracuse 034). He also took on two other individuals but only on temporary basis. He took over Lugal-ibigul from Ur-Šulpa'e, probably the inspector of the (plow-)oxen (YOS 04 175 and YOS 04 180) and Gudada (BPOA 1 0574 and UTI 3 1702)

However, the supervisors commissioned for the work at the flow-divider of the I-sala canal were almost identical to those that Erdingir commissioned in the course of his tenure (see table 7.9). This indicates that Erdingir's sphere of action was not significantly different from those of the other authorizing officials. However, he is the most frequent administrator for the flow divider of the I-sala-canal. As has been discussed earlier the I-sala irrigation system appears to have been the most important, possibly also the largest irrigation system operated by the governor-run sector of the Umma province. There are more than 150 references to the I-sala-canal and its water control devices in the Umma record.

Table 7.9 Supervisors (ugula) attested at the flow divider at the I-sala canal			
Supervisors working at flow divider at I-sala under various superior officials		Supervisors working under Erdingir during his tenure	
Supervisors	**# years attest.**	**Supervisor**	**# years attest.**
Abba-gina	2	Abba-gina	1
Abba-sig	1	Abba-sig	1
Agu	1	Agu	1
Akala	4	Akala	4
Aramu	1	Basa	1
Basa	1	Dadaga	1
Dadamu	2	Dadamu	3
Šara-amu	1	Šara-amu	3
Ikala, scribe	2	GuTAR	2
Ipa'e	4	Ipa'e	1
Lu-balasig	1	Lu-balasig	5
Lu-Damu	1	Lu-dingira	4
Lu-Šara	1	Lu-duga	1
Lu-duga	3	Lugalema(e)	5
Lugalema(e)	2	Lugal-ezem	1
Lugal-itida	3	Lugal-gu'e	2
Lugal-kuzu	4	Lugal-igisasa	1
Lugal-mumanag	2	Lugal-itida	1
Lugal-unken(e)	2	Lugal-kuzu	8
Lusig	2	Lugal-mumag	5
Šeš-kala	4	Lugal-nesaga	1
Tab-šala	6	Lugal-unkene	2

Ur-Enlila	1	Lu-sig	3
Ur-Šulpa'e	1	Šeš-kala	2
Ur-dun	1	Tab-šala	3
Ur-mes	9	Ur-Šulpa'e	1
Ur-sig	2	Ur-mes, son of dumu Ur-Ašnan	3
		Ur-sig	1
Total: 27		Total: 28	

The fact that Erdingir was in charge of this canal and its diversions points in particular, shows, that he occupied a high position in the management of irrigation in that particular area. Obviously the texts will not allow us to reconstruct the full range of his responsibilities but the fact that there was an office mainly in charge of water distribution further supports the conclusion of a high degree of centralized control in the management of irrigation and water courses.

7.3 Water Management in the Umma Province as a Whole

The data presented above as well as the those presented in Chapter 4–6 describe a very small part of the irrigation and water management of the Umma province and the Ur III state as a whole. As mentioned in Chapter 5, the amount of agricultural land under management of the provincial sector amounted only to 7% of the entire surface of the Umma province. While it is difficult to determine the percentage of all arable land managed by the provincial sector and the royal sector respectively, it is fairly certain that the portion managed by royal settlers was considerably larger (Steinkeller 2013a: 353–356). There is no information on the organization of irrigation of landholdings of the royal sector, as the two sectors operated as almost entirely separate economic entities, each having their own accounting and bureaucratic system. The two sectors did though cooperate on some level (e.g., grain loans in return for harvest labor, see above). Some form of cooperation must have existed concerning irrigation, flood control and river management as both sectors depended on the same water source – the ancient Tigris. There is some evidence that points to the existence of agreements concerning water usage and shared responsibly towards commonly used irrigation and water control facilities.

7.3.1 Conflict Resolution and Evidence for Mutual Agreements

Three court documents are most informative, as they record the infringement on such agreements. While the agreements themselves are never spelled out in any detail, the nature of the conflicts provides some insight into the rights and duties of the respective sectors. The first court document (YOS 04 031) appears to have only concerned members of the royal sector as no officials of the governor-run sector were present. Also, the matter at hand might have been a petition rather than a charge. If AŠ.DU.PEŠ had to file a petition for the approval of the construction of a new canal, this shows that the central government (crown), in this case represented by the royal envoy, retained some control over water distribution. The presence of two generals, Ea-ili from Umma and Lu-Nanna (Molina 2013: 146–148) as witnesses suggests that each of them represented interest groups of water users, which might have lent legitimacy to the court hearing.

YOS 04 031 (= NSGU 130)	
obverse	***o. 1 – 7***
1. ka I[dig]na-[t]a	"From the inlet at the Tigris till the SUHpalirdama, (a
2. SUH pa$_4$-Li-[ir?]-dam-´ma?`-´še$_3$`	distance of) 420 m length (and) till the Dununuzka-
3. 70 nindan gid$_2$	canal, I want to run water" AŠ.DU.PEŠ declared.
4. i$_7$-Du$_6$-nunuz-ka-kam	***r. 1***
5. KU-bi-še$_3$	The petition (?) entered the palace.
6. ki AŠ.DU.PEŠ-e	***r. 2-3***
7. a ga-gid$_2$ bi$_2$-in-du$_{11}$-ga	The case of AŠ.DU.PEŠ was rejected
reverse	***r. 3 – 6***
1. e$_2$-gal inim ba-an-ku$_4$	infront of (witness) Ea-ili
2. AŠ.DU.PEŠ	infront of (witness) Lu-Nanna
3. di-bi-ta ba-taka$_4$	infornt of (witness) Erra-qurad, the royal envoy
4. igi E$_2$-a-i$_3$-li$_2$-še$_3$	**Year:** AS03-00-00
5. igi Lu$_2$-^{d}Nanna-še$_3$	
6. igi ^{d}Er$_3$-ra-qu$_6$-ra-ad lu$_2$-kin-gi$_4$-a lugal-<še$_3$>	
7. mu {giš}gu-za ^{d}E[n-li]l$_2$-la$_2$ ba-d[im$_2$]	

The second case AnOr 07 322 likely concerned a water dispute between the town of Nagsu and Umma. Nagsu was a royal settlement, thus the conflict appears to have concerned both sectors. Since no witnesses were present, this assumption cannot be proven. However, this record shows again that this dispute was mitigated by the central government (royal envoy).

AnOr 07 322 (= NSGU 111)	
obverse	
1. i$_7$-Pa$_4$-sikil-nun-na	***o. 1- 4***
2. lu$_2$ Umma^{ki}-ke$_4$	The 'men of Umma' litigated with the 'man of Nagsu'

3. lu$_2$ NAG-su^{ki}-da 4. di in-da-an-du$_{11}$ 5. lu$_2$ NAG-su^{ki}-ke$_4$ ***reverse*** 1. ´x` [x x]-´mu` / [...]-´a` 2. b[i$_2$-i]n-du$_{11}$ 3. lu$_2$ NAG-su^{ki} 4. di-ta ba-taka$_4$	over the Pasikilnuna-canal. ***o. 5 – r. 1*** "The man of Nagsu' did […......] he said. ***r. 3 - 4*** The verdict the 'man of Nagsu' was rejected.

The third case is more complex as both sectors were also represented by officials from either side (see text YOS 04 001). The offender Lu-gina cannot be further contextualized. However, as the governor is testifying against him, it appears he might have been a member of the royal sector. Three members of the royal sector functioned as witnesses, probably on behalf of Lu-kala, the cupbearer (Zuluhu, the colonel, Ur-Damu, the solider, and Lu-Suen, the fattener). Lu-kala, the cupbearer (sagi) is attested mainly in records from Puzriš-Dagan, further supporting the assumption that he was a member of the royal sector. Ur-gigir, son of Baran, on the other hand, was an inspector of the plow(-oxen) under the authority of Egalesi (Vanderroost 2012i: 99). He appears in most administrative documents in the capacity of the sealing and authorizing official and might have occupied a high position in the administration of the agricultural sector in the Da-Umma district. It is possible he might have attended this hearing as a representative of Egalesi or Lugalemah(e), and in support of Lu-gina.

