Journal of Earth Sciences and Geotechnical Engineering, Vol.10, No.3, 2020, 17-39
ISSN: 1792-9040 (print version), 1792-9660 (online)
Scientific Press International Limited

The Sumerians and the Akkadians: The Forerunners of the First Civilization (2900-2003BC)

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Abstract

Sumerians were the first People in history to invent the cuneiform script, which made the reporting of their achievements possible. Therefore, this had marked the beginning of written history. Moreover, their experience as pioneers in practicing large-scale irrigation is detailed in this paper, which also describes the intricate canal networks systems they had constructed together with the engineering works related to them. The land was flat and the two rivers had built themselves to higher levels than the surrounding lands by the continuous silting process, so gravity irrigation became possible and the people took the opportunity to construct these networks and establish their communities here. Description of the political and social developments, which led to the establishment of the city-states, is also given together with a list of the most prominent ones, and their locations are shown on a map indicating the heartland of Samaria in southern part of Iraq; close to the Persian Gulf. Wars between some city-states over water rights are detailed with their results in excavation of new canals, which are described here. A vivid description of the irrigation canals and the hydraulic structures that were needed and built are also presented which show that the Sumerians were versed in hydraulic principles, while in illustrating their methods of land preparation, seeding, irrigation and harvesting indicates they were skillful farmers. Moreover, the tools and implements invented for field operations such as those for water control, land preparation, seeding and harvesting, which are fully described, show that they were also inventors.
The type of crops produced are given special attention and the abundance of yield they obtained was outlined indicating that surpluses had encouraged trading with other parts outside Samaria and so new commercial relations were developed. The economic aspects of this civilization such as wages and loans for farmers, work

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Article Info: Received: February 10, 2020. Revised: February 15, 2020.
Published online: March 30, 2020.

specialization and the appearance of new professions to meet cultivation requirements were described. The social hierarchy on which social relations and organization of work was based are presented especially those related to the agricultural and irrigation works which are given their share of explanation and discussion.
Flood protection works needed for better safety from the Tigris and Euphrates rivers recurrent floods were routine practices of the Sumerians to protect themselves and their lands from the grave dangers of these floods. Therefore, they excelled in them, while canals maintenance by constant dredging of the silt brought down by the two rivers every year was a constant concern. The Sumerians over long period had accepted within them some other people namely, the Akkadians who intermingled with them, lived in their cities, and even mixed with them in marriages. This explains how a smooth transition of power had resulted in the rise of the Akkadians King Sargon, after he had started as a high-ranking official at the court of (Ur-Zababa) the last Sumerian king and replaced him to mark the start of the Semitic Akkadian domination, which lasted almost 200 years to 2150 BC. Sargon managed afterwards to unite all the city-states and establish the first empire in the world extending well beyond Sumeria, so it was said that his influence was felt from Egypt in the west to India in the east.
Finally, this paper presents briefly the various theories behind the decline of the Sumerian- Akkadians power and the reasons for passing this to the new rising city of Babylon, which took over this civilization to establish its own.

Keywords: Sumerians, Akkadians, Ur, Iraq

1. Sumerians and the Akkadians

During this very long period, many changes and developments occurred affecting societies and ways of life in this important part of the ancient world. The volume of writings and research on this period is so tremendous that it can be summed up here only in a very concise and brief way and with the inevitability of leaving much of the details. It is also necessary to divide this era into periods according to the main actors in the Sumerian theatre. In all this, special emphasis is given on water and irrigation works that developed then, but due regard is also given to the background in which these developments occurred.
It is an established fact that the first successful efforts to control the flow of water on a very large scale were made in Mesopotamia. The Sumerians in southern Mesopotamia built city walls and temples and dug canals, which may be counted as some of the earlier of the world’s first engineering works of their kind. It is also of interest to note that these people from the beginning of recorded history fought over water rights and agricultural land, and irrigation were extremely vital to them. Flooding problems were more serious in here than in Egypt because the Tigris and Euphrates were much swifter than the Nile and carried several times more silt per

unit volume of water than the Nile did. This resulted in rivers rising faster and changing their courses more often in Mesopotamia **[1]**.

The Sumerians had to solve much bigger hydraulic problems than the Egyptians whose civilization had not developed at that time yet. The processes leading to the Sumerian Civilisation cannot be understood except as creative adaptation to the priceless resources of the Tigris and Euphrates waters which led to this civilisation during the third millennia BC. The vigorous later traditions continued to build on assured food supply ensured by the two rivers. To study the full role of the two rivers in history one cannot but consider the whole geographic unit comprising their watershed area and their whole valley. Archaeological findings from Tell Bark on the Khabour tributary and from Ancient Mari on the Euphrates in Syria, which belonged to the third millennia and second millennia, showed the strong relationship between these parts of upper Mesopotamia in Syria and Lower Mesopotamia in Iraq. There were to be sure some periods when deep socio-political divisions extended across the two rivers during Parthians, Sasanian, the Umayyad and Abbasid empires. The valley of the two rivers, however, remained in other extended periods open for inter-regional contacts, and the banks of the Tigris and Euphrates were vital for heavily travelled routes between Mesopotamia and the world around the Mediterranean **[2]**.

To follow things, a brief account must be given to the history of the next period, which witnessed some of the most important changes in Mesopotamian history. A beginning is made here with what we may call the *"Dawn of Civilization*" or the *"Early Dynastic Period (ED)"*, which generally dates to (2900–2350 BC) and had been preceded by the *Uruk* and-*Jemdet Nasr* periods. It saw the invention of the cuneiform text and the formation of the first city-state. This development ultimately led to the unification of much of Mesopotamia under the rule of Sargon, the first monarch of the Akkadian Empire. Despite this, the *early dynasties* city-states continued to share a relatively homogeneous material culture.

During the *early dynasties`* period, the *Sumerian* cities such as *Uruk*, *Ur*, *Lagash*, *Umma*, and *Nippur* located in Lower Mesopotamia, were very powerful and influential. To the north and west stretched states centred on cities such as *Kish*, *Mari*, *Nagar*, and *Ebla*. The population of *Ur*, which was one of Sumer's largest cities, has been estimated to have had 34,000 inhabitants at its peak, (See Appendix 3 of the inventory given by Modelski **[3]**. Given the other city- states in Sumer and their large agricultural population, a rough estimation for Sumer's population shows that it might have been somewhere between 200,000 and 260,000, (Appendix 1 of the same inventory). Agriculture in all this time continued to be the most important source of living for these city-states. The *early dynasties'* era ended by the accession of King *Sargon* to the throne of *Sumer* and *Akkad* and the unification of the *Sumerian* city-states into the *Akkadian* Empire and the inauguration of the *Akkadians* period (2350-2150BC).

The transition was very smooth and the mixture of the *Sumerian* and *Akkadian* cultures continued to flourish and then passed to the Neo- Dynasties of *Ur*, known as the *Ur* or *Ur III*. The period between The *Akkad* Dynasty and *Ur III* is not well documented. Most scholars believe that there was a short period of power struggle between the most powerful city-states after which the city of *Ur* rose to prominence during the period (2150-2003BC), and so *Ur III* controlled the cities of *Isin*, *Larsa* and *Eshnunna* and extended as far north as *Jazira*. This glory ended at last at the hands of the *Gutian* invaders from the Zagros Mountains, whose kings ruled in Mesopotamia for an indeterminate period until the rise of *Babylonia*. These people were illiterate and nomadic, and their rule was not conducive to agriculture or developments in other fields.

