

Maintaining the Healthy Life of the Yellow River

Li Guoying



Yellow River Conservancy Press

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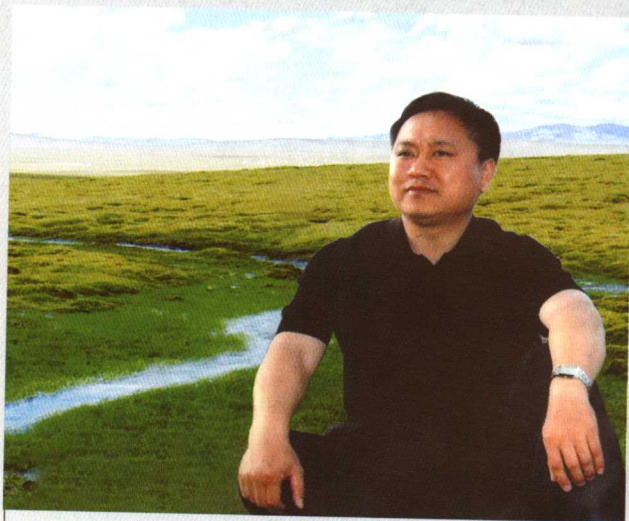
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Li Guoying, Professor,
Commissioner of the Yellow
River Conservancy Commission



Rivers have bred the civilization of Homo sapiens, who in the process of their development caused harms to rivers and paid prices for such deeds. For a long period of time, the Yellow River has been suffering from such problems as ever-deteriorating sedimentation and shrinkage of the main channel, pressing situation of “secondary hanging river”, aggravating water pollution, and increasing contradiction between supply and demand of water resources, all of which without exception reflect the subsistence crisis of the Yellow River. Therefore, the author advocates that maintaining the healthy life of the Yellow River be the ultimate goal of the Yellow River harnessing, based on which the river harnessing system of “1493” is set up; furthermore, the author elaborates on the modes of water and sediment regulation, the control, utilization and modeling of flood, the “three lines of defense” for control of coarse sediment, the establishment of water and sediment regulation system as well as the strategies for downstream channel harnessing of the Yellow River.

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Chapter 1

A Survey of River Life





Section 1 River — Cradle of Civilization of the Human Race

From the ancient astronomy to the modern astronautics, man has never stopped searching life on Mars — the fourth planet in the solar system and the nearest neighbor of the earth. Among the planets of the solar system, Mars is similar to the earth in many aspects: there are 24 hours and 37 minutes in a day on Mars, which is close to that on the earth; the ecliptic angle on Mars is 24° which is also close to that on the earth (the ecliptic angle on Earth is $23^{\circ} 27'$). Therefore, Mars has a change of seasons similar to that on the earth. These similarities, however, do not indicate that there is life on Mars. Before we can ascertain there is water on Mars we must ascertain there is water on Mars for life can exist without oxygen as long as there is water. This was demonstrated by the early life on the earth that lived in an environment with extremely thin oxygen. The pictures taken from the spaceship orbiting Mars show that there are dried up river courses. Without any doubt, Mars has been and shall remain the most important planet onto which man look for life in the solar system.

On June 11 and July 8, 2003, Mars exploration rovers “Spirit” and “Opportunity” lifted off successively into space from Florida. After a 206-day journey of 480 million km, they landed on Mars with a mission to determine whether there is water on Mars.

No matter how advanced the human being has evolved compared with its ancestors, and no matter how abstruse the human being's exploration has been, the precondition on which human beings rely for subsistence and development, water, has never changed. From the very first day of life on earth, life has been closely related to water. The life in any form and in every step of evolution is all linked to water. Without water, there is no life.

Along with the development of productivity, human beings have increased our capacity of transforming the natural environment. At the very early stage, human beings could only adapt to and rely on the nature as they understood little about nature. For the sake of water, man lived by riverside; and for the convenience of transportation, man hollowed canoes out of a tree trunk to navigate in rivers. Man has been completely relying on water from the nomadic life to settling down to create agricultural civilization. The four countries with ancient civilization — ancient Egypt, ancient Babylon, ancient India and ancient China — initially all relied on rivers for development. The abundant cultural heritage of philosophy, natural science, literature and arts of human beings all originated from the ancient civilization of the said regions.

If we hold that water gave birth to life, then it's correct to say that rivers have nurtured the civilization of mankind.