YOS 04 001 ***obverse*** 1. Lu$_2$-ge-na a i$_7$-Sal$_4$-la i$_3$-in-e$_3$ 2. ensi$_2$-ke$_4$ e$_2$-gal-la di-da kab in-na-an-du$_{11}$ 3. Lu$_2$-ge-na e$_2$-gal-še$_3$ na-an-du-un 4. a-ša$_3$ Lu$_2$-kal-la sagi a-e de$_6$-a 5. a ga-ab-su in-na-an-du$_{11}$ 6. mu lugal-bi i$_3$-pa$_3$ 7. igi Zuluhu$_2$ nu-banda$_3$-še$_3$ 8. igi Ur-^{giš}gigir dumu Bar-ra-AN-še$_3$ ***reverse*** 1. [igi Ur]-^{d}Da-mu [aga$_3$]-us$_2$-še$_3$ 2. [igi Ur]-ku$_3$ aga$_3$-us$_2$-še$_3$ 3. [igi ...]-banda$_3$^{da}-še$_3$ 4. [igi Lu$_2$?]-´{d}`Suen kurušda-[še$_3$] (=KWU_822) ============ 5. ============ # (and erasure over A [x]) 6. mu us$_2$-sa en ^{d}Nanna maš-e i$_3$-pa$_3$ ============	***o. 1*** Lu-gina let water out from the I-sala-canal ***o. 2*** The governor testified against him in the palace. ***o. 3–5*** Lu-gina said to him "I will not go to the palace. The water that has been taken away from the field of Lu-kala the cupbearer, I will replace it." ***o. 6*** He swore an oath on the king. ***o. 7–r. 5*** infront of (witness) Zuluhu, the colonel infront of (witness) Ur-^{g}igir, son of Baran infront of (witness) Ur-Damu, the solider infront of (witness) […] the colonel (?) infront of (witness) Lu-Suen, the fattener ============ **Year**: SH44-00-00

This text clearly indicates the existence of water rights tied to land ownership in the royal sector. As Lu-gina had infringed upon the water rights of Lukala, the cupbearer, which suggests that he himself, was entitled to a share and puts into question whether he belonged to the governor-run sector. Water distribution there appears to have been entirely centrally managed by agricultural administrators, as it watered only state land - leaving no room for meddling on the individual level. However, one has to bear in mind that the available records only concern the management of land under the authority of the governor. If there was land managed differently, it would not have been included in the records of the governor-run sector. The alternative explanation would be that both Lu-gina and Lu-kalla were royal settlers. The presence of Ur-gigir might be related to the fact that the water theft in question occurred on the I-sala-canal. As discussed earlier, this system was mainly operated by the governor-run sector. This document indicates that the royal sector had some user rights to that system.

7.3.2 Cooperation in the Maintenance of Shared Water Control Facilities

There are other examples of the common use of certain canal systems. As discussed in Chapter 5, 5.2.3, the scale of constructing new canals carried out by the governor-run sector was very limited. This was most likely related to the fact that most of the irrigation systems were already in place at the onset of the Ur III period. The opening of new agricultural land for royal settlers on the other hand would have required the construction of irrigation canals and devices, which appears to have been done primarily by the royal sector. Steinkeller (2013a: 376, fn 115) argues that “the beginning of Amar-Suen’s reign saw a large development of new canals in the Umma province” many which are named after him. The name of the famous Amar-Suen-kegara-canal, as well as Amar-Suen-Šara-ki’ag (canal: Amar-Suen loves god Šara), Amar-Suen-nitum-canal (?) and Šara’adah-Amar-Suen/Amar-Suen-adah-canal (god Šara, helper of Amar-Suen).

Since the contribution of the provincial sector to the construction of any of these canals (approx. 600 m^3 of excavated earth for the Amar-Suen-kegara-canal) was very limited, this suggests they were primarily dug by members of the royal sector (see appendix B). As examined in Chapter 5, 5.2.2, the lack of records on the construction of the Amar-Suen-kegara-canal stands in stark contrast to the heavy labor investment (30 work crews) put into profiling work of the canal embankment and the construction of the inlet dam from the side of the provincial sector (see appendix B). This labor division suggests common responsibilities for the construction and upkeep of this canal possible due to shared usage. Some shared use is also indicated for the Amar-Suen- Šara-ki’ag- and Šara’adah-Amar-Suen/Amar-Suen-adah-canal. The provincial sector contributed minimally to the digging of the Šara’adah-Amar-Suen/Amar-Suen-adah-canal (see appendix J, table J.1.3) and, to the restoration of the weir at its outlet (kun i$_7$) (see appendix A). The provincial sector appeared to have operated the flow divider of the Amar-Suen- Šara-ki’ag-canal, and contributed to the upkeep of its barrage/weir, indicating some shared use of this canal (see appendix A and L). There are no records of any contribution by the provincial sector to the construction and upkeep of the Amar-Suen-nitum-canal, except for records on the transferal of boats (ma$_2$ bala-ak). This suggests the barrage was large enough to obstruct traffic and that labor and material costs would have been comparable to those constructed and maintained by the governor-run sector (e.g. Tigris barrage at Apisal). The same applies to the barrage at Maškan, which suggest that these devices were managed by the royal sector (see appendix A).

There is an indication that both sectors assumed common responsibility over the large Tigris barrages as they would have benefited all water users. Text Nisaba 24 10 lists the provisioning of reed bundles for the barrage of the Ištaran-Sisa-canal as “internal expenditure” (e$_2$-ta e$_3$-a) versus those provided by soldiers (aga$_2$-us$_2$). While the soldiers could have belonged to either sector, the term “internal expenditure” suggests that two entities, the governor-run and the royal sector contributed materials for the construction and upkeep of these devices.

Nisaba 24 10 (BM 106039)	
...	
reverse	***r.v 25–30***
column v	761 2/3 bundles of reed
25. 600+120+41 2/3 gu-/kilib gi	internal expenditure
26. [e$_2$-t]a e$_3$-a	160 bundles of reed
27. 120+40 gu-kilib gi	from the soldiers
28. ´aga$_3$?-us$_2$?-ta`	for the barrage of the Ištaran-Sisa-canal opposite of the
29. kun-zi-da [^{d}Ištaran]-	Eduru-Luduga village.
30. si-sa$_2$ gaba-ri [e$_2$]-/duru$_5$ <Lu$_2$>-du$_{10}$-ga-$_{še3}$	
...	

Furthermore, SNAT 477 specifically lists eren$_2$ people from Apisal and Nannatum as contributing to the upkeep of the barrage/weir Edena-canal (i$_7$-Eden-na) which is possibly a syllabic writing for Idigna/Tigris. While most of the recorded materials and labor for the Tigris barrages at Apisal and Eduru-Šulpa'e village came from known Umma officials of the provincial sector, it is noteworthy that the provisioning 21,633 bundles of reed was made by Biduga. According to Studevent-Hickman's analysis (2006: 56–69), Biduga was a beer brewer and very prominent figure in the Umma province. Not only did he hold usufruct rights to extensive land holdings, but supplied officials with a large array of commodities, including labor, reeds, tools, animals and animal products and authorized the withdrawal of an equally diverse set of products. He appears to have been involved in a large number of transactions of the bala – obligations of Umma province. He also appears to have been able to make withdrawals directly from the state sector. This places him at the intersection of the provincial government and the crown. The reason for him supplying such a large amount of reed to the construction of the Tigris barrage is unknown but it shows that there must have been a complex system of right and duties in place that translated into a division of labor for maintaining devices from which the both sectors profited. A more detailed reconstruction of the management system in place would however require a detailed prosopographic study of all the officials involved, which goes beyond the scope of this dissertation but will be pursued in the future.

7.4 Summary

In terms of the social organization of irrigation, the finding of a highly centralized, top down management of the irrigation infrastructure is probably not surprising in the context of the Ur III state, which is known for its high levels of governmental control. This finding is not changed by the fact that the control over the most important agricultural district Da-Umma was in the hands of two important families of land surveyors: Inim-Šara and Lugal-kugani. As suggested by document BPOA 2 2547, the gubernatorial family retained authorization power over larger water management projects. Further, given how vital grain production was for the survival of the state, it is hardly surprising that the infrastructure for watering the agricultural land and protecting it from flood was tightly controlled and managed.

The Ur III case of a highly centralized irrigation and water management system might be an exception to the norm, for a number of reasons. It is worth noting, while the results have a high internal validity for the governor-run sector, we cannot generalize from these results to all of

Umma nor to the entire Ur III state. In other words –there is no means at the moment to measure whether or not that kind of top-down management of the irrigation infrastructure applied to all systems in operation in Umma or the Ur III state. There is evidence that the neighboring province Girsu/Lagaš might have organized the maintenance work in a somewhat different manner (Rost 2011). The existence of water rights for the members of the royal sector might indicate that the management of those systems might have been more decentralized, though the prerogative of water distribution and conflict resolution remained in the hands of the central authority. In addition, the state investment into the construction of new canals suggests a high degree of state involvement in the management of these systems. Further research, in particular archaeological research will be necessary to accurately determine the degree of centralization and state involvement in irrigation and water management.