During the long history of development in Mesopotamia, all the time the two rivers often spilt their flood waters over the banks into the surrounding plains. Their heavy loads of silt were deposited on these lands, but the coarser parts were deposited on the banks close to the rivers themselves and by so building higher grounds in the form of berms. As more silt was deposited on the bottom, the water level became increasingly higher than the adjacent land which helped the settlers along the rivers to use gravity irrigation and flood their fields to grow their needed food. And this is how *Sumerians*, *Akkadians* and later on the Babylonian civilisations constructed canals to carry the water further and extend the irrigated areas which helped these civilisations to flourish. It was only later on that they invented water-lifting devices but only to be of limited use. Figure 8 illustrates a typical arrangement of the cultivated plots of land and how irrigation water is transferred to them [4].

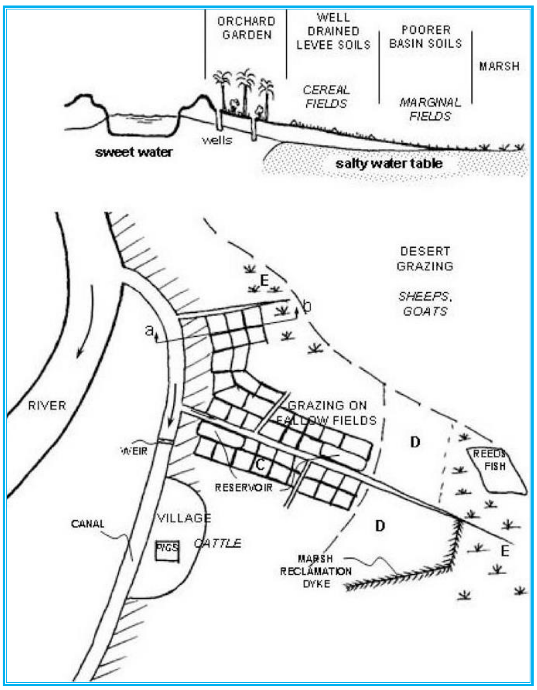

Figure 8: Hypothetical layout of an agricultural cell in south Mesopotamia

The two rivers, however, remained a source of constant danger to the people living along them as destructive floods were also frequent, which caused destruction and human losses. Such catastrophic floods together with wars obliterated some of these civilisations and opened the way for others. During all these times, the inhabitants had also to invent ways to protect themselves and their lands from flooding by means of building dykes and learn how to close breaches in these dykes. High floods did not threaten the safety and the cultivations of the inhabitants only but also caused from time to time the shifting of the two rivers away from their original courses as characterised by fluvial rivers. The consequences were of such large magnitude that people had to abandon some of their flourishing cities since canals, and their intakes became obsolete. This meant building new cities, and new canal systems and new intakes to follow the new courses of these rivers.

The long history of Mesopotamia is full of such occurrences as discovered from archaeological excavations and the remnants of the old courses of the two rivers. As evidence for these changes, we may cite the fact that the Tigris and Euphrates at the Sumerian times did not meet as they do today to form Shatt-Al Arab, but they emptied separately in the Gulf as shown in Figure 9[5], a fact which underscores the changing nature of their watercourses. On the locations of the Sumerian settlements and city-states; more than often, these cities were established closer to the Euphrates River than to the Tigris, although the distance between the two rivers was not great in this delta as seen clearly from the map in Figure 9. The obvious reasons can be summarized. First, the general grade of land was in the direction from the Euphrates towards the Tigris which resulted in the irrigation networks` slope being in this direction toward the fertile lands below. Second, is the milder slope of The Euphrates River itself, which resulted in calmer flow and slower water level rise and fall, making the construction of diversion works and canals off takes much easier. Finally, the Euphrates was characterized by much smaller flood volumes than the Tigris due to curtailment of the very high flood peaks by flooding upstream natural depressions such as *Al-Habaniyah* and *Abu Dibs* depressions whose excess water could replenish the Euphrates flow later on in the season.

In any study, which aims at the understanding of agricultural society of the Sumerians, it is very important to understand the social background of such societies. Social and governance system in Sumeria was based on the city-state system; whereby every city-state was sovereign and had its Deity, King, Temple, Priests, the Noblemen and the majority of the ordinary people who depended mostly on cultivating the agricultural land of the state; but there were also the Tradesmen, the Scribes and Artisans in addition to Slaves.

In most cases, irrigation water was carried to the cultivated lands by main canals, which were often shared between states. This gave rise to constant tensions, conflicts and even wars between these states over water rights, and at the same time encouraged some of the kings of these states to construct new canals and diversion works. The list of important city-states of *Sumeria* is long, and they belong to different periods; most important of these are *Ur*, *Eridu*, *Uruk*, *Girsu*, *Umma*, *Lagash*, and *Kish*, and history recorded to us some of the fierce wars between some of them.

Figure 9: Map Showing the Sumerian Heartland and Tigris and Euphrates estuaries.

In *Sumeria*, and generally in Lower Mesopotamia, the alluvial plains` agriculture was depended completely on irrigation in contrast to the upper Mesopotamia where dry farming was possible. For the inhabitants of Lower Mesopotamia irrigation had prime importance, and the control of water was decisive to ensure perpetual prosperity. Therefore, complex systems of canals, reservoirs, dykes, and control structures had to be planned and constructed to meet this end. Such works necessitated knowledge of hydraulic principles, which the *Sumerian*s had developed and mastered in their applications. They dug canals, which followed the grade of the land so to have a smooth flow and not to scour their bottoms or sides; some of these canals reached a width of 120 meters or large enough to permit navigation, and frequently such canals had levees or dykes. Sumerian texts described many of their canals and gave details of their lengths and dimensions. One of these described was198 meters long canal, 1meter wide and 0.25 m deep. In their irrigation networks, principal canals feed the smaller ones as clearly shown in Figure 8.

The description of an irrigation system which belonged to *Umma* mentioned one branch canal with depth of 0.5-1 meter, and another having 6 m width with length reaching up to 1710 m. Secondary canals could be as wide as 1.00-1.25 meter and 0.5-2.25 meter in depth. The material from the excavation was probably used to raise the levees, increasing the canals depth. Although most of the received mathematical texts dealt with rectangular shaped canals, probably this was simplified of trapezoidal shape in order to facilitate quick computations for recording the daily progress during excavation as implied by these texts. On one tablet, two trapezoidal channels were presented, where the concept of side slopes was introduced, measured as the horizontal distance per 1 unit of length in the vertical. Side inclination in both canals was V: H = 1:0.5 [4].

In the intricate systems of irrigation, the *Sumerians* constructed control structures in the form of weirs across main streams to divert part of the flow into large lateral canal intakes, Figure 10. Such a weir consisted of two gates that can turn, blocking the river or the entrance to the canal depending on their positions. Probably they were made of reeds and bitumen or, also wood. In more advanced works such as weirs were built with fire-baked clay bricks and earth [6].