Egypt is located in the Nile River basin in northeastern Africa and the Sinai Peninsula in southwestern Asia. The geological coverage of the ancient Egypt was a bit smaller than Egypt today, which included the narrow long stream valleys from the north of the 1st Cataract of the Nile River to the Mediterranean. Egypt faces the Red Sea and the Arabian Desert in the east, borders Libyan Desert in the west, Nubia (Sudan today) in the south and the Mediterranean in the north^[1]. The Nile River originates in Burundi Highland in Eastern African Plateau, and its mainstream flows through Burundi, Rwanda, Tanzania, Uganda, Sudan and Egypt before it enters into the Mediterranean (see Figure 1-1). Its tributary flows through Kenya, Ethiopia, Congo and Eritrea. With a mainstream length of 6,670km, the Nile is the longest river in the world. The Nile River is sourced at Khartoum, the capital of the Sudan, by the White Nile River and the Blue Nile River. Below Khartoum is the mainstream of Nile River, which flows through Egypt for about 1,200km. The total area of Nile River basin is about 2.87 million km², accounting for over 1/9 of the total area of Africa. The normal annual runoff is 84 billion m³ at Aswan and 81 billion m³ at sea outfall. The Nile River is a sandy river and its sediment mainly comes from the Blue Nile River. The mean annual sediment discharge at Aswan is 134 million ton, with mean sediment content of 1.6 kg/m³ and maximum one of 5 ~ 6 kg/m³^[2].

There are two rainfall centers in the Nile River basin. The first rainfall center is the Ethiopian Plateau in the southeast of the river basin. In summer, as the northern African and Arabian Peninsula are under the depression belt, the southeast trade wind from the south Indian Ocean, after traversing the equator, changes to southwest wind, joins the humid and hot air stream from the Gulf of Guinea, and thus developing a formidable southwest air stream. This air stream rises up along the windward slope of the plateau and forms the

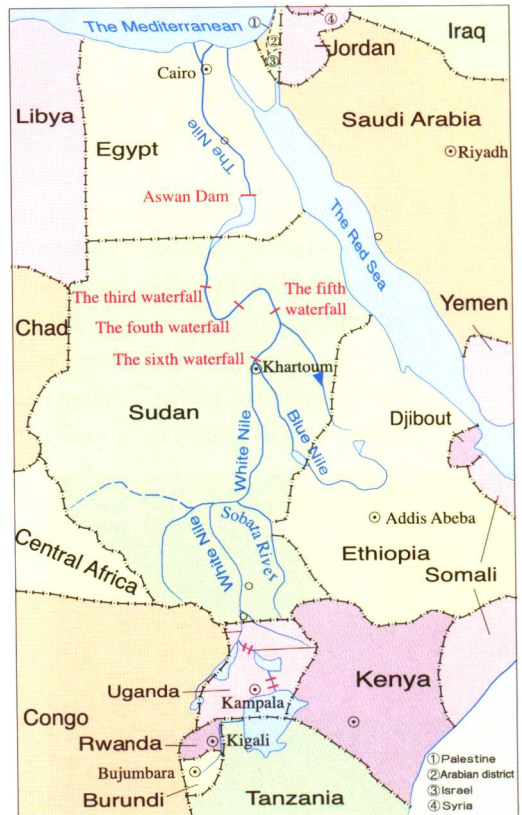
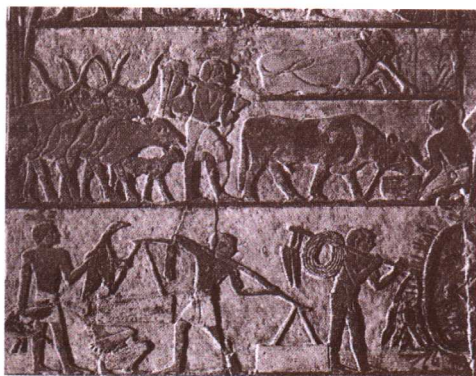


Figure 1-1 Sketch map of the Nile River basin



The Nile River

heavy rainfall period from July through September. The annual rainfall in this region reaches 1,000 ~ 2,000mm. The second rainfall center is in the northwest part of the Eastern African Plateau in the southern river basin, which is located along the equator and thus has strong solar radiation and vigorous convection current and is affected by the humid current from the Gulf of Guinea. This region has abundant rainfall with annual rainfall of 1,200 ~ 1,300mm. In the north beyond these two rainfall centers, the region from Khartoum to the estuary (except the stream valleys of the main stream of