Chapter 8 Conclusion

This thesis represents an empirical investigation into the management of watercourses in southern Iraq at the end of the late 3rd millennium B.C. It explored the kind of technology employed to manage watercourses to coordinate the requirements of waterborne transportation, irrigation, and flood control, and it described how each of these functions was carried out and what kinds of devices were used. The thesis also analyzed the social organization of the adopted watercourse management system as it relates to labor organization, social inequality, gender relations, bureaucracy and political centralization. The result of this investigation allowed for addressing the fundamental question of the degree of political centralization in an early state society and how political control was realized on the local/provincial level.

This dissertation research was based primarily on an analysis of cuneiform administrative documents, in addition to limited archaeological data, modern environmental/agronomic and comparative ethnographic data, and ethno-archaeological research. In order to effectively use the detailed information recorded in Ur III administrative texts to address the above-mentioned issues, it was necessary to reanalyze the Sumerian terminology pertaining to the management of watercourses for the three core functions. Due to the lack of a systematic study, there has been considerable confusion surrounding the translation of nouns and verbs describing water control devices and related tasks. The textual analysis was done within the framework of a grain cultivation calendar, which was based on modern environmental and agronomic/ethnographic data. It outlines the timing and the order in which specific tasks have to be carried out in order to irrigate, cultivate, and harvest grain successfully and protect it from the flood efficiently. As one-fourth of all relevant tablets are dated by month, the calendar was instrumental in distinguishing between devices and tasks related to river navigation, irrigation, and flood control. In addition, discrepancies between the modern and ancient calendars revealed the idiosyncrasies of Ur III grain cultivation and water management.

8.1 Results: Water Level Control/Navigation and Flood Control

The central component of the watercourse management system was control of the fluctuating water levels of the ancient Tigris. The water levels of the Euphrates and Tigris conflict with the water demands of barley and wheat—that is, water levels are low during the sowing period in October/November and peak just prior to the harvest in April/May. Low water levels at the onset of the agricultural cycle are problematic, as the inlets of the primary canals will be located above the rivers' water level. In contrast to the modern situation, grain fields in the late 3rd millennium B.C. were only irrigated once or twice in early spring (Jan.–Mar.) and not after sowing. However, fields were frequently flooded to soften the soil prior to plowing in August/September, when the river's water level is at its lowest (see Chapter 5, 5.3). The water level in the river needed to be raised in order to force water into the inlets of the primary canals. Peak flooding around the harvest, on the other hand, posed a considerable risk of losing a year's worth of food supply and of causing major flood damage to the water control infrastructure and settlements. Thus, flood control was as important as irrigation (see Chapter 6). Water levels begin to drop at the end of May and the beginning of June, which greatly impacts the navigability of the Tigris—as travel time triples—and limits the weight of the cargo that can be transported between August and November. As discussed in chapter 4, waterborne transportation was of tremendous importance for the functioning of the Ur III state, as it was needed for the state-wide exchange of goods, mainly grain, to fulfill the bala-obligation paid by the individual provinces to the central government. In order to meet these obligations, grain was shipped all year round, but especially in September, when the river is naturally at its lowest (see chart 4.1). It is clear that there must have been a mechanism in place that kept water levels high enough to allow for waterborne transportation year round.

As discussed in chapter 4, there is very clear evidence in the textual record that the water levels in the ancient Tigris at Umma were controlled by means of large barrages, similar to those documented for the early 20th century A.D. These barrages (kun-zi-da) were placed in the river, and there are numerous records of boats being hauled (ma_2 bala-ak) over them as they blocked passage. These ancient barrages consisted mainly of reed and mud, and there is further evidence for the provisioning of reed mats and reed ropes, pointing to a very similar construction design to those documented ethnographically. The recorded amounts of reed, usually deployed in a single repair/construction effort, were always above 1,000 bundles and in the five-digit range (e.g., 21,633 bundles for the Tigris barrage) for the largest barrages along the Tigris, indicating that we are dealing with massive structures (see table 4.2). Evidence of the timing of documented construction and repair works shows that work was done at these barrages all year round. Moreover, there is evidence that these barrages were restored (gi_4) right after the flood. In addition, most of the recorded construction materials were deployed right around and shortly after the flood season, when these devices would have suffered the most damage (see chart 4.6; 4.7). These data suggest that the Sumerian barrages were kept permanently in the river to raise the water level for irrigation but also to keep the river navigable year round.

One of the largest barrages, big enough to obstruct boat traffic, was found at the city Apisal (Tell Muhalliya). Given the general flatness of the terrain of southern Iraq, the ancient Tigris must have had a very low bed gradient right around the area of Apisal, where it fanned out into multiple branches. Controlling the water level at the lowest point possible would have had an effect on the river's water levels upstream for a much longer stretch than at a location where the river had a steeper gradient. In turn, long stretches of the river could have been kept free of barrages that would otherwise have been an obstacle for boat traffic. In addition, placing a major barrage below the main agricultural area allows for stabilizing the river's water levels, which remain relatively unaffected by direct water use further upstream. The water levels in the ancient Tigris River must have been controlled again further upstream, where the damming effect of the barrages at Apisal would have ceased. There are three more barrages known to have been located at the Tigris that were of similar size to the one at Apisal. For all of them, the transfer of boats is attested, suggesting that they blocked the major part of the river. Reconstructing the approximate location of the barrages at Maškan, Kamari, and the inlet of the Amar-Suen-nitum canal suggests that the water level of the ancient Tigris had to be controlled approximately every 10 km. Due to our poor understanding of the historical geography of the Umma province, this conclusion cannot be proven with certainty.

Keeping a permanent structure in the river posed a considerable risk, as the river was more likely to overtop its levee at these locations. As has been discussed in chapter 2, 2.2.5, there is geomorphological evidence that the ancient Tigris in the area of Umma had a more anastomosing configuration that would have distributed the river flow over two or more main channels. As a result, the flood and the difference between high and low water levels would have been less severe and more manageable. The fact that *one-fourth* of the 2,500–3,000 studied texts pertain to flood control illustrates its importance for the functioning of the watercourse management system (chapter 6). The methods deployed were similar to those recorded ethnographically and consisted of construction flood dikes (eg_2-zi-DU) alongside the Tigris River and surrounding agricultural fields (eg_2 a-ša$_3$ GN). Most of the attested flood dikes and field embankments were located in the southeastern part of the Umma province close to the city Apisal and the border of the neighboring province Girsu/Lagaš. As mentioned above, this is also the area in which the ancient Tigris appears to have fanned out into multiple branches, with the major channel taking a sharp southern turn towards Girsu. When a river adopts such a configuration, the multiple branches tend to have weak levees and surrounding areas are more prone to flooding, which would explain the concentration of most of the major flood protections works in this area.

Additional flood control measures consisted of installation of a flood watch in charge of monitoring the rising of the river's water levels at the bank of the Tigris (a zi-ga gu_2 Idigna gub). This flood watch consisted of work gangs of about 12 men who would patrol the river for a period of one to two months in March/April (see chart 6.8). These work gangs would also be the ones that took appropriate action if necessary. The ancient texts indicate that the floods in the 3rd and 4th regnal years of king Šu-Suen were particularly severe, calling for the demolition of the major Tigris barrages at the Šulpa'e village, the inlet of the Sisa canal and Apisal. Other flood emergency measures entailed deliberately breaking the river's levee to send water to nearby depressions and marshland in order to prevent the flooding field downstream. Flooding fallow or recently harvested field was additional measure to lower dangerously high water levels in the river.

The ancient records, however, also indicate that built-in flood control structures were in use. There is evidence for the use of inundation canals (see 2.3.3.14) in antiquity. As discussed in chapter 4, section 4.1.6, the so-called Engabara canal was wide but extremely shallow, which was typical for the construction design of inundation canals. Moreover, the canal's name indicates that it guided water away from the river to the so-called Engabara, which was a major marsh area close to the city of Umma. Furthermore, there is evidence of the use of other installations that made it possible to divert water from the river. Some of the documented flow dividers (kab_2-ku_5) made it possible to divert water when the river rose to a dangerous level. There is evidence that the flow divider of the I-sala canal had such a dual function (5.2.4.4.C). In addition, the device called U_3 was likely a controlled breach in Tigris levee that was opened (šu--ur_3, lit., "to level/to smooth out") to divert water in order to lower the water level in the river. There is evidence that three such controlled breaches were located in the vicinity of one of the large Tigris barrages located at Šulpa'e village, where the river was more prone to overtop its levee. The high number of references (177, chapter 6, 6.4) to the repair of breaches (a-e_3-a) alongside levees of watercourses and flood dikes alongside the river and fields indicates that in certain years the flood control measures in place were insufficient for the water masses arriving in southern Iraq at the time.

8.2 Results: Irrigation

The Ur III documents allow for a fairly comprehensive description of how irrigation was carried out in southern Mesopotamia at the end of the 3rd millennium B.C. All the necessary tasks are represented in the documents, clearly showing that irrigation management was carried out in a very centralized fashion with a hierarchy of responsible official and state-employed workers (chapter 7). Unfortunately, the layout of individual systems could not be reconstructed with the available records for a variety of reasons. For one, Sumerian does not distinguish between natural and man-made canals (i_7), nor does it differentiate between canals of various sizes, except for minor canals (pa_4-a-da-ga). Furthermore, the exact dimensions of canals and water-control devices are rarely documented, since the records focus primarily on the expenditure of labor and construction materials for a single repair effort. So far, only the relative size of these devices could be established. Fortunately, texts recording the annual removal of sediment from canals allowed for distinguishing between irrigation canals and other watercourses. While the cleaning (šu/$šu_2$ luh-ak) of irrigation canals is well attested in the Umma record, the number of references to the construction (ba-al) of new canals in the governor-run sector is limited. This suggests that most of the primary canals operated by the governor-run sector of the Umma province might have already been in place at the onset of the Ur III period. The construction of new canals is mainly attested for the royal sector (see below) in the context of developing agricultural land that could be allotted to royal settlers. Based on size indicators (e.g., amount of removed sediment, relative size of water control structures, etc.), seven major irrigation canals could be identified, which suggests that the governor run-sector operated seven irrigation systems.

Only the length of the Guruš-gendu canal is known, amounting to 8 km, suggesting a slightly more dendritic layout of the irrigation system than the envisioned herringbone pattern system deduced from the shape of the of agricultural fields. The six secondary canals attested for the Guruš-gendu canal took off at regular intervals of 1–1.5 km to provide water for either tertiary canals or the irrigation furrows themselves. As levee systems constituted the prime agricultural ground in southern Iraq, the canal length of 8 km is difficult to reconcile with the average width of a levee cross-section, which ranged from 2 to 5 km. The textual record indicates that the agricultural landscape of southern Iraq in the late 3^{rd} millennium B.C. was characterized by elongated fieldstrips (1–2 km long, 0.1–0.3 km wide) running down the levee slope on either side of the river. This suggests that water was provided by short primary canals (1–2 km) running alongside the long edge of the field strip, resulting in a herringbone pattern irrigation system. The practice of furrow irrigation at the time would have required a further subdivision of the fields—probably by means of secondary canal—as water in a furrow can only travel up to 500 m. How the length of the primary canal can be reconciled with the information of the agricultural landscape is not entirely clear. However, it is possible that the Guruš-gendu canal ran somewhat parallel to the river to feed secondary canals that ran parallel to levee slope, providing water for tertiary canals.

In order to keep water levels high in the river year round, inlets of primary canals and tributaries appear to have been blocked by means of dams. As discussed in chapter 4, 4.2, a set of 34 tablets made it possible to reconstruct the sequence of the construction process of the dam that blocked the inlet of the Amar-Suen-kegara canal (see map 3). These records showed that this dam was supplied with clay pipes that allowed for water withdrawal from the river. The water flow within the canal appears to have been regulated by means of two devices. Flow dividers (kab$_2$-ku$_5$) are attested for 132 locations and are the most frequently recorded devices in the Umma record. The most prominent amongst these was the flow divider of the I-sala canal irrigation system, which might have been one of the largest systems operating within the province Umma. These devices—most likely proportional flow dividers—were regularly inspected and carefully maintained, as they regulated the adequate division of the water flow within the irrigation system. Damming the flow within a canal to facilitate diverting water into lower-order canals or fields was accomplished by small weirs (kun-zi-da) constructed from adobe (u_2 sahar-ba). Based on an ethnographic analogy, I argued that these weirs ran across the entire width of the canal and that only a small section of the dam was regularly removed and restored (gi_4), which resonates with the textual evidence.

The soil of agricultural fields was worked more than once before sowing in October/November and fieldwork began as early as July. As the soil is dry and hard from the summer month, an initial irrigation (a--de2) was applied prior to the fields being plowed. There is no indication that this was done to all fields, as the number of references to flooding fields is fairly small in comparison to documents recording the irrigation of fields (a-$ša_3$-ge a--du_{11}.g). As has been discussed in chapter 5, 5.3.2, grain fields appear to have been only irrigated in early spring (Jan–Mar), indicating slightly moister climate conditions at the end of the late 3rd millennium B.C. This finding agrees with the paleoenvironmental evidence of the larger Near East as discussed in chapter 2, 2.2.1. Excess irrigation water appears to have been drained into a nearby depression or an artificial pond/channel (a-ga-am, see chapter 5, 5.4). This drainage area was primarily associated with the Ganamah/Emah, the Igi-emahše, Ninura and the Šara-gugal field domains and a few others—all of which were located in the southeastern corner of the Umma province in the vicinity of Apisal. As mentioned earlier, the general topography of this area appears to have been fairly flat, lacking the necessary slope for natural drainage of excess irrigation water into nearby depressions. The lack of natural drainage might have been remedied by constructing an artificial drainage area—a method that is attested ethnographically (see chapter 2. 2.3.3.12). This drainage area consisted of two sections, the regular one (a-ga-am) and a large one (a-ga-am gu-la), whose water was contained by a 10 km or more long dike (eg_2-zi-DU a-ga-am). The drainage area was equipped with several inlets (ka a-ga-am) that were opened after the irrigation of fields. It was also equipped with an outlet (kun) that allowed for draining the pond into a nearby watercourse.

8.3 The Social Organization of the Watercourse Management System

The administration in charge of organizing the tasks related to the watercourse management system could only be partially reconstructed. This is in part due to the fact that the available textual record only describes the water management under the jurisdiction of the governor. We have hardly any information on how waterworks were organized in the royal sector. In addition, there is hardly any evidence of how and to what degree the two sectors cooperated in regulating the shared use of irrigation systems and the Tigris River. Agreements must have existed about the latter, as any control structure in the river would have affected and benefited all users. There are only three court documents that provide indirect evidence of the existence of such agreements. All three texts deal with a water conflict of some sort, either between individuals or towns (chapter 7, 7.4). In all three cases it appears that the crown was involved in hearing and judging the lawsuit at hand. In each case, the conflicting parties appear to have been the royal and governor-run sectors, which were politically on equal terms and required a neutral or higher-order authority to arbitrate the conflict. It appears that the resolution of such conflicts remained in the hands of the central government. This is the only direct evidence of the central government being involved in the management of irrigation. What remains unclear is how day-to-day conflicts were resolved. Given that the irrigation systems of the governor-run sector were managed in a very top-down fashion, the centralized distribution of water for the irrigation of state-managed land might have reduced water-related conflicts to a minimum. There is, however, evidence of the existence of water rights for the royal sector (chapter 7, 7.4.2), whose violation became the subject of one of the recorded court cases. It can be assumed that water conflicts occurred fairly regularly, and it remains unclear who was in charge of resolving these issues.

Agreements over the upkeep of commonly used water control devices are difficult to discern from the available records. The only clear indication of such an arrangement can be found in the construction and maintenance of the Amar-Suen-kegara canal. This canal was constructed during Amar-Suen’s reign, possibly to develop more agricultural ground for potential royal settlers in the vicinity of the city Umma. There are hardly any records of its construction in the Umma record, which stands in stark contrast to the high number of texts (69 total) documenting the compacting of the canal’s spoil bank as well as the construction of its inlet dam. Moreover, there are no records of the annual removal of sediment from this canal in the Umma record. Thus, it is fairly certain that the initial construction and the annual cleaning were done by members of the royal sector, while the construction and upkeep of the inlet dam and the maintenance of the spoil bank were the responsibility of the governor-run sector. This division of responsibility must have been related to the shared use of this canal by the two sectors. There is further indication of the contribution of labor and construction materials by the royal sector and other individuals (e.g., Biduga the beer brewer) to the upkeep of the major Tigris barrages. The set of arrangements that governed these mutual obligations and rights of the various sectors and individuals and different social groups cannot be described at present. Such a description would require a comprehensive prosopographic analysis of all the individuals and groups involved as well as a better understanding of the labor and material costs required in the upkeep of water control facilities for which a shared use is attested.