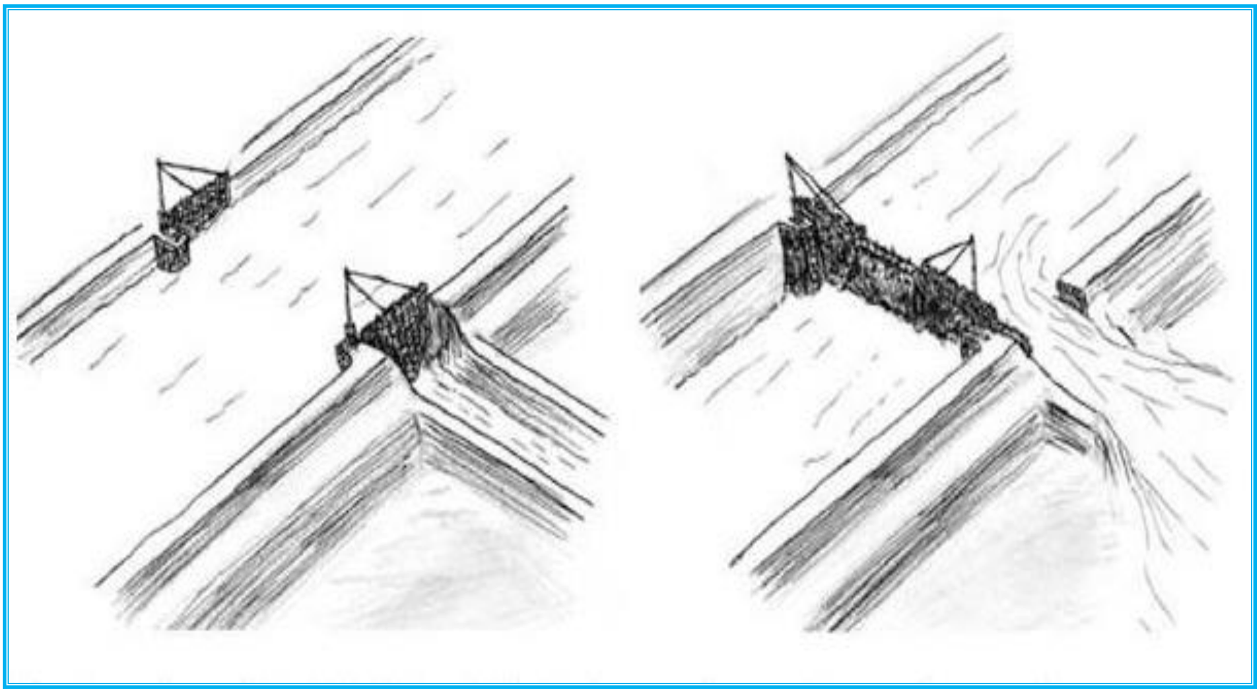

Figure 10: Damming of a large stream, Lambert (2007) [6].

Another arrangement of feeder canals intakes may have looked like Figure 11 where a sluice gate was placed at the head reach of feeder canals to regulate the flow entering the canal or shut it off completely. This arrangement was documented by Buccellati [7] from excavations in Terqa in Middle Euphrates in Syria, but it can very well represent similar situations in Lower Mesopotamia. Other arrangements were also used as indicated by many tablets left by the Sumerians. More elaborate works were constructed to fulfil multipurpose objectives; such as, slowing down the flow to avoid scouring of the canals, settling basins to reduce the silt load and provide clear water, in addition to acting as water storage for later uses; one example is given in Figure 11.

The inscriptions recorded different designs with different dimensions for reservoirs, and examples were given of dimensions, which varied between 12 meters to 72 meters long and widths ranging between 6 meters to 12 meters, and heights between 3 meters to 5 meters. Figure 12 is conceived from *Ur III* text, which was reconstructed by Shin T. Kang and quoted by Tamburrino [4]. The nomenclature shown on this figure gives the Sumerian names and their equivalent in English as translated by Kang.

The *Sumerians* did not fail to control the flow in their canals by constructing regulators similar in many respects to regulators of modern times. Genouillac and Parrot uncovered one example of such structures during excavation from 1929 to 1932 in a site at *Tello*, the ancient town of *Girsu*.

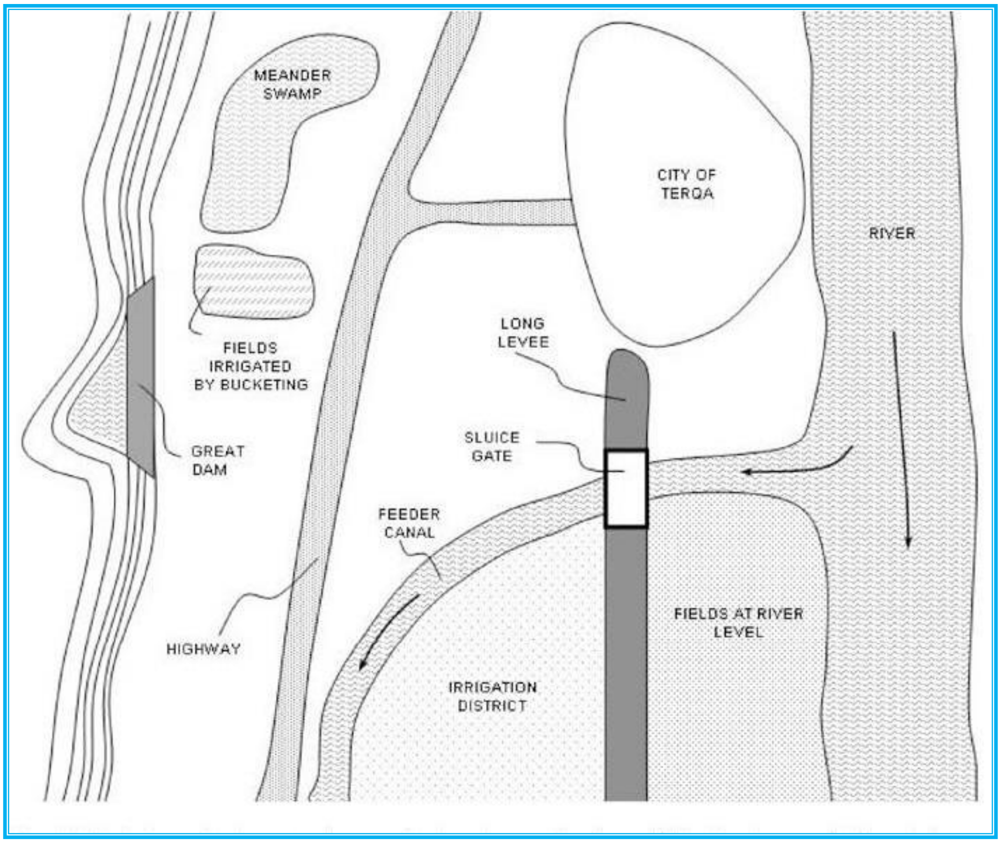

Figure 11: Schematic layout of an agricultural complex in middle Mesopotamia. From Buccellati [7].

