Hydrology in ancient time in China

Hydrologie dans l’ancien temps de la Chine

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Abstract
Some selected aspects of hydrology in ancient times of China are presented in this paper, including hydrologic observation, hydro-geographic survey, hydrologic cycle and applications of hydrologic knowledge. Some important events and conceptions of hydrology which first appeared in ancient China are particularly mentioned here.

Key words: Hydrology, History, Ancient, China.

Résumé

Dans cet article, ont été également donnés de nombreux exemples concernant la pratique des informations hydrologiques et celle des connaissances hydrologiques dans l’ancien temps de la Chine, sur les impôts, l’irrigation, la prévention des inondations, etc.

Mots-clés : Hydrologie, Ancien, Chine.

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1. Introduction

China is a country with more than five thousand years of civilization history and great contributions to ancient hydrology. Some selected aspects are presented in this paper, which include the methods and techniques used in the fields of hydrologic observation, hydro-geography, hydrologic cycle and the applied hydrology in the ancient time of China. The following important events and conceptions which first appeared in ancient China are particularly mentioned, i.e. the water level observation started in 251 BC, the float
measurement of flow velocity and discharge calculation started in AD 1078, the precipitation gauge started in AD 1247 and the measurement of river sediments using sediment sampler started in the same period, the river classification and the physical regional divisions developed in the VII\textsuperscript{th} Century BC and the IV\textsuperscript{th} Century BC respectively, a famous hydro-geography book entitled \textit{Sang Hai Jing} published in AD 527, which is a collection of geographic features of one thousand two hundred fifty two rivers, a clear and precise conception of hydrologic cycle about mainland of China formulated and expounded in 239 BC. Besides a number of examples are given in this paper on the application of hydrologic knowledge and information to irrigation, flood prevention, tax revenue and so on.

2. Hydrology observation

2.1. Water Level Observation

Three statues of stone-man with 2.9 m tall and the graduations from foot up-to shoulder were found at the canal head of Dujiang Weir Project, a famous irrigation project constructed in 211-207 BC (Fig. 1).

![Fig. 1](image-url) Statue of stone-man as a depth gauge unearthed at Dujiang Weir Project in 1974

According to the archaeology and the historical records, the stone-men were used as a depth gauge indicating the water level of canal head and by which
the inflow discharge at canal head can be determined, it is regarded as the earliest water level observation in ancient China.

Some stone-tablet with graduations and world explanations were found by archaeologist at Chi San Lake in 1919 and 1964. The textual criticism shows that the stone-tablet was called Shui Ze Bei (water level tablet) which was used as depth gauge indicating variation of water level of the lake during the period of AD 238-250 (Yao Hanyuan, 1987). Since about AD 581 - 618 the stone-tablet has been replaced by wood tablet. The wood tablet was divided into seven equal portions with 0.25 m interval, and the level of each portion indicated the inundated farmlands and farmhouses (Fig. 2). Since AD 1035 the wood tablet as the depth gauge has been widely applied in the whole country (Wang Jingsheng, 1997).

![Fig. 2 Stone-tablet as a depth gauge](image)

A very important characteristic of the water level record in ancient China is that the residents along rivers were concerned about the water level variation particularly during the big floods and serious low flow periods. The residents marked vestiges and records of highest and lowest water levels on cliffs along rocky coast or important and age-old buildings such as temples and city walls.
Making full use of the abundant historic records of high and low water in China has facilitated the planning and management in water sector (Fig. 3 and Fig. 4).

Fig. 3  The vestiges and records of 1870 flood marked on the wall of the Prince Temple in Si Chuan Province, which is the biggest flood of Yangtze River and has been taken as design flood of the Three Gorges

Fig. 4  Stone-fishes carved on the stone ridge of riverbed at the Fu Ling river reach of Yangtze River in A. D. 764, during lowest water level the stone-fishes appeared from water as a mark of low water level
2.2. Discharge Measurement

Fan Ziyuan, an official in North-Son dynasty (AD 960-1127) developed the conception and technical term of discharge, in AD 1078 for description and comparison of water quantities of different rivers. At the same period float method measuring the flow velocity was initiated on Yellow River and Yun Ding River. The measurement of float velocity was taken with the aid of a running horse who runs after the float, because field counter timer in that period was not available while the velocity of the running horse could be roughly estimated.

2.3. Precipitation Observation

Rough but quantitative records of rainfall were found in ancient documents, for example, the rainfall amount was divided into four ranks in XI\textsuperscript{th} century BC and more detailed division of seven ranks were found during the period of 770 BC - 211 BC. The earliest precipitation gauge was a tank with different shapes, which appeared in AD 1247, but till AD 1724 the cylinder, as unified precipitation gauge was used and regular daily observation was put into practice over the whole country.

2.4. Sediment Observation

Historic records of river sediment appeared in many books and documents in ancient times, such as the book entitled \textit{Han Shu - Gou Xiu Zhi (Survey of Rivers in English)} written by Ban Gu (died in AD 92) it tells, “Zhang Ren, an official of Yellow River Commission during AD 9 - 22, measured and pointed out that there are about sixty per cent of sediments in water of Yellow River during the flood period” that is to say that the conception of sediment content of river flow was developed during AD 9-22 (Ban Gu, AD 92).