8.3.1 The Role of the State in the Management of Watercourses

The role of the central government in the management of watercourses in general and at the provincial level in particular remains obscure. It appears that the involvement of the crown at the provincial level was restricted to the resolution of high-profile water conflicts. The only evidence of direct state involvement in water management comes from royal inscriptions, in which rulers claim patronage over the construction of canals or water-control devices. Among the Ur III kings, Ur-Namma, the founder of the Third Dynasty of Ur, is the most vocal about his role in improving navigation and water supply and claims to have initiated and financed the construction and/or revitalization of no fewer than seven overland canals.[195]

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[195] The (1) Ur canal (i_7-Uri_5^{ki}), the (2) Inturugal canal (i_7- EN.EREN$_2$.NUN, var. EN.URIN.GAL, see Steinkeller 2001: 43), (3) the Nun canal (i_7-Nun), (4) the Aba-^{d}Nanna-gin-drainage canal (?) (a-ba-^{d}Nanna-gin$_7$), the (5) Nanna-gugal (^{d}Nanna-gu$_2$-gal), (6) the A-Nintu (i_7-A-^{d}Nin-tu), and the (7) Giššuba canal (i_7-Giš-šub-ba) (Sallaberger 1999: 135-136). See also Flückiger-Hawker (1999: 33-35), who includes the canals mentioned in royal hymns, which would bring up the number of canals to 12. However, as noted by Tinney (1999: 35–36), none of the canals mentioned in the hymns are attested in administrative texts. He believes that the "canal digging" (i_7--ba-al) referred to in the texts is a metaphor for sexual intercourse. He bases this observation on several other religious texts, such as Inanna Hymn H, which lists the cost of various sexual acts. The text reads as follows: "It costs one and a half shekels for me to bend over. Don't go digging any other canal: I will be your canal! Don't go plowing any other field: I will be your field! Farmer, don't go looking for any other moist patch: I will be your patch!" The connection between human sexuality and agricultural fertility is further emphasized in the tale of Enki, god of the subterranean freshwater ocean, *abzu* (see Black 1992: 75–76), who fills the Tigris by ejaculating into it (Cooper 1989). Tinney (1999: 36–37) further argues that there is "a heavily allusive overlaying of sexual interaction and the life-bringing powers of a canal water." His argument is further supported by the fact that the Sumerian word *a* stands for both water and semen.

One of the four major royal hymns lauds Ur-Namma as the *Aba munbale,* “Ur-Namma, the canal digger” (Ur-Namma D) (Flückiger-Hawker 1999: 228–259; Hallo 1966; Tinney 1999). There are three existing versions of this hymn, one from Ur, one from Nippur and one of unknown provenience (Yale version). According to Tinney (1999: 41), all three share the same basic outline, despite some variations.[196] The hymn begins with the rhetorical question “Who will dig it?” (referring to the canal) (1), followed by the answer: (2) “Ur-Namma the wealthy one (optional), the vigorous youth and the prosperous one.” Then the text switches to the first person, in which Ur-Namma first (3) describes his claim to kingship, which was bestowed on him by various gods of the Sumerian Pantheon. Then follows the actual description of the canal itself (4) and the prosperity it brought.

“As for me (Ur-Namma), my city’s watercourse is fishes, its flow is birds, Ur’s fresh water is fishes, its flow is birds. As for me, he (Enki) planted the sweet plant in my canal, (now) the carps grow fat. As for me, my city’s zi-reeds[197] are sweet, so my fish may eat them. Ur’s zi-reeds are sweet, so my fish my eat them. As for me, since my canal was founded it is full of fishes and birds.” (Nippur-version, line 9–14). And further: “Their (the canals’) banks are lush with munzur-plants, with sweet plants to eat. Their arable tracts are growing fine grain, sprouting abundantly like a forest.” (Ur-version 37–38).

Ur-Namma further claims in the prologue of the law code that is accredited to him: “At that time, [I regulated] the riverboat traffic on the banks of the Tigris River, on the banks of the Euphrates River, on the banks of all rivers. [I secured safe roads for] the couriers (?); I [built] the (roadside) house. [I planted] the orchard. The king placed a gardener in charge of them.” (Ur-Namma Law code, Prologue A iv 150–161; C i 22–ii 29; Roth 1995: 16). The beginning of this passage suggests that Ur-Namma understood the importance of waterborne transportation for the economic well-being of the kingdom he had established. Sallaberger (1999: 135) even suggests that Ur-Namma’s investment in the watercourse surrounding the ancient city Ur was related to boosting trade with the Persian Gulf and Oman (Magan). Ur-Namma’s general concern with the

[196] All direct quotes of the hymn derive from Tinney’s (1999) publication and are cited according to his edition and labeling. For a more philological analysis of the texts, see Flückiger-Hawker (1999: 228–259).
[197] According to Sallaberger (1989: 314), gi-zi refers to green fresh reeds used mainly as animal fodder. In the Ur version of this hymn, the zi-reed (Tinney 1999: 41) is eaten by the cows and not by the fish.

country's transportation infrastructure (land and water) is also expressed in a year formula: "Ur-Namma, the king, straightened out the road from the south to the north."[198]

The commemoration of Ur-Nammu's effort in improving waterways and water supply is unique to his reign. Based on the canal name "Canal set down by Amar-Suen," it is generally believed that the construction of the Amar-Suen-kegara canal in the Umma province was initiated and financed by the crown (Frayne 1997: 241–244; Steinkeller 2013: 376, fn 115). There are three other canals named after Amar-Suen as well as one named after king Šu-Suen (namely, Šu-Suen-hegal-Šara). Even though there is no evidence of direct involvement of the crown in these construction projects, it is certain that the establishment of new settlements did go along with the construction of new canals in order to develop new agricultural land. How this was organized and who was responsible for financing these projects remains unclear.

The disproportionately high investment in improving the watercourse infrastructure by Ur-Namma compared to his successor might have been closely linked to his coming to power and the consolidation of his supremacy over a number of former city-states. It might have been a strategy to create economic incentives that would attract labor and a population to rule and in turn increase agricultural production and states' revenues. The marked increase in settlements in the Ur region during the Ur III Period as discussed in chapter 3, 3.2.2 might be an indication of this. State investment in the construction of new irrigation systems played an important role in the process of settling (and resettling) people on the landscape in the Neo-Assyrian Period as well (Ur 2005). It has been argued that a settled and concentrated population both could be more easily controlled and could secure access to much-needed labor, particularly in areas with low population density (Stone 1997, Trigger 2003). Moreover, colonizing conquered land with subjects solidified the state's claim of control over its territory. How these processes were realized remains not well understood, and while coercion is frequently assumed, state investment in irrigation systems as a public good could have also been a means to create economic incentives to entice people to voluntarily join a polity (Rost forthcoming, see also Blanton and Fargher 2008: 285).

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[198] mu Ur-^{d}Namma lugal-e sig-ta igi-nim-še3 giri3 si bi2-sa2-a.

In addition, state-sponsored investment in irrigation and water transport infrastructure might have not only been economically motivated (to increase revenues) but also employed to serve political ends. As shown by Harrower (2009), the social and political capital gained from assuming patronage over the construction of hydraulic devices of monumental size—clearly visible in the landscape—was just as important as economic development, if not more so (see also Ertsen 2006; Molle et. al 2009; Morrison 1994, 2006, 2012; Sidky 1997). Harrower (2009) argues that state investments in irrigation systems in ancient Yemen were more closely tied to the ideology of kingship than to agricultural necessity, as sufficient dry-farming areas were available to support large populations. Royal patronage of monumental water control devices (e.g., the dam of Ma'rib) was important to legitimize the power of the ruler as the provider of agricultural abundance. This motive has also been observed in royal rhetoric of ancient Mesopotamia (Winter 2007). According to Winter (2006: 211), in Sumerian thought, natural and agricultural abundance (he$_2$-gal$_2$) is provided by gods and ruler alike, this idea is invoked in the hymn of Ur-Namma as the canal digger: "Ur-Nammu, the shepherd, the provider of Sumer and Akkad, beloved of Enlil" (Ur-version, line 40). Ur-Namma's concern with water management might have been a strategy to advance his political ambitions. The description of Ur-Namma as "the wealthy one" might allude to the fact that he was capable of funding such investments, which in turn might have secured him the support of those groups that depended on the water flow he restored.

The directly observable role of the central government in conflict resolution might have been also partially economically and politically motivated. Unresolved conflict could have seriously crippled the watercourse management system and slowed agricultural production, which was to be avoided at all costs, given its importance for the functioning of the Ur economy. Armed conflicts over agricultural land and water are attested throughout Mesopotamian history, and the most prominent case is the conflict between neighboring Early Dynastic city-states Umma and Lagaš (Cooper 1983). While agricultural land was the main concern, the fact that Umma was located upstream of Lagaš was certainly part of the dispute. The different written sources mention altering the course of the irrigation channel as one of the offenses committed by Lagaš (Cooper 1983: 27). Given that Umma controlled the flow upstream, altering the irrigation channels might have been the only means of securing water. The construction of barrages to temporarily raise water levels has been a cause of armed conflict between upstream and downstream users until very recently (Fernea 1970: 35–36). It is not water per se that became the matter of dispute but its temporary damming further upstream at the time when it was also needed to water grain fields downstream. It is possible that similar disputes were at the core of the Umma-Lagaš conflict. The conflict lasted for several generations and was not resolved even after the intervention of Mesalim, king of Kish, in Northern Babylonia (Copper 1983: 22–24). Centralized conflict resolution might have been the means by which potential conflicts of that magnitude were kept in check, as the central government had the necessary authority to make the fighting parties comply.

8.3.2 Centralized Watercourse Management at the Provincial Level

The work related to the management of watercourses carried out by the governor-run sector was primarily administered by the agricultural bureau of the governor-run sector of Umma and was run in a highly centralized fashion. The agricultural sectors of each of the four districts of Umma (Da-Umma, Apisal, Gu'edena, and Mušbiana) was run by a hierarchy of officials, which consisted of scribes of 10, 20, or 30 plow(-oxen), inspectors of the plow(-oxen), and plow teams (one cultivator and 1–2 ox drivers). The permanent agricultural staff consisted of approximately 400–476 individuals (95–114 cultivators and 285–342 ox-drivers, 20 inspectors of the plow[-oxen], see chapter 7, 7.2.2). High-level agricultural administrators such as Lugalemah(e) and Egalesi, the scribes of 30 plow(-oxen) in charge of the agricultural sector of the Da-Umma district, frequently sealed tablets recording water work projects that were supervised by inspectors of plow(-oxen) under their jurisdiction (see chapter 7 and appendixes A–W). I argued that the ox drivers of the 5–6 plow teams under the supervision of one inspector of plow(-oxen) frequently formed a crew of 12–15 workers that performed work on the irrigation or watercourse system during the slow season in the agricultural cycle, when fairly little work had to be done in the fields (Nov.–Apr.). They did so either as part of their corveé obligations (180 days) or as hired laborers after their work duty to the provincial government or the state was fulfilled.

As discussed in chapter 7, 7.2.2, the agricultural sector also relied heavily on seasonal and hired labor, as the available agricultural labor force was insufficient to handle the amount of work, in particular during cultivation/plantation and the harvest. The adopted labor organization system was highly complex and exhibited a high degree of labor division. The plowing and cultivation of the fields was done primarily by cultivators (engar) who appear to have not been employed for any other tasks. The cultivators' sons, usually employed as ox drivers (ša$_3$-gu$_4$), were deployed for all kinds of tasks related to the cultivation of fields (e.g., weeding, harrowing) or the upkeep of the irrigation and water control system. The removal of dirt clods from irrigation furrows (ab-sin$_2$-ta la-ag--ri-ri.g), on the other hand, was primarily done by hired laborers (lu$_2$-hun-ga$_2$). Given that this task was carried out during planting, labor might have been hired from the cultivator's family or from the urban population. Unskilled laborers, or menials (UN-ga$_6$), were employed for a wide range of tasks and appear to have functioned as a permanent labor reserve pool that could be deployed as needed. The work diary of the supervisors Lu-Nanna and Šara-Nirgal (see appendix M) exemplifies the high degree of mobility and flexibility of these work gangs. Seasonal labor—particularly female workers (geme$_2$) from the weaving and milling establishments—was regularly employed for tasks related to the management of watercourses, particularly during the flood season, when flood emergency measures (e.g., the repair of breaches) put an additional strain on the preexisting tight labor bottleneck.

The highly complex labor organization system required a fair amount of administration and logistics, which was realized by means of multi-level bureaucracies, extensive record keeping and archiving, and complex computational procedures. The administrative complexity of the Ur III period was made possible by the conceptual breakthrough of considering human labor in abstract terms (e.g., labor days, standardized work norms, etc.). This allowed any human activity to be described numerically and used to calculate future labor demands, which could then be operationalized through labor mobilization and organization of laborers into work crews (Steinkeller 2004, in press). The available records allow for a reconstruction of the individual administrative steps of certain tasks related to the management of watercourses for navigation, irrigation and flood control (chapter 7, 7.3, Rost in press).

The available records show that these administrative steps entailed inspection of water control devices for potential damage (e.g., by Erdingir) and collecting the necessary data to assess the amount work that needed to be done. The workload, as well as its division and assignment to various supervisors and their work crews, was computed in an office setting. The evidence of the Amar-Suen-kegara canal shows that up to 30 work crews were deployed at a single work site simultaneously, engaged in constructing various water control devices (e.g., flow divider, weir, inlet dam) and compacting the spoil bank of the canal. Labor expenditure and material costs (including wages and compensations) were accounted for, and the recorded data were used for economic projections and planning future construction and maintenance work. In addition, scribes kept records on the fulfillment of everyone's corveé obligations. The procurement and transport of construction materials (mainly reed but also various rushes and brush woods) was an additional logistical challenge that had to be met. These logistics could not be reconstructed in this thesis, as this would have required a comprehensive prosopographic analysis of the officials involved and knowing where the materials came from. The latter is particularly difficult to determine given our poor knowledge of Umma's historical geography.

So far, only the office of the "water of water" (a-igi-du$_8$) could be directly linked to the management of irrigation systems. Only the tenure of Erdingir, who operated mainly in the Da-Umma district, could be described. Even though he presided over 10 subordinated waters of water, their tenures are not sufficiently well attested in the Umma record to allow for reconstructing their activities and responsibilities more precisely. In the case of Erdingir, his sphere of action did not drastically differ from that of other supervisors engaged in agricultural and waterworks, though it appears that he was primarily in charge of the flow divider of the I-sala canal. This flow divider is by far the most frequently attested device, which may be related to the fact that the I-sala canal irrigation system was the biggest and the most important irrigation system operated by the governor-run sector. The fact that 60% of the agricultural land cultivated by the governor-run sector of the Umma province was located in the Da-Umma district supports this conclusion. The I-sala canal's importance is further supported by the fact that Erdingir appears to have been put in charge of supervising the operation of this device.

This highly centralized management of the various tasks related to the management of watercourses and individual irrigation systems permeated the entire political structure of the provincial government headed by the governor. While work projects were usually authorized by the high-level agricultural administrators of four districts in which the work was carried out (e.g., Lugealemah(e), Egalesi, Ur'e, and Lugal-kuzu), members of the gubernatorial family regularly appear as the authorizing party in the records. Since Ur-E'e and his son Lu-Haya were in charge of the agricultural sector of Apisal, it is unsurprising that their seals appear regularly on tablets recording waterwork projects carried out in the district of their sphere of action. The same applies to Lugal-kuzu, who was in charge of running the agricultural sector of the Gu'edena and Mušbiana districts. However, Lu-kala, Ur-E'e's son, also sealed records documenting waterworks, even during his tenure as chief household administrator in charge of managing the treasury of the governor's household (Dahl 2007: 105–113; see for example AnOr 07 240). It is somewhat unclear in what capacity he participated in the administration of the watercourse management system, but he might have filled in for his father in times of need.