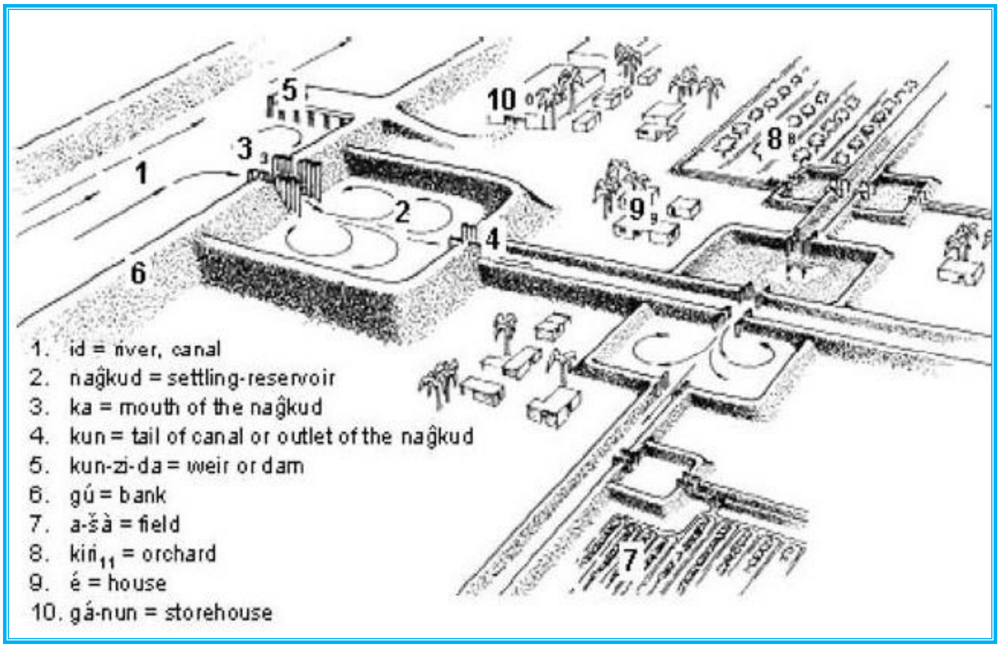

Figure 12: An example of a settling reservoir and complimentary waterworks.

This regulator was placed at the eastern levee of an affluent of the Euphrates, which was called *Nina-gena* canal that flowed from North to South [8]. The original plan and full description were given by Parrot [9], in addition to his visualization shown in Figure 13. The structure was made entirely of baked bricks bonded with bitumen. Sounding done in the site during excavation discovered a bitumen impregnated reed mat under the brickwork of the foundation. Bricks of various sizes were used in different parts of the structure, but this had no significance to its length or mode of action. The brickwork walls (A-B) and (C-D) were protecting the clayey silty banks from erosion and were set at an angle forming the funnel shaped entrance and were supported by the external brickwork projections (a, b, c) and (d, e, f, g) which added extra support to these walls. The walls (B-E) and (C-F) which formed the rectangular section of the main structure were supported by the buttresses (h, l, j), and (k, i, m) respectively.

Moreover, the thick sluice floor was made of six courses of bricks laid on a bed of reeds and bitumen, and the sluice measured 11.4m x 3m. The downstream part was formed from the wing walls (E-G-H) and (F-I-J) which were supported by buttresses and formed a fan that directed the flow into the 16 m wide canal. From the excavation, the sidewalls were about 5 m high, but bricks may have been pillaged from the top of the structure, so it is possible that the structure could have been higher enabling it to cope with most flood conditions and provide water from April to June. Throughout the excavation works, it was revealed that the soil filling adjoining the structure was of compacted clay while loose materials that had concealed it during all those years buried the structure itself.

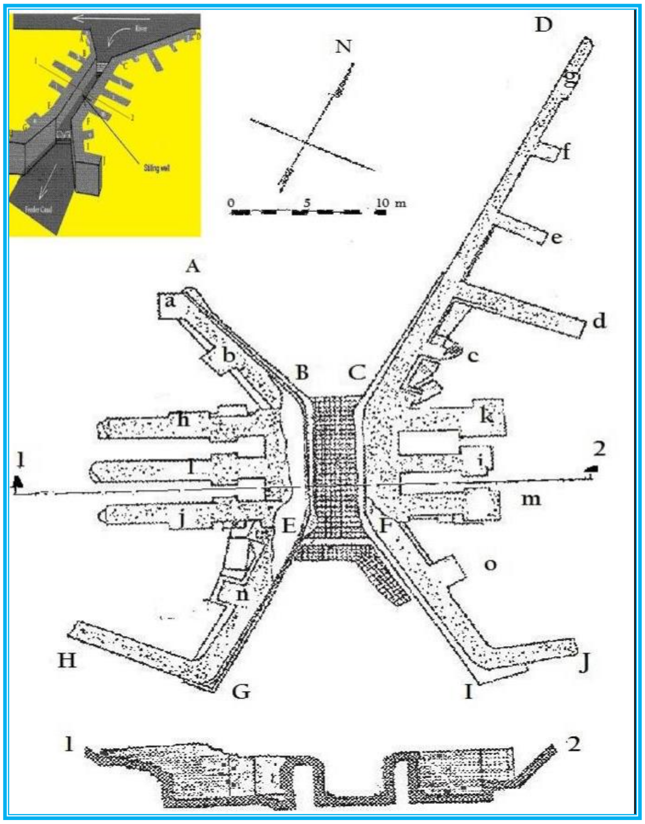

Figure 13: Head Regulator of Nina- gena canal, Plan and cross-section with a perspective view (Image modified from Parrot [9].

Control of the flow through the regulator was done by using horizontal wooden beams, which may have been similar to the stop logs we use today in such hydraulic structure. But, there were, however, no side grooves in the walls to install the beams and it is assumed that these beams were held in position using wooden supports. The number of beams could be increased or decreased following the fluctuations of water level in the river, and the discharge required in the canal. Evidence of the use of such beams was revealed in the "Epic of Gilgamesh", the great Sumerian version of the Great Flood [10]. In one text, which belonged to Pre-Sargonic Lagash, description is found of one irrigation system on three tablets, which described the length of a canal that was under construction or repair, and the description of a regulator, which fed another canal.

From information given by Stienkeller [11], the dimensions of this regulator were 18m x 3 m as visualized in the sketch of Figure 14. In addition, it had upstream wing walls 27 m and 24 m long to protect the structure which itself cut through the levee on the river bank and fed a canal 6m wide. Other details are similar to the regulator in Tello (Girsu) which indicated that such structures were very common, and that there was an accumulated wealth of experience in such works at the disposal of the planners and constructors of these networks[Error! Bookmark not defined.].

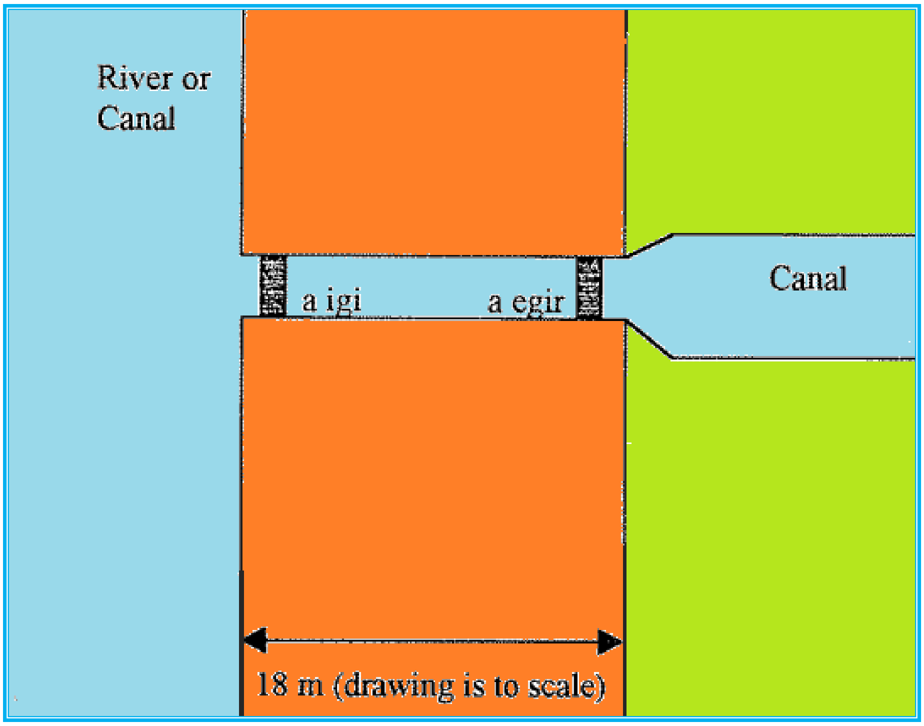

Figure 14: Plan of regulator described in Sumerian tablet [11].