Relief sculpture of the farming in ancient Egypt

the Nile) is tropical deserts with little rainfall of about 25 ~ 200mm concentrated in winter^[2]. Under such a climatic circumstance and during summer months, the upper reaches of the Nile River will experience torrential rain that is widespread and will flood the basins and deltas of the river. The floods carry the silt and remains of plants in the upper reaches down to the lower reaches of the river, and deposit along the two banks of the river a heavy layer of fertile black soil which is very suitable for grain planting. This climate is also favorable for human beings

when the productivity is low and human beings do not resort to other means for making shelters. Abound in gifts of nature, the ancient Egyptians gradually moved from the highland to the stream valleys in the lower reaches of the Nile from 5000 BC, and started to transit to agricultural period when they settled down. Around 4000 BC, as the ancient Egyptians mastered the regularity of the flooding of the Nile, they set the interval of flooding as one year, which was divided into 12 months and 30 days in a month, thus forming the ancient Egyptian solar calendar 6,000 years ago. As the rise and fall of the river water was closely related to human life, the ancient Egyptian invented a method to observe water level. Around 4000 BC, they discovered copper for the first time in the world. They used this hard material to make working tools and gradually discarded stone tools. The productivity of the society was greatly increased accordingly. Around 3300 BC, when towns and cities began to emerge in the lower reaches of the Nile, the pictograph was formed. Around 2000 BC, ancient Egyptian ripped straw stems into thin slices for paper and dipped the reed stem into pigment for pen to write on the thin slice. For the sake of measurement of the land, the construction of irrigation works and architecture, the ancient Egyptians adopted decimal notation, and were capable of calculating the area of a triangle, a rectangle, a circular and a trapezoid as well as the approximate value of the ratio of the circumference of a circle to its diameter^[3].



Solar calendar in ancient Egypt

Undoubtedly, the unique natural conditions of the Nile met the need of the ancient Egyptians for survival and production, and greatly promoted the socio-economic development of ancient Egypt, and furthermore, rendered irreplaceable conditions for the creation of the ancient Egyptian civilization. The Greek historian Herodotus once wrote: "Egypt is the gift of the Nile".

The two river basins refer to the basin of the Euphrates and the Tigris flowing into the Persian Gulf, which was called "Mesopotamia" by the ancient Greek meaning the region between the Tigris and Euphrates rivers. This region is roughly the area of the current Iraq. The Euphrates originates in the Anatolian Plateau in eastern Turkey, winds to the south, enters Syria in the south of Birecik, penetrates Iraq through Kusaibar, flows to the southeast through Hit and reaches Qurna giving the Euphrates a total length of 2,750 km, a total catchment area of 675,000 km² and an average annul runoff of 32.4

billion m^3 . The Tigris originates from the Lake Hazar, enters Iraq through the northeast frontier of Syria, flows through Mosul and Baghdad in the southeast and reaches Qurna giving the Tigris a total length of 2,045 km, a catchment area of 375,000 km^2 and an average annual runoff of 36.6 billion m^3 . After the Euphrates and the Tigris join at Qurna, they are called the Arabian River. From Qurna to the Persian Gulf, the Arabian River is 193 km long (see Figure 1-2). The total area of the two river basins is 1.05 million km^2 and the mean annual runoff into the sea is 47.3 billion m^3 ^[2].

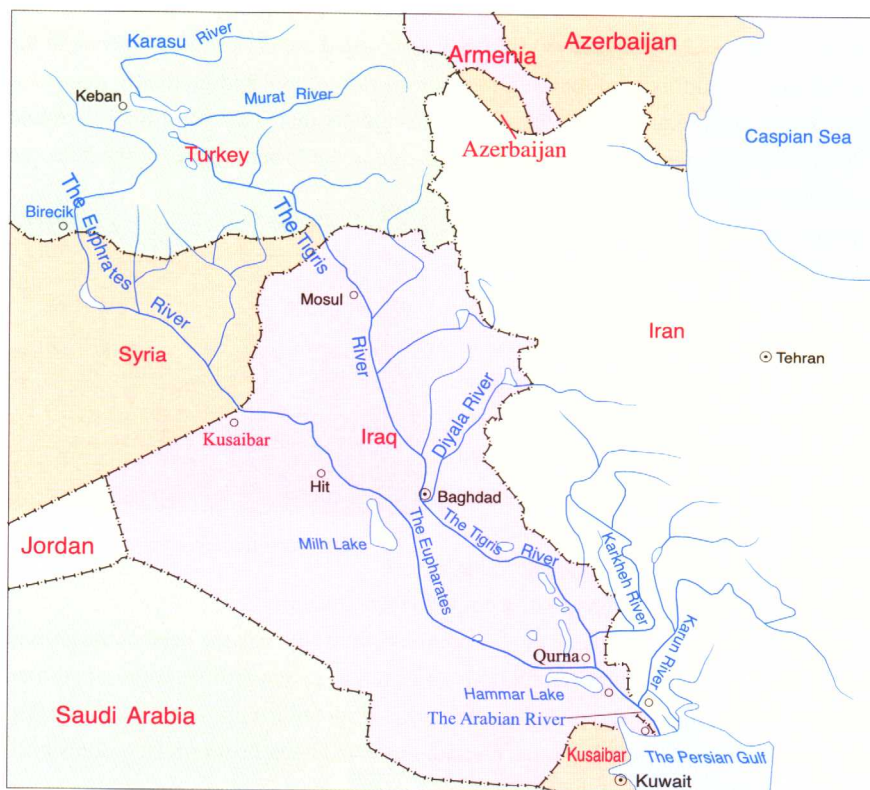
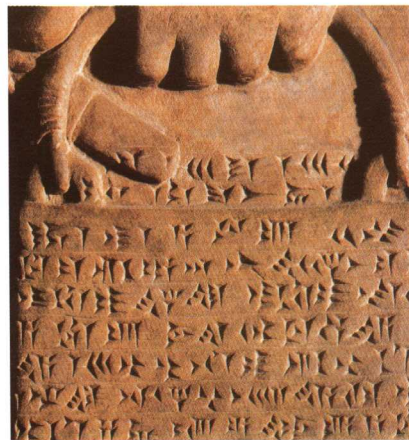