A number of other members of the gubernatorial family sealed documents pertaining to water management, such as Akala and Dadaga—prior to their respective tenures as governors of Umma—and their brothers Lugal-hegal and Inim-Šara. Akala and Dadaga appear predominantly in records pertaining to work projects that were carried out in the Da-Umma district. Dadaga in particular is very prominent in work related to the Amar-Suen-kegara, Guruš-gendu, and the I-sala canals (see also chapter 7, 7.3.3.2). However, the brothers also sealed tablets documenting work in other districts (though much less frequently), as for example at the barrage of Apisal or the A'uda-field domain located in the Apisal district (see appendixes A–W). Inim-Šara and Lugal-hegal are predominantly attested in records documenting projects in the Apisal district. Frequently, they seal records dating to the same year as those sealed by their brother Ur-E'e. It is possible that Ur-E'e delegated some of the workload concerning the agricultural sectors to his brothers and sons (see above), particularly since he was also in charge of the livestock production in the Umma province as the chief livestock administrator.

This brief overview clearly shows that the gubernatorial family was intimately engaged in the management of the agricultural sectors. While the Da-Umma district was primarily run by Lugalemach(e) and Egalesi, the frequency with which Dadaga and Akala appear as authorizing parties in the records for that district shows that the ruling family retained close oversight over the entire agricultural operation of the province, as suggested by Dahl (2007).

8.4 The Possible Function of Centralized Watercourse Management

The "institutional mode" of organizing the agricultural and various other economic sectors adopted in the Ur III period had a long history in Mesopotamia, particularly for temple estates, which were operated in a very similar fashion (Deimel 1931; Postgate 1992:186–187). I would even argue that the mode adopted by the governor-run sector might have been how the landholdings of the earlier city-states were managed (see also Steinkeller 1999: 293). The management form was largely maintained during the Ur III period, with the difference of a government-imposed extensive accounting system related to the bala-taxation system that was levied on each province (Steinkeller 2004: 82). As has been pointed out by a number of scholars (Postgate 2004: 188–190; Steinkeller 1999: 301–309), there are advantages to the institutional mode of agriculture. Most importantly, conducting agriculture on a larger scale was one way of spreading the risk of salinization more evenly, allowing for greater flexibility to let land lie fallow land and to shift agricultural land if necessary. As has been shown by Poyck (1962: 59ff) for modern times, farmers tied to one plot of land did not have this flexibility, and as a result, their income and labor productivity were lower than those of tenant farmers in a sharecropping arrangement. Poyck (1962: 65) even showed that the income of tenants working for big landowners (<4000 meshara = 971.24 ha) was significantly higher, despite higher rents, than that of tenants working for medium-size landowners (> 4000 meshara). In addition, the sharecropping or institutional mode allows for resources (both labor and capital) to be pooled more easily and effectively than on a family level, which allowed for investments in agricultural gear (e.g., tools, plows, and draft animals) and the water control infrastructure that furthered the intensification of agricultural production.

Moreover, the institutional mode allowed for a complex labor organization system that was very effective at mitigating the Mesopotamia-specific annual labor bottlenecks. As has been shown, the provincial government had the authority to draw labor from other economic sectors when needed, which guaranteed a smooth workflow and the timely execution of all necessary tasks. In turn, any organizational obstacles that would have affected agricultural output (e.g., a delay in the harvest) could be eliminated. I would further argue that the high labor division in the agricultural sector was an additional means of making the workflow more efficient. Tasks for which little prior knowledge was needed (e.g., removing dirt clods from irrigation furrows) could easily be outsourced, which allowed the more skilled labor force to concentrate on those tasks for which more expertise was needed (e.g., plowing, irrigating fields, constructing water control devices, etc.). Moreover, maintenance work, particularly in irrigation systems, can be hard to enforce and can lead the system to malfunction. A centralized mode of maintaining a system was a way to ensure its proper functioning. It might be noted here that many Mesopotamian rulers (e.g., Hammurapi and Rim-Sin from Larsa) mention having restored the water flow of rivers and canals that fell into disarray during times of political instability.

The centralized mode appears to also have been necessary to implement the watercourse management system described in this thesis. Coordinating the requirements of river navigation, irrigation, and flood control required planning on the provincial, if not national, level. Blocking the flow of the river as comprehensively as the texts suggest needed to be coordinated with the water users downstream. For this system to be effective, all inlets of canals and watercourses needed to be closed off, which in turn allowed for water withdrawal that did not interfere with waterborne transportation. Flood control had to be coordinated, as localized protection measures could seriously interfere with the overall success of the system. As has also been discussed by Fernea (1970: 28), the uncoordinated damming of the western branch of the Euphrates with multiple temporary barrages led to the silting up of a natural canal. Eventually the channel shifted through avulsion, leaving entire tracts of land without water. It is possible that Sumerians understood this danger and adopted a more centralized scheme in order to avoid this pitfall.

8.5 Degree of Centralized Control in Watercourse Management and Political Centralization

The way watercourses and irrigation systems in Ur III Umma were managed resembles far more closely the highly centralized model developed from the organization of the Gezirah irrigation scheme on the provincial level. In both cases (Gezirah and Ur III Umma), state control went all the way down to the individual field level. Also, the agricultural area was subdivided into administrative units (i.e., blocks in Gezirah and field domains in Ur III Umma) that were assigned to a hierarchy of responsible officials. It appears that the management of the Gezirah scheme conducted most of the work related to the upkeep of the system as well as the plowing of fields with seasonally employed laborers. In Ur III Umma, however, there was not such a division between the management of the irrigation system and the cultivation of the fields. As has been discussed above, the permanent agricultural labor force was also in charge of the management of watercourses and irrigation systems. Hired and seasonally employed laborers were employed as needed.

The striking similarities in the management of both systems are quite astonishing, considering their significant difference in size. The Gezirah scheme, with 3,780,000 hectares of agricultural land, was enormous when compared to the 13,154.76 hectares under the control of the governor-run sector. The result of this study shows once more that the size of an irrigation system is not indicative of the way it is/was managed. This result supports the findings of Hunts's (1988a) comparative study and indicates that they are applicable to ancient times. Archaeological evidence also suggests that centralized control was not a necessity for operating these kinds of systems. A hydraulic system was discovered northeast of Nippur consisting of multiple irrigation systems with short primary canals arranged in herringbone pattern along a main channel. This agglomerate of irrigation systems was in operation for close to 5,000 years. Wilkinson et al. (2012: 170) suggest that these systems, which were modest in size, could have easily been organized by kin groups. As result, these systems were more sustainable, as they allowed greater flexibility in their management in response to environmental and political change. The long-term use of these systems suggests that when the state was politically weak, the operation of these systems was probably in the hands of local/kinship groups. This suggests that how an irrigation system is managed depends on the political and economic organization of the society that operates it. In the case of Umma, it appears that the way watercourses were managed was closely related to how agricultural production was organized (see above).

On a national level however, Ur III water management was even less centrally organized than the management of watercourses in modern Iraq. The central government was in charge of managing the primary canals and the water distribution down to the level of the secondary canal by means of a hierarchy of officials who belong to the national ministry of irrigation. Decisions made by local officials must have been approved at the national level (e.g., an increase of water supply for users) (Fernea 1970: 123). In Ur III, as discussed in chapter 3, governors (ensi$_2$) of the individual provinces were derived from longstanding local elites, and were co-opted and integrated into the political structure of the Ur III state. These governors were not elected state officials who were installed to carry out orders made at the center. Rather, the Ur III kings had to find the means to secure the cooperation of these local rulers by a system of checks and balances. While the governors were nominally subordinate to the crown, the central government does not appear to have been intimately involved in the affairs of the governor's household beyond the system of taxation. There is also very little evidence that governors needed royal approval for decisions made at the provincial level. At least in the management of watercourses, there is no evidence of interference by the central government beyond the occasional conflict resolution pertaining to water disputes.

With regard to overall political centralization, the results of this study show that the highly centralized management of watercourses and irrigation systems at the provincial level under the authority of the governor is not a reflection of the overall political centralization of the Ur III state. It is a reflection of the political organization of the provinces and possibly the preceding city-states. Most interestingly, this study shows that the degree of economic and political centralization can be at times higher at the local/provincial level than at the national level.