The Sumerian irrigation canal system was very extensive, and the number of excavated archaeological sites was so large that the remnants of many major canals could be pinpointed and traced as shown in the map in Figure 15 which was originally produced by Jacobson[12]. In this map, the old Euphrates river course is shown from which all the major canals were branching. Locations of major regulators are also shown on this map and indicated by red colour rectangles. The sites of some of the most important Sumerian cities are shown also, where it is clear that these cities were located close to these headwords in order to control the water flow to the territories along these canals. Modern cites of Iraq are also shown in addition to so many locations of excavation sites, which were dug during the period from the end of the 19th century to well into the 20th century.

It must be emphasized here that there are probably thousands of such sites waiting to be investigated. The area irrigated from two of these canals, namely *Girsu* canal and *Kimah* canal, were estimated by Dight.et.al [13], based on their dimensions of 16 m width and 6 m width respectively assuming a four-month irrigation period during winter and growing cereal crop with a water requirements of 600 l/m^2 per year and 40% of water losses due to evaporation and seepage in the distribution network. The conclusion was that the *Girsu* canal and *Kimah* canal irrigated 10,000 ha and 2,000 ha respectively. Considering that the cultivation system was based on the fallow system it follows then that the total areas served by the two canals can be doubled to 20,000 and 4000 ha.

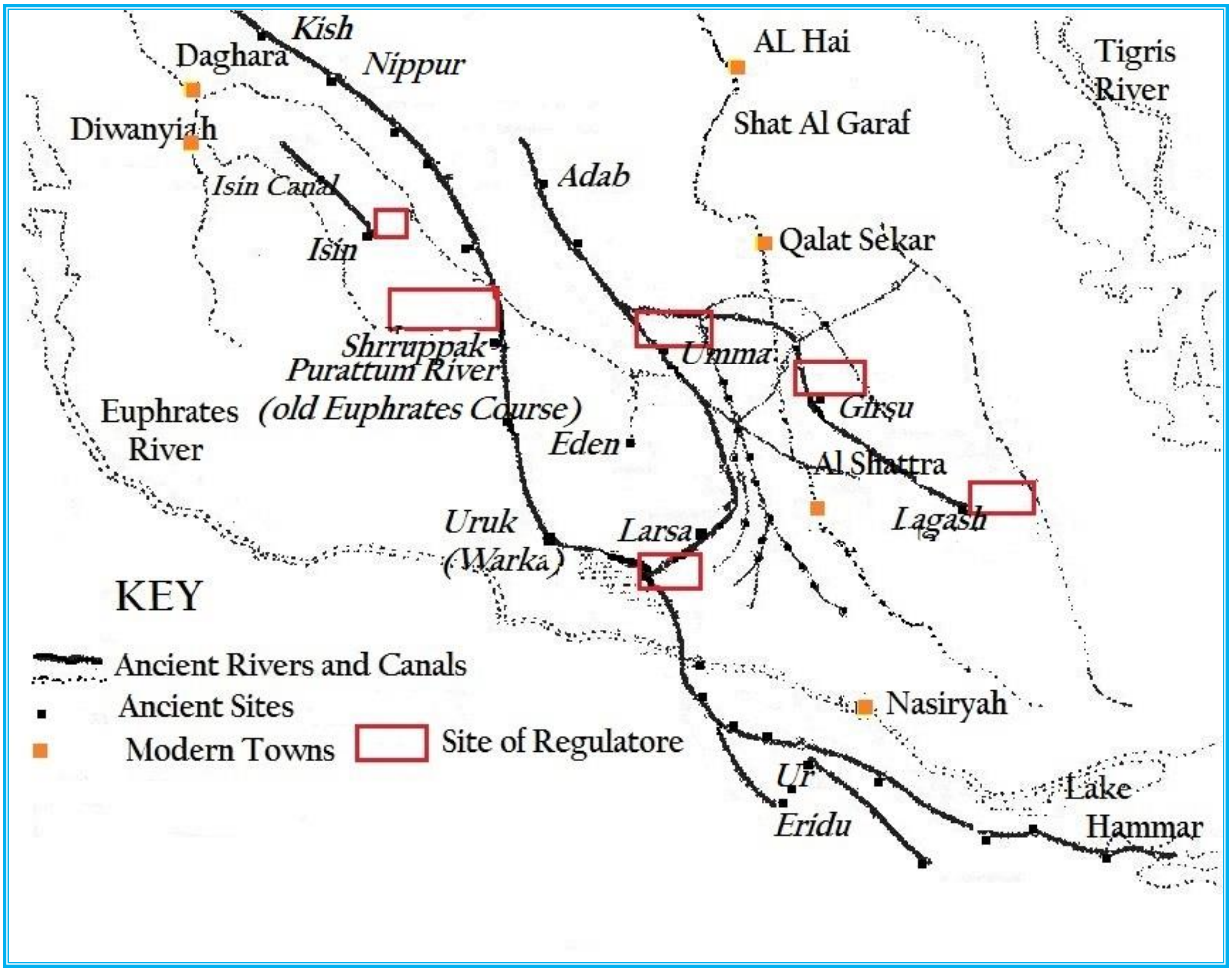

Figure 15: Map of the remains of major irrigation canals and regulators produced by Jacobson [12] (Modified).

The social system that supported agriculture and land cultivation in these city-states was mostly based on the feudal system. As one city-state fights and conquers another city-state then the land ownership of the conquered city-state is turned to the King and the Temple of the victorious city-state. There were also the other lands which are under the collective ownership of groups of farmers, in addition to many other holdings, which belonged to landlords from noble families who had acquired written documents verifying their ownership. Maintenance of the canals was a continuous task, and major canals were supervised by high officials who reported directly to the King. Large gangs of workers were necessary to free the canals of silt, which demanded the removal of enormous amounts of mud. This was clearly documented on clay slabs of the types used at the time for writing and found during archaeological excavations reported by Tamburrino[4].

The secondary irrigation canals, however, were solely owned and controlled by the farmers and owners of the served plots of land, and on their shoulders rested the duty of clearing them from sediments and maintain the continued discharge. In a similar parallel in modern Iraq up to the middle of the 20th century, large groups of peasantries called "*Hushoor*" used to get together to remove the silt depositions from irrigation canals and keep the free flow going in them. The Schematic diagram in Figure 16 sheds light on the hierarchy in the Sumerian society in which obviously the last rank in this hierarchy, consisting of slaves and criminals, were an important source of free labour in all the heavy tasks of farming and canals' maintenance works. Most salves were prisoners of war, but a free man could become a slave in case of failing the payment of a debt or committing a grave offence.