The regular sediment measurement started in Ming dynasty (AD 1369-1643). A kind of sediment catcher named Weigh Sediment and Measure Water Gauge invented by Liu Tianhe, an official of Ming dynasty (died in 1545 AD). He initiated the application of Weigh Sediment and Measure Water Gauge with unified shape and size for sediment measurement along Yellow River (Wang Jingsheng, 1997).

3. Hydro-geographic survey

In VII\textsuperscript{th} Century BC, Guan Zong, a famous philosopher in ancient China, divided rivers into three classes, i.e. Main River which flows directly into the sea; Branch River which flows into Main Rivers; Intermittent River, whose flow is not permanent in dry seasons such as the rivers in arid region of China.

In 551-479 BC, Confucius, a great philosopher of ancient China, who divided the territory of China into nine parts with different geographic characteristics and described mountains, rivers, lakes, low lands, soil, plants and
their respective local agriculture products of each part. It was the first time of geographic classification in China.

There are many hydro-geography books in ancient China and the *Shui Jing Zhu* (entitled in English, *Notes on Water Classic*) is the well know publication written by Li Dao Yuan, a famous physiographer (died in AD 527). This book described in detail the general situation and feature of one thousand two hundred fifty two rivers scattered over vast area from Mongolia to Cambodia and from East China to Iran and India. The book was a monumental work in the field of hydro-geography in ancient China either in aspects of systematic and totality or in aspect of science (Li Daoyuan, AD 527).

Another brilliant one is entitled *Xu Xiake You Ji* (entitled in English, *Travels of Xu Xiake*) written by Xu Xiake (AD 1586-1641). The author was a famous traveler in ancient China who traveled almost the whole country in his life and made huge amount of investigation on rivers, mountains, lakes, terrain, cataracts, springs, and plants. He recorded every thing he observed and investigated in detail and then compiled all the information as a great collection. He is the first one who discovered and identified the head of Yangtze River, as well as the Karst landforms and Kast hydrology in Southwest China. He was a great contributor in the field of hydro-geography (Xu Xiake, AD 1586-1641).

4. Exploration on hydrologic cycle

The earliest records of observation, conception and inference on the phenomenon of hydrologic cycle appeared in an ancient book entitled *Huang Di Ne Jing* (*Huang Emperor’s Questions And Answer For Nature* in English) written in 400 BC it says, “vapor rising from ground surface and becoming clouds, clouds falling from sky and becoming rainfall, rain is originated from vapor” (Qi Bo, 400 BC).

Another famous book with title of *Lü Shi Chung Qiu* (entitled in English: *Master Lü’ Spring and Autumn Annals*) written in 293 BC, which says “Cloud and water vapor flow westward in all seasons, streams flow eastward day and night, because the atmosphere is the inexhaustible sources of water and the ground can never be filled with water. Water flow concentrates from small rills into large stream and evaporation from land water and becomes vapor. So this is called the water cycle”. This gave a clear conception of hydrologic cycle on mainland of China early in 239 BC which is still valid today (Lü Buwei, 293 BC).

5. Application of hydrologic knowledge

There are many examples applying hydrologic knowledge in ancient China that deal with irrigation, flood protection, tax and other matters. Early in the third century BC, the designer and leader of Dujiang Weir Project controlled inflow discharge of canal head according to different water level indicated by
different submerged part of stone-man body. For example he controlled inflow discharge of canal head equals to 40 % of main river discharge in flood period but 60 % in dry season for making yearly water balance in irrigated area. The example shows that in ancient China the designer of this project had quiet good knowledge on the relationship between water level and flow discharge (Wang Jingshang, 1997).

After Qin Dynasty (221 BC - 207 BC) it was mandated that every county must report rainfall amount to central government monthly, and the tax was levied according to precipitation amount.

Some records on wet and drought prediction, flood warning were found from Jia Gu Wen, a kind of pictograph in Sang Dynasty (xvii BC - xi BC)

The earliest flood forecasting and flood warning has started since Zhou Dynasty (770 BC - 256 BC). According to the records of an important book titled Zi shui Quan Di (entitled in English, Water Harnessing Methods) published in AD 1573, many post stations to pass on flood information were set up along middle and low streams of Yellow River and Tong Guan was the first station at middle stream and Su Qiang was the last station at outlet of Yellow River. When flood occurred at any station of middle stream the special horseman ran forward to down stream with fast speed to bring the flood information to stations at lower stream, since the speed of horseman was faster than that of the flood movement so that people at down stream station can be informed before the time of flood arrive so as to facilitate them to take emergency measures to reduce flood disaster (Wang Gong, AD 1573).

6. Conclusions

(1) There are great contributions to hydrology in ancient China either in hydrologic observation and hydro-geographic survey or in hydrologic cycle and the application of hydrologic knowledge.

(2) The great achievements in hydrology in ancient times of China were related to the fact that the economy was booming and the science and technology was well developed in ancient times of China.

(3) Making coordinated relationship between humanity and water is the basic purpose and eternal subject, the needs of the development of society is the basic and eternal motive power to develop hydrology.

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