8.6 Intellectual Merit of the Entire Project for the Field of Anthropology

The importance of agricultural surplus for the development and functioning of early states is widely cited in the anthropological literature. My thesis provides for the first time empirical evidence of how it was accomplished. It is known that irrigation is a means to intensify the agricultural production (Hunt 2000: 262–271). Intensification is understood here as the increase of agricultural output per unit of land per unit of time. In order words, the increase in labor productivity by means of technological innovation where less time is spend on the cultivation of a unit of land with equal or higher outputs. As correctly stated by Hunt (2000: 272–273, contra Boserup 1965) labor productivity has to go up as societies become more complex since segments of the society are no longer engaged in the production of food due to the greater degree of labor division. Technology (e.g., irrigation, animal drawn plows, tools such as hoes etc.) is always cited as being at the core of the process of agricultural intensification (Hunt 2000: 260–262). Technology was certainly an important aspect in the intensification of agriculture during the Ur III period, such as the use of draft animals and a variety of metal tools and particularly the use of the seeder plow by which sowing and drawing irrigation furrows became part of the same operation. However, I would propose that the way how irrigation and cultivation was organized might have been an important aspect of increasing labor productivity as well. This aspect has not yet been considered in the anthropological assessments of the intensification of agriculture.

The data presented in this dissertation do not allow for investigating this question as it would require another case of a differently organized agricultural regime that could function as a comparative. However, the results of my dissertation do pose the question of the implications of the deep centralization of irrigation and cultivation for agricultural intensification. The highly centralized labor mobilization and supervision combined with a high degree of labor division might have allowed for streamlining the workflow in cultivation as well as in the operation of the watercourse management system. In addition, I have argued that the highly centralized organization might have been necessary to implement a very effective water management system that coordinated three function of economic importance (i.e. waterborne transportation, irrigation and flood control). The results of this thesis do show that both – the agricultural production and the watercourse management system were developed to a degree that allowed for supporting a state with a high degree of economic and political complexity.

The decade-long focus on the question of centralized versus decentralized control in the study of ancient irrigation management somewhat detracted from investigating the consequences of either choice to better understand the function of irrigation in early states. This thesis provides for the first time detailed insights into the possible outcome of a centralized mode of watercourse management. In addition, the richness of the available textual data allowed me to make considerable progress in defining the size of the water control devices and irrigation systems in question. These records also provide detailed insight into labor and material requirements that are unmatched in history. Thus far, there is very limited knowledge about the size of the irrigation systems in early states, which makes it difficult to assess the socio-political implications of labor and material input and economic output. The data provided in this thesis could function as a model for energetic reconstructions of archaeological complexes for which such data are far less abundant.

This thesis also provides important insight into the organization of manual labor. This includes how labor organization rested on a system of social inequalities related to age and gender and concepts of ethnicity (i.e., dumu-gi_7 = native son of the land). Monumental architecture, state institutions, and status hierarchies are evidence of underlying labor divisions and complex labor organization systems. How these were realized can frequently not be reconstructed. This thesis, like other studies that deal with the organization of various economic sectors, provides detailed insight how it was realized. Such insights make an important contribution to the history of labor and understanding early state economies.

This study also provides the first detailed look into how state control was exercised on the local/provincial level. Territorial states (as defined by Trigger 2003: 104–119) face the challenge of how to rule a large area. So far, these mechanisms for early states are not well understood, which impacts our understanding of the evolution of political complexity. The historical record, and in particular Ur III texts, provide a tremendously important insight into the various strategies employed by a central government that gained and maintained control on the local level. As has been discussed above, the organization of the province under the governor appears to exhibit a higher degree of political centralization than on the national level. This evidence raises questions regarding the trajectories of the development of political complexity — a question I want to pursue in the future.

8.7 Limitation of this Study and Future work

As has been mentioned numerous times in this thesis, Umma is a case with very high internal validity and limited external validity. At this point it remains unclear even whether this case study is representative of how watercourses and irrigation systems were managed in all of the Ur III state. The amount of agricultural land and related water control infrastructure was fairly modest. The 13,154.76 ha of land represents only 7% of the surface of the Umma province. It remains unclear how much agricultural land was available and how it was managed. As has been pointed out in various sections of this dissertation, we have no information on how the majority of the available agricultural land was managed. Nor do we know if there was agricultural land that was cultivated outside of the institutional mode. Due to the lack of sales documents, the existence of private land ownership has been ruled out for the Ur III period (De

Maaijer 1998: 59; Falkenstein 1965a: 146–147). It is clear that state ownership of land was an important means of labor mobilization, as argued by Deimel (1931: 79–80). However, since the texts represent only the agricultural production under the governor, we cannot assume that all arable land, in particular marginal areas, were under state control.

The external validity of The Umma case for other river valleys in which complexity occurred — the Nile Valley (Egypt), Indus Valley (Pakistan/India), Yangtze and Yellow Rivers in China — cannot be assessed at this point due to the absence of good documentation on how irrigation and water control was organized. The limited information on Egypt suggests that flood irrigation and water control was managed locally throughout pharaonic history (Butzer 1976, Hassan 1997, Garcia 2014). However, there is no written documentation on how exactly it was managed that would allow for a meaningful comparison with the case of Umma or later cases in Mesopotamian history. There is no information on the matter for ancient China and the Indus Valley. The lack of local documentations for these places considerable limits the ability assess the function of irrigation and water control in early states societies from a cross-cultural perspective. Future archaeological investigations on water control systems might increase the comparability of these early cases, which are so far limited.

The greatest limitation of the present study is the lack of archaeological data and as a result the poor knowledge of the historical geography of the Umma province. This limited my ability to reconstruct canal networks and transportation routes, the size and layout of irrigation systems, and the configuration of the agricultural landscape. In turn, I was not able to construct models of labor and resource requirements of the systems and devices in question, which would have allowed for contextualizing the available labor data. In spite of the richness of this data set, a full description of the system of labor organization remains difficult. Derived exclusively from the illicit antiquities market the organization of the records in its original archival setting is entirely lost. Thus, evaluating the textual information more comprehensively and effectively will require a reconstruction of the larger context.

The poor state of knowledge of the historical geography of the Umma province has also impacted our understanding of the organization Ur III economy. An abundance of written sources enables individual economic sectors to be well understood (e.g., grain cultivation, fishery, forestry, labor, taxation, finance) (Englund 1990; Ouyang 2009; Sharlach 2003; Steinkeller 1987; 1996; Stepien 1996; Vanderroost 2008). While the texts provide ample information on the economic transactions between the individual sectors, it is hard to reconstruct how individual sectors were articulated with one another to form the complex whole of the Ur III state economy. For example, the logistics of provisioning construction materials and the seasonal labor exchange cannot fully be reconstructed, as this would entail knowing the location of production centers and productive areas (field and canal systems) and tracing transportation routes. Only by visualizing the movement of goods and services will it be possible to describe the network of statewide and interregional exchange and to describe more fully the system of rights and duties of the various sectors and provinces on which the complex economic organization of the Ur III state was based.

Consequently, I propose reconstructing the historical geography and ancient landscape of the Umma province to understand the watercourse management system more fully in the larger economic context. Such a research project will require a comprehensive settlement survey analysis in order to gain a better understanding of demography and the general outline of the province. Due to the precarious political conditions in Iraq, fieldwork might not be possible in the near future. However, I propose that a schematic reconstruction of the historical geography can be achieved with an intensive remote sensing analysis, combined with the results of newly collected archaeological survey data (Hamdani 2008) and the geographic information derived from texts. I propose that the creation of a geographic information system (GIS) model of the landscape and geography will be an important tool in the reconstruction of Umma's historical geography, as it allows for integrating disparate sets (archaeological and textual data) into one format that can be manipulated for multiple-hypothesis testing (Hritz 2010; Pournelle 2007; Ur 2003; 2005).

The textual analysis requires the use of modern data mining techniques and digital data analysis. The sheer amount of information puts a considerable limitation on what can be manually analyzed by a single researcher. In particular, the geographic information recorded in texts can only be understood in relation with other locations. Administrative hierarchies of officials can only be established in cross-reference with other administrators. Collecting and memorizing these cross-references can be extremely time consuming and at times difficult to record and visualize for further analysis. Modern data mining techniques, particularly network analysis, however, open up new possibilities. A network analysis of place names and names of officials will allow us to better discern the spatial relationship between locations and disambiguate individuals with identical names in a reasonable amount of time and will allow us to better understand the administrative structure of the Ur III state. Furthermore, as officials are frequently stationed at specific locations, integrating results into the GIS model of Umma geography will provide key insights into the spatial dimension of Ur III state power. The project of reconstructing Umma's historical geography with the methods outlined above is currently in planning with Amir Hamdani and colleagues of the State Board of Antiquity of Iraq and Sumeriologists Piotr Steinkeller, Manuel Molina, and Adam Anderson.

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