Figure 1-2 Sketch map of the Euphrates and the Tigris River basin

Both the Euphrates and the Tigris are sandy rivers, whose estuarine sections were deposited continuously and gradually formed the Mesopotamian Plain. The major water replenishment for the upper reaches of the two rivers is the ice, snow water and rainfall in the spring season, with the maximum flow of the two rivers occurring in April and May. However, the Mesopotamian Plain located in the middle and lower reaches of the two rivers is in arid region with annual rainfall of less than 100 mm^[4]. Such a natural

condition is quite similar to that of the Nile, and is suitable for human survival and agricultural development. Around 7000 BC, people began to settle down in northern mountainous areas of the river basins, and the primitive agriculture and animal husbandry appeared. In 5000 BC, the Sumerians settled down in the southern part of the two river basins, thus creating the early Sumerian civilization. Due to the dry climate and little rainfall in this region plus the low productivity at that time, they made their shelters with reeds, which was both convenient and practical. From 4500 BC to 3500 BC, the Sumerians started to use copper tool and potter's wheel, grow wheat and barley and raise sheep and ox, and towns and cities appeared along with the social development. In 3500 BC ~ 3100 BC, plough drawn by ox was already in use in agriculture, which was the advanced level in the world, and the Sumer City-States with cities as centers had formed. During this period, the Sumerians invented the earliest characters in the world — cuneiform. Around 3200 BC, they mastered the techniques of engraving characters in mud plate. From 3100 BC to 2900 BC, there appeared painted pottery, and commerce, foreign trade began to develop, and the richly endowed valleys of the Euphrates and the Tigris became the birthplace of trade cities. During this period the Sumerians also invented the decimal system and sexagesimal system. In 2334 BC, the first empire in the world emerged there. In this stage, the scale of irrigation diverting water from the mainstream of the two rivers was expanding, and large areas on dry land became rich granaries, what had greatly promoted the agriculture production. At the same time, along with the frequent commercial exchange thanks to the development of transportation and metrology, trade business reached as far as the Indian River basin. In 1894 BC, the ancient Babylonian Kingdoms were set up. Its 6th King Hammurabi (1792 BC ~ 1750 BC) united all the two river basins. In order to increase the economy of Babylonian Kingdoms, Hammurabi took measures to construct irrigation and water conservancy works to promote agriculture, and made his regime age the heyday of the Kingdoms. The Code of Hammurabi remains the most complete ancient written code in the history of human being. Through learning from the ancient Babylonians, the Sumerians formed the sciences and astronomy in the early days.



The earliest characters in the world —
cuneiform

On the basis of numeral of 60, they designed a set of notation system, and used the sexagesimal system to calculate time and circumference. For instance, they divided the circumference into 360 degrees (60×6), one hour into 60 minutes etc. which are still in use in the world today.

It is obvious that the richly endowed natural conditions of the two river basins gave birth to the farming civilization of the Sumerians and created the prosperity of ancient Babylonian Kingdoms.

The Indus River basin is one of the birthplaces of ancient civilizations. As early as in 3000 BC, there had appeared very developed agriculture, commerce and handicraft; and it entered into Bronze Age earlier than Mesopotamia and Egypt.