The distribution of water between users followed a fixed system agreed upon and followed by all those users, but this did not prevent conflicts and skirmishes over water rights. In the exploitation of their lands often, landlords of the larger holdings used hired hands to cultivate their land and paid their wages after harvest either in barley, sheep wool, and live animals or even in silver. Some of the poorer owners were forced to mortgage their land to buy seeds, tools and other cultivation requirements and pay back after the harvest, in which cases they were protected from the exploitation of greedy money lenders by the law. If the harvest failed, however, for reasons beyond the control of the farmers, the law also exempted them from the payment of the interests.

King and Priests
|
Land Owners, Government Officials, and Wealthy Merchants
|
Farmers and Artesian
|
Slaves and Criminals

Figure 16: Class hierarchy in the Sumerian Society

Conflicts over water rights and agricultural lands between city-states were also common. These conflicts were settled either by, arbitration or even by one of the two states digging a new canal and build new control and distribution structures to avoid sharing, or if all means of settling the matter fail, then this will end in the eruption of full-scale war between these states. Such wars may end by conquering of one of the two city-states and taking over its lands or, by signing a new reconciliation treaty with new conditions and payments of large penalties. In this respect, many examples are given in the Sumerian history. One such example is found in the long feud between the city-state (Lagash) and the other Sumerian city-state (Umma). The conflict focused over the irrigation of the lands around the present-day town called (Al-Shatra) very close to the southern part of the present-day river (Shatt- Al-Garaf). Lagash was located on the left side of this river, 20 kilometres northwest of Al-Shatra, while Umma was situated near the present-day mound called (Tel Khoja) on the right side of Shatt-Al-Garaf river at a time when this artificial river did not exist.

The lands of Lagash were irrigated from the watercourse branching from the old course of the Euphrates River and passed through Umma’s territory, which had also water rights to the same water course. There were many instances when Umma had taken more than its share of water, and other times when it diverted the flow on purpose to damage the Lagash cultivations; in addition to the ambitions perpetuated by Umma to take over one of the larger and more fertile estates of Lagash called (Guedinna) and annex it to its own lands. This estate, however, had been the subject of a claim by Umma especially that it was irrigated from the same canal supplying both Lagash and Umma. This led to a series of skirmishes and bitter disputes between the two city-states.

An old inscription, however, states that the dispute was solved at least temporarily by arbitration. Both parties had accepted that Mesilim, the King of Kish, who seemed to have patronage over both of the conflicting cities, should act as an arbitrator. Mesilim in his turn proceeded to arbitrate the controversy by measuring the boundary line between the two city-states and reached his decision, which was in favour of Lagash. He then installed land marks of stone to mark the border and settle the case. Later on, the new king of Umma called Ur- Nanshi who removed those landmarks, crossed the border, and then seized the land again violated this decision. Fighting erupted many times until this was settled in a fierce battle between the armies of the two states in which victory was the share of (Eanna-Atum), King of Lagash and the killing of (Ayna-Kala) King of Umma and son of Ur- Nanshi at about 2470 BC [14]. The victorious king took further steps to remove all reasons for such fights with Umma and he accomplished this by digging a new large canal off taking this time from the Tigris River and not from the Euphrates.

This new and very large canal he called (Lumna- gimdug) which is the present day (Shatt- Al Garaf), mentioned previously, and which extended for 130 kilometres to reach Lagesh territory. This work remained an example of very highly sophisticated engineering achievements for a very long time, in which technical methods and surveying works were utilized. It was lined with baked clay bricks and plastered

with bitumen, and bunds were constructed along its banks.
In the passage of time, however, the dimensions and depth of this large canal increased steadily due to its steep slope, and it became the main branch of the Tigris River; the Shatt- Al- Garaf itself(i). From Sumerian inscriptions, it is known also that Eanna- Atum accomplished more of such engineering achievements. Among these, he had built a small reservoir and a new canal connected to it and called (Khoma- Dimsha), and a submerged weir on a canal called (Jarso) at about 2430 BC to raise the water level and have a higher command of the land. Other inscription also indicates that the successor king (Enti-Mena) had also constructed such a weir at about 2400 BC. The quantity of bitumen used in both weirs was about 270, 000 litres and the number of burnt bricks were more than eight million bricks.
This first *Sumerian* dynasty continued from 2900 BC. It ended in 2350 BC at the hand of *Sargon I*, who had started as a high ranking official at the court of (*Ur-Zababa*) the last king of this dynasty and had probably killed him and replaced him to mark the start of the Semitic *Akkadian* domination which lasted almost 200 years to 2150 BC.
Sargon was a powerful man and a military genius and administrator who probably consciously or not began to change the Sumerian culture to the Semitic one but failed to stamp out the Sumerian culture, which continued even after the fall of "*Agade*" his capital some 200 years later. One thing, which may be said on Sargon's credit, is his unification of all Sumerian city-states under his rule and extending his empire, so it was said that his influence was felt from Egypt in the west to India in the east.
During this period of Akkadian control, the *Sumerian- Akkadian* culture was dominant in every day's life and practices and irrigation, and agriculture continued to flourish until the *Akkadian* empire collapsed in the destruction of its capital "*Agade*" at the hand of the barbaric and nomadic people, the *Gutians*. These tribes had descended from the mountainous region of Elam in the east and ruled for a very short period, but this did not prevent the rise of a second *Sumerian* dynasty (*Ur III*) which continued to rule from 2150 BC until 2003BC, and so the *Sumerian-Akkadian* culture was kept alive during all this long period.
The *Sumerians and Akkadians* of ancient Iraq were indeed "The Peoples" who had laid the foundation of civilization as we know of today. To describe this civilization, it was an agrarian civilization based on irrigated agriculture; so it may be worthwhile here to describe some of the methods, equipment and far-reaching technologies and achievements developed by the *Sumerians and Akkadians* in the fields of irrigation and agriculture. Each of these innovations represented at that time a real breakthrough, which was used in so many countries of the world for thousands of years, afterwards without much change or improvement and even being used nowadays in some communities. These achievements can be clearly seen in the construction of an intricate system of canals, weirs, dykes, and reservoirs, which demanded considerable engineering skills and knowledge. Surveys and plans had to be prepared, which involved the use of levelling instruments and rods, in addition to drawings and mapping. The need for calculating areas and volumes

enhanced trigonometric and geometric methods.

The growing of crops and farming operations had to follow strict time schedules and instructions which the farmer had to adhere to in order to fulfil the tasks in the best possible way and get the full reward for his work. Sumerians therefore, had to follow the change of seasons and the sun movement, which gave fruit in the developing astronomy. An account of some of the farming operations, rules and instruction was inscribed on a clay tablet uncovered during excavations in the city-state *Ur*, and described by Kramer [14] [15].

On this tablet, there were inscriptions of such detailed instructions that give clear insight into all farming operations followed at that time. At the start, the dry soil is wetted by flooding the farm with water; as water recedes then lose shod oxen are let loose to crumble the wet ground, thus stamping out the weeds and levelling the surface which must be dressed with small light axes until it is even. Since the hoofs of oxen have left their mark on the still wet ground, men with pickaxes must go around the field to smooth it out.

While the field is drying, the farmer is advised to prepare his tools, equipment, beasts and seeds that are necessary for the next stage which involves such operations as harrowing and raking the ground to break the clods and removing the weeds. The actual ploughing and seeding can now take place by ploughing the field twice using two different deep soil ploughs. Seeding will be done simultaneously with the second ploughing operation by means of a seeder; that is an attachment to the plough which carries the seeds from a container through a narrow funnel down to the furrow as shown in Figure 17.

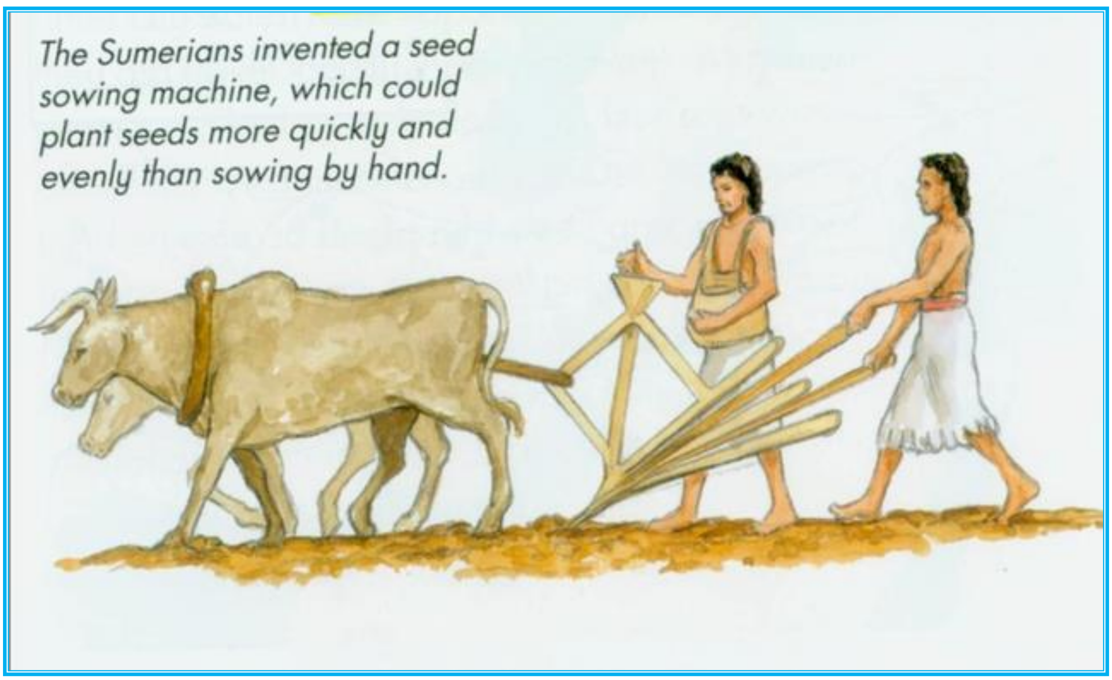

Figure 17: A plough and seeders of the type used by Sumerians.

The farmer was advised to plough eight furrows in each strip, which was about six to seven meters wide. Following all this the field had to be cleared of clods and ground elevations and depressions and levelled off so that sprouting of barley would not be restricted in any way. When the plants had grown sufficiently to fill the narrow furrows, it was time to water it; and when it stood a little higher than the furrow's top, it was time to water a second time. The third irrigation would then take place when it reached its full height. If the barley or wheat was doing well then fourth, irrigation could be done to obtain an extra yield of about ten per cent. As the time of harvest arrived, the farmer was informed not to wait until the barley bends under its own weight but to harvest it while it is still erect.Teams each of three men were to reap, bind and to arrange the yield in the sheaves.

The thrashing, which followed harvesting, was done in two stages. First, the mounds of crop were trampled down by wagons drawn back and forth over them for five consecutive days. Then thrashing sled, consisting of beams with iron teeth fastened with leather strips and held secure by bitumen, was used to "open the barley". Next step in this sequence of work was winnowing, which was done by two men who used large wooden forks or shovels to lift the mixture of barley or wheat and chaff it in the air thus freeing the grains from the straw and husk.

The *Sumerians* and *Akkadians* in developing these procedures had to invent and manufacture all the equipment and tools required to fulfil the intended tasks and to use available recourses such as wood, bitumen, leather and iron which they had already mastered its production. Figure 18 illustrates many of the tools and equipment they used in this work.

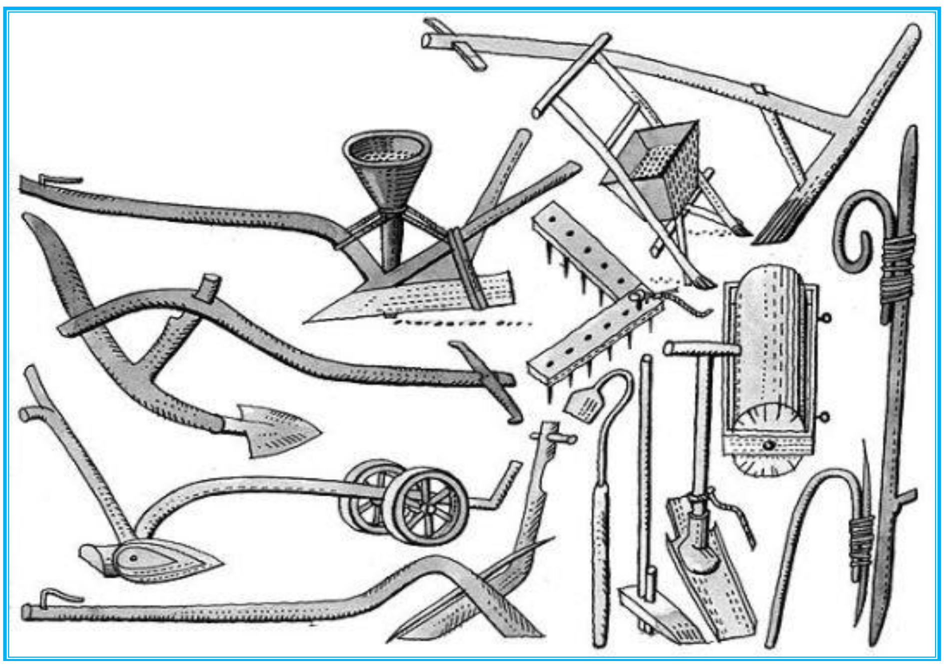

Figure 18: Tools and equipment used in Sumeria.

On the irrigation side, *Sumerian*s used gravity irrigation helped by the extensive network of canals and the many weirs they had built on rivers and large canals to get the required command. On the field level, they practised such methods like basin flooding, check flooding, border strip irrigation and furrow irrigation. These methods are still used in a great many countries of the Middle East and the world now. When water levels are low in the main feeders, they devised ingenious ways to practice lift irrigations. Among such devices was the "*Dalia*" which is still in use in Basrah in Iraq. Other devices were used such as the "*Charid*" or "*Kared*", water wheels driven by oxen or mules, in addition to the huge water wheels driven by river's flow. Many examples of such water wheels can still be seen on the upper Euphrates in Iraq and Syria. Full description of these devices is given by Sousa **[16]**. Many of the mentioned implements have proven their efficiency and usefulness till very recent times and some are still in use, even today in many places in Iraq. In fact, the southern district of Baghdad called "*Karrada*" has taken its name from the "*Kareds*" used to irrigate its extensive palm trees and mandarin orchards until the early days in the 20th century.
The Sumerians had excelled in hydraulics; apart from designing and constructing irrigation system they had to device ways and means for flood control as they were constantly threatened by the floods of the two rivers, so they had to learn ways to protect themselves and their lands from such floods, which came periodically every spring. In this way, they constructed levees along the banks of the Tigris and Euphrates and kept them maintained **[17].** They even devised methods of protecting the levees side slopes in contact with water from the erosive power of the strong flood currents. This was done by laying mats of woven date palm fronds on these slopes and pins them down by long slender wooden poles. These mats and poles were still in use in Iraq until only few years ago, whereby the mats were called "*Bawari*" for the plural and "*Baria*" for the singular, and the wooden rods were tagged as "*Hawalesh*" for the plural or "*Halosh*" for the singular. The most recent use of these *Hawalesh*" and "*Bawari"* in Iraq was during the Euphrates floods in the sixties of the last century, and in the floods of the Diyala River in 1973 and 1974, which had threatened the capital Baghdad.
If any breach developed in these levees during one of these floods, the Sumerians could use ways to close the breach quickly before it enlarged to threaten the collapse of the whole levee. This was done by use of "*Batkha*" which again remained in use until a few years ago in the lower Euphrates area. The "*Batkha*" itself consisted of a long role of brushwood and reeds bound together by ropes made out of the fronds of date palms. A completed "*Batkha*" would be laid in the stream against the breach and loaded with layers of palm tree fronds, dry branches of trees, dry thorn, thistle and earth to sink it to the bottom and to be followed by the next one which should be ready by now. The process would continue until the breach was closed. Sussa (15) again describes the process in full.
The Sumerian ecosystem may be described as being very fragile. The nature of alluvial delta, its geography, topography and its bordering marshes and lagoons

imposed strict organization and operation procedures to keep the fertility of the land to produce enough yield. The shallow depth of groundwater and the danger of salinization required that the fallow system of cultivation be adopted, whereby a plot of land could not be cultivated in two consecutive years but left one year to rest to keep the groundwater level below the root zone. The second matter, which had its bearing, was the arid climate with precipitation below 250 mm/ year, which forced artificial irrigation on the communities of the lower Mesopotamian region. The intensive canalization dictated communal work to keep irrigation canals free from sediments and to maintain constant full discharge.

This communal work also reflected on the organization and administration aspects of the irrigation and agriculture procedures. The land or farms were mostly divided into plots of elongated and rectangular strips to allow the irrigation of each of them from a single outlet. The area of each farm had to be limited to a manageable size between 90 and 135 Sumerian *iku* which would approximately equal 32 to 49 hectares. Texts retrieved from *Ur III* revealed that in provincial land, "cultivators" were organized in groups of fives under the direction of an "inspector", who in turn answered to an "overseer" (*Uggula*), and one "cultivator" was usually to be in charge of one field or a parcel of fields. Some of the agricultural workers on the provincial fields had even full rights to plots of the land and such holders would receive fixed annual grain ration based on the plot size according to the predetermined production rate irrespective of the inevitable regional and annual yield fluctuations**[18]**.

Historians agree that the *Sumerians* were successful in establishing the first great civilization in the history of mankind, where it had all the characteristics for any civilization to be worthy of the name. In its fabric, all the elements for such civilizations were present; including socio-politico-economic features, centralization, the domestication of animals, specialization of labour, monumental architecture and taxation. It was organized in densely populated settlements divided into hierarchical social classes with ruling elite and subordinate urban and rural populations, which engage in intensive agriculture, mining, small-scale manufacturing and trade. The *Sumerian* civilization was agrarian as one would expect to have in such a long past.

Like all great civilizations of past history, this civilization in its rise had also the seeds of decline interwoven in its fabrics, which only could have an effect after it had passed its maturity. Being an agrarian civilization, it had the two basic elements of land and water resources, which contributed to both its rise and decline. *Sumerian* heartland was a deltaic region built by the sediments of the Tigris and Euphrates Rivers over a very long period, so it had the nutrients brought by the floods of these two rivers. At the same time, it was low land by nature of its geological origin surrounded by water from three sides; namely the Tigris from the east, the Euphrates from the west and the marshes and lagoons and the Gulf from the south. It was natural that the water table was very high, and in order to have successful agriculture, the *Sumerians* had to resort to fallow cultivation to avoid the rise of the water table into the root zone and cause waterlogging.

One great danger facing the *Sumerians*; was the *salinization* of the land. The semiarid climate of southern Mesopotamia and the general low permeability of the soils exposed it to the dangerous accumulation of salts, which are harmful to crops and could cause the abandonment of the land. The source of these salts was the irrigation water from the two rivers that had been dissolved from the sedimentary rocks forming their catchments in Southeastern Anatolia.

Even though the concentrations were, low the accumulation of these salts in the soils over hundreds of years resulted in generally inferior soils that had to be managed with care. Citations of salinity problems from ancient records indicate that a serious problem of salinization of the land appeared from 2400 BC on ward after a time when agriculture had just flourished to a very high level. Apparently, this problem had its roots in over irrigation of the land. The long and bitter conflict between the two city-states Girsu *(Lagash*) over one of the largest canals taking off from the Euphrates had lasted for many generations. The matter was not settled until the King of *Lagash* had dug a very large canal, which was already described, to transfer large quantities of water from the Tigris.

Finally, this had contributed to the rise of the groundwater table to unmanageable levels. To this fact Jacobsen et al [12] attest that the abundant source of water had simply resulted in over- irrigation and led to the salinization of the soil. The presence of patches of saline ground was mentioned in records of ancient temples' surveyors. In a few cases, individual fields, which at that time were recorded as salt- free, were shown in an archive from 2100 BC to have developed conditions of sporadic salinity during the 300 intervening years of cultivation. The choice of the crop that was grown in the region showed another indication of these deteriorating land conditions.

Counts of grain impressions in excavated pottery from sites of about 3500 BC suggested that at that time the proportions of wheat and barley were nearly equal. A little more than 1000 years later at *Girsu*, the less salt tolerant wheat accounted for only one-sixth of the crop. By about 2100 BC wheat had slipped still further down, and it accounted for less than two per cent of the crop in *Girsu* area. By 1700 BC the cultivation of wheat was abandoned completely in the southern part of Mesopotamia. The shift to barley cultivation was due to serious decline in fertility, which for the most part, can be attributed to salinization.

At about, 2400 BC in *Girsu* number of field records gave an average yield of 2537 litres per hectare. This is a very good figure even in advanced courtiers today. This figure had declined to 1460 litres per hectare by 2100 BC, and by about 1700 BC, the yield recorded by *Larsa* had shrunk to an average of only 897 litre per hectare. This general decline in the yields had its adverse impacts on the wealth and livelihood of the region, which was not abandoned completely but had caused the cultural and political leadership to pass permanently out of it with the rise of *Babylo*n in the 18th century BC. This is how the story of this great civilization ended. Other civilizations, which followed, will remain indebted, however, to the *Sumerians* for all what they have contributed.

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