

## **The remarkable hydrological works of the Aztec civilization**

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**ABSTRACT** The Aztec civilization has been described as one of the most remarkable cultures in the world, not only because of its material achievements, but also because of its rapid evolution from a tribe of nomads to a highly sophisticated society which was able to produce beautiful pieces of poetry as well as complex urban developments. The Aztecs surrounded, in the beginning, by enemies, built a city in the middle of a lake. Among the remarkable pieces of engineering produced by the Aztec culture, are their hydrological works. The Aztecs were able to build magnificent aqueducts as well as flood control works and they were responsible for the development of a unique hydroponic form of irrigation: the chinampas. This paper describes their main hydrological works of the Aztec's, and their most important water gods are considered and their relation to the culture explained.

*Les ouvrages remarquables hydrologiques de la civilisation aztèque*

**RESUME** La civilisation aztèque a été décrite comme une des cultures les plus remarquables du monde, non seulement à cause de ses réalisations matérielles mais aussi en raison de son évolution rapide d'une tribu de nomades à une société fort sophistiquée qui a su produire de beaux morceaux de poésie aussi bien que des développements urbains complexes, et qui a construit une cité au milieu d'un lac, bien que les Aztèques aient été entourés d'ennemis au début. Parmi les chefs d'oeuvre de construction remarquables qu' a produits la culture aztèque, on doit admirer leurs constructions hydrauliques. Les Aztèques ont été à même de construire de magnifiques aqueducs aussi bien que les ouvrages pour la protection contre les crues et c'est à eux qu'on doit attribuer le développement d'une forme d'irrigation hydroponique particulière: celle des chinampas. Cette communication décrit leurs ouvrages hydrologiques principaux, considère les dieux de l'eau aztèques les plus importants, et explique leur rapport avec la culture même.

### **INTRODUCTION**

"As long as the world exists, the glory and honour of Mexico-Tenochtitlan will never be forgotten". With these words from Chimalpahin-Quauhtlehuanitzin, the greatness of the main city of the

the Aztec empire is well described.

Among the so-called "hydraulic" cultures (Biswas, 1970), there is one that was not considered, the one most related to water, given the fact that it was born in water, lived and flourished in water and died in water.

The Aztec people spent an Aztec century (52 years) searching for the place the prophecies had pointed out to be the site where they must found their empire and develop their culture (Tibon, 1986). Similar to the Jews, they suffered an exodus from Aztlan, where they were slaves and had no land and no future, and headed to the promised land: Mexico-Tenochtitlan, the Moon's navel.

In their journey to the promised land, the Aztecs left evidence of their abilities as hydraulic engineers and hydrologists, like the artificial lake that they built in Coatepec, near to Tula, where they tried to reproduce the habitat they were seeking. Unfortunately, their priests destroyed this piece of engineering in order to force the Aztecs to keep searching for the promised land.

Once they finally reached the chosen place, their culture had a rapid evolution, in about 300 years, and they changed from a tribe of nomads to a one of the most surprising cultures of Mesoamerica, and probably of the whole world.

Living in a place surrounded by water and enemies, they had to deal with the two facets of the hydrological cycle: floods and droughts. Maybe this fact contributed to the development of their abilities as hydraulic and hydrology engineers, because they started to build their hydrological works just 100 years after the beginning of the construction of Mexico-Tenochtitlan, the capital city of the Aztec Empire.

## GEOGRAPHIC SETTING

The Valley of Mexico is 8000 km<sup>2</sup> in area (Bribiesca-Castrejon, 1960), its limits being latitude 20°09'12" in the south 19°01'18" in the north, the meridian 98°31'58" in the east and longitude 99°30'52" in the west. The closed basin is well defined by several topographic barriers. It is interesting to note that the natural outlet of the basin was located in the south in the direction of Cuautla, but a tectonic disturbance caused by the raising of the mountain range of the Ajusco, closed the outlet and made the valley a closed basin favouring the growth of a lake that has been extensively modified throughout the years (Fig.1).

The set of lakes that formed the hydraulic area, were the Lake of Mexico in the middle, and a lower lake, the lake of Saint Christopher or Ecatepec, located to the north. The northern lakes of Xaltocan, Zumpango and Citlaltepctl were high level lakes. In the south were the highest lakes of the valley, the Chalco and Xochimilco, which in former times consisted of one lake. To the east, was the Lake of Texcoco, which was the lowest and the largest lake of the valley. Table 1 shows the relative elevations of the lakes with respect to the Lake of Texcoco. During intense rainy seasons, they combined to form one lake with an area of 2000 km<sup>2</sup>.