Indus River originates from the Shiquanhe River (Sengecangbu) in the north Gandise Mountains in Tibetan Autonomous Region of the People's Republic of China. It traverses from southeast to northwest through Kashmir, turns to southwest, runs through Pakistan, and near Karachi flows into the Arabian Sea. Its upper left tributaries are in India, such as Jhelum River, Chenab River, the Sutlej River, and small proportions are in Chinese territory such as Shiquanhe River, Xiangquanhe River (Lanqincangbu), Gaerzangbu (River). The tributaries on the upper right side rise from Afghanistan, such

as the Kabul River and the Gowmal River (see Figure 1-3). The Indus River basin covers an area of 1.034 million km^2 , with a length of main stream of 2,900 km, mean annual runoff of 207 billion m^3 , annual sediment transport of 540 ~ 630 million tons, and average sediment content of 3 kg/m^3 ^[2].

The topographic, climatic and hydrological conditions supported the birth and the development of the Indus civilization. Looking from the perspective of topographic conditions of the Indus River, the upper

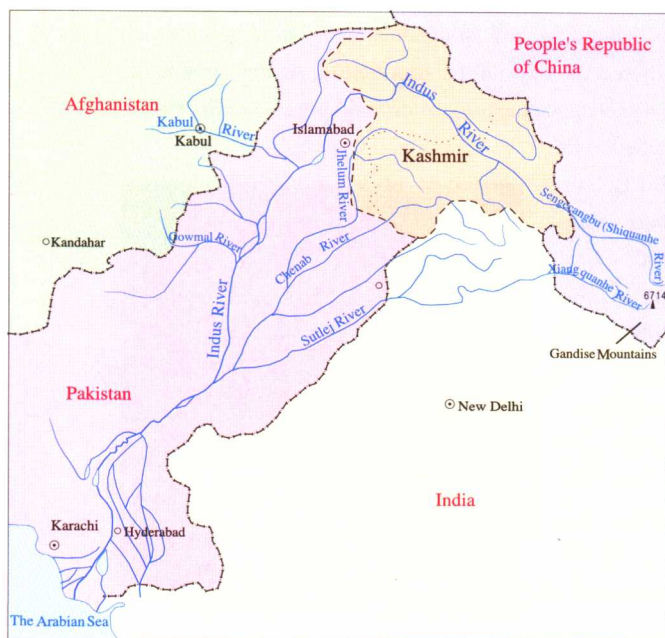


Figure e1-3 Sketch map of the Indus River basin

reaches of the mainstream and the upper reaches of the tributaries on the left are all located in high mountain areas with deep valleys and huge elevation drop, while its lower reaches of the mainstream and estuarine areas are in the Indus Plain — one of the largest alluvial plains in the world, which extends from the southern Himalayan all the way down to the Arabian Sea, and covers an area of 266,000 km² with very fertile land. The average width of the plain from the west to the east is 320 km, while the widest is 560 km and the narrowest is 161 km. In the upper Indus Plain in particular (where the mainstream and tributaries join together), there are vast interfluvies, which are generally 5 ~ 20m higher than the riverbed. The sediment brought down by floods often accumulated into new alluviums and beaches. As this region is not like the low-lying Indus Plain which is often flooded, the upper Indus Plain is therefore suitable for human residing and agriculture production. Looking from the angle of climatic and hydrological conditions, the Indus River basin belongs to subtropical weather, with distinct features of monsoon climate. But due to the influence of the Himalaya in the northeast, the climate is often between arid and semi-arid, or between tropical and subtropical weather. Except from July to September (90% of the rainfall of the year are in this period), there is little rainfall in other months, while the evaporation is strong and the mean annual rainfall is only 300mm. In upper Indus River the snow replenishes the water, thus making the runoff stable all the year around, and providing satisfactory condition of agricultural irrigation. According to research, as early as in 3000 BC, water diversion for irrigation had been developed in the narrow areas along the Indus River.

The Indus civilization, or sometimes called the South Asian Subcontinent Civilization of the Bronze Age, originated in 2500 BC. Taking advantage of silt and fertilizer brought down by the river flood, people there grew many crops such as barley, wheat, corn, muskmelon, rice, and flax. This region is also the earliest region where human grew cotton. At the same time people here domesticated water buffalo, goat, sheep, pig, dog, elephant, camel and donkey, created the binary system and decimal system in mathematics. During that period (around 2000 BC) there were two largest cities in upper Indus Plain in the world. One is Mohenjo-Daro located at Larkana of Sind



Relics of the sewer of the residence in ancient Mohenjo-Daro