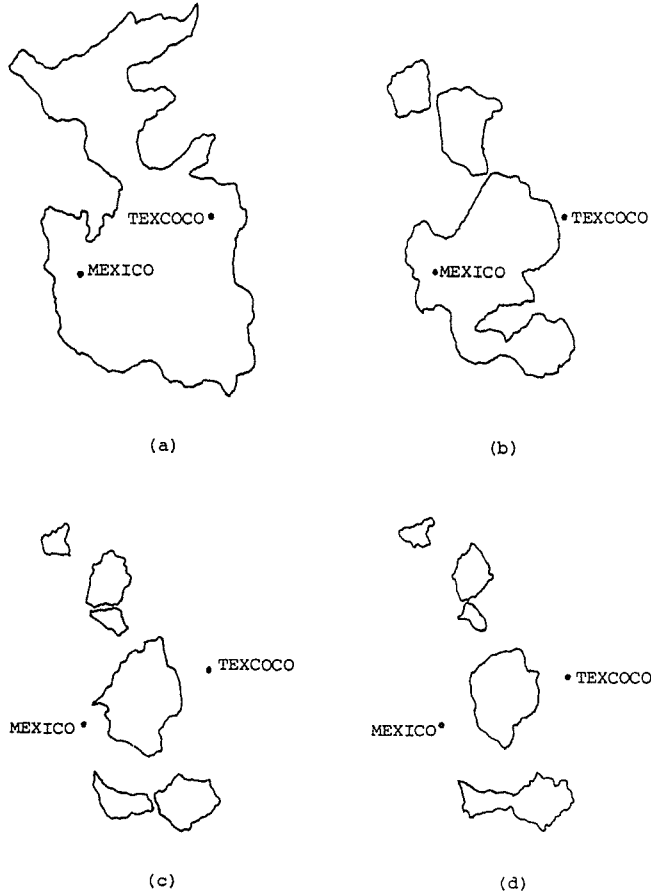


FIG.1 The evolution of the lakes of the Valley of Mexico. (a) deluge era, (b) beginning of the sixteenth century, (c) beginning of the nineteenth century, (d) 1889 AD.

TABLE 1 Relative elevations of the lakes of the Valley of Mexico with respect to the elevation of the Lake of Texcoco

Name of the lake	Elevation (varas)
Zumpango	6 with 62 thousandths
Xaltocan	3 " 474 " "
Saint Christopher	3 " 597 " "
Mexico	1 " 907 " "
Xochimilco	3 " 119 " "
Chalco	3 " 82 " "
Texcoco	0

1 vara = 0.838 m

## HYDROMYTHOLOGY

As coined and defined by Back (1978, 1981), "hydromythology is a study of hydrologically inspired folklore, myths, or legends that can be used to deduce beliefs of early people concerning water".

The Aztec theology is very rich in what water gods were concerned. Here, only two of the most important water gods will be described: Tlaloc and Chalchihuitlicue.

Tlaloc, the main water god, was the god of rain and lightning as well as of floods and droughts. This god was probably the ancient and most famous water god of Mesoamerica, because the people of Teotihuacan (200 BC-600 AD) venerated this god and they were the first settlers in the Valley of Mexico.

Tlaloc lived in the Tlalocan, located on the crest of the hills that were rich in all foods. That place was also the home of a maize goddess, child servants and dwarfs, called tlaloques (Back, 1981). Tlaloc possessed four jars from which he poured the rain upon the earth. One of the jars contained good water that caused maize and fruits to flourish. The second one, brought cobwebs and blight. The water of the third jar developed into a frost and killed the plants and the fourth jar contained water that was followed by droughts and lack of crops. The waters of the jars are related with the cardinal directions and only the one from the east was good. When the dwarfs or tlaloques smash their jars with a stick, there is thunder and the pieces cast below are thunderbolts. The Aztecs had ceremonies for Tlaloc, which included sacrifices of figurines, jewellery or selected human victims.

Chalchihuitlicue was the flowing waters goddess and was represented by a jade skirt; she was the sister and probably the consort of Tlaloc. This goddess was very popular and feared among the Aztecs, and many houses of Mexico-Tenochtitlan had a special place for her where they offered presents to appease her during her temperamental outbursts. Snakes and maize were associated with her, and she was also a cleanser (Back, 1981).

## AZTEC MAJOR HYDROLOGICAL WORKS

Only two classes of hydrological works will be considered here: aqueducts for water supply and flood control structures.

*Aqueducts*

The first aqueduct of the Aztec empire was that of Chapultepec, also named "the great aqueduct". The aqueduct started to be built when the tlatoani, some sort of ruler, was Chimalpopoca and it was reconstructed and improved under the ruling of Moctezuma Ilhuicamina. It consisted of a twin pipe distribution system made in part of compacted soil and in part of wood for the crossings of the aqueduct over the bridges built to allow the passage of the canoes. It was finished around 1466 AD, and the main purpose was to supply fresh water to Mexico-Tenochtitlan, to mitigate its thirst.

The main source for the aqueduct was the spring of Chapultepec and the purpose of the twin pipes was to ease the maintenance of the

system, because the water was conveyed through one pipe, and when it got dirty, the water was diverted to the other pipe while the dirty pipe was cleaned and, if necessary, repaired (Palerm, 1973).

The director of the construction of the Chapultepec aqueduct was the famous Texcocan engineer Netzahualcoyotl, and as it will be shown later, this remarkable engineer and celebrated poet, participated in several engineering works in the Valley of Mexico.

The building materials for the construction of the aqueduct, wood, stone and lime, were obtained from the Tepanecs, a tribe settled along the lake shore. The bargain between Aztecs and Tepanecs ended with the murder of Chimalpopoca, the lord of the Aztecs.

Another important aqueduct was that of Acuecuexcatl, which was marked with a dark fate. Due to the growing water needs of the flourishing Mexico-Tenochtitlan society, the Aztecs considered how to obtain the waters of the Acuecuexcatl spring, located in the neighbouring kingdom of Coyoacan, in the south of the valley. The king of Coyoacan, Tzotzoma, warned the Aztecs who came to see him to obtain his permission to use the waters of the spring, about the marked irregularities on the spring flow. When the Aztecs told Ahuizotl, the ruler at that time, about the objections of Tzotzoma to his project, he got very angry and made war on Coyoacan and finally hanged Tzotzoma.

Once Ahuizotl eliminated the last obstacle to his project, he started work on the aqueduct of Acuecuexcatl and finished it about 1500 AD. But to his surprise, when the water started to flow through the aqueduct, it came in large uncontrollable quantities, as had been predicted by Tzotzoma, causing a devastating flood in Mexico-Tenochtitlan. Ahuizotl sent for Netzahualpilli, king of Texcoco and son of Netzahualcoyotl, in order to get his help to stop the flooding of the city. Netzahualpilli used divers to cut down the flow from the spring of Acuecuexcatl. As usual in Aztec history, the end of this chapter was the tragic death of Ahuizotl, who died from injuries to his head produced by a fall that he suffered during the flood.

#### *Flood control works*

Flood control works were started early in the history of the Aztec empire, given the need that they had to protect lives and goods against excess of water. In spite of the original purpose that they served, roads played an important role as structural measures for flood control.

The first road that the Aztecs built was the Tacuba road, which was the first link with firm land. It was constructed under the ruling of Chimalpopoca, around 1418 AD (Fig.2). Later the Tlaltelolco-Atzacapotzalco road was built under the rule of Itzcoatl, the successor of Chimalpopoca. The connection with the conquered lands of the south was made by the construction of the Coyoacan-Xochimilco road (Fig.2). With these three roads, the fresh waters of the west and southwest parts of the valley were confined and fishing was improved.

Everything seemed to be running smoothly in the Aztec Empire up to 1449 AD, when a very wet rainy season produced a large flood in



FIG.2 Major flood control works at Mexico-Tenochtitlan. (1) Tlatelolco-Atzacapotzalco road, (2) Tacuba road, (3) Coyoacan-Xochimilco road, (4) Mexicalzingo road, (5) Cuitlahuac road, (6) Netzahualcoyotl's dike, (7) Tepeyac road.

the capital city of the Empire. Water rose to a depth of about 2 m, flooding all the places where the Aztec people could normally walk. Moctezuma Ilhuicamina, the ruler at that time, sought the help of his cousin the king of Texcoco, Netzahualcoyotl, who immediately began hydrological works that would protect Mexico-Tenochtitlan from the floods coming from the surrounding lakes. He proposed to Moctezuma the construction of the most important flood control work of the Aztec culture: the Netzahualcoyotl's dike or dike of the indians (Fig.2). The dike was 16 km long and 20 m wide. Netzahualcoyotl's dike from the hydrological point of view, as was pointed out by Raynal-Villasenor (1986), is a typical flood control structural measure, in purpose and in conception. This is contrary to the arguments of some historians who see this dike as a water quality structural measure. The dike was completed with the construction of the Cuitlahuac road, which divided the waters of the lakes of Chalco and Xochimilco, and with the construction of the Mexicalzingo road, which divided the waters of the lakes of Mexico and Xochimilco, (Fig.2).

Those hydrological works had gates to control the flow of water from the lakes and to allow canoes to pass. During the ruling of Moctezuma, the Tepeyac road was also built: it had the double purpose of containing the waters coming from the northern lakes and to open the access to the lands in the north of the valley (Fig.2). Fig.2). This set of hydrological works was the first comprehensive flood control project of Mesoamerica.

## CONCLUSIONS

There is no doubt that the Aztec culture reached a degree of development in hydraulic and hydrological engineering that can be described as excellent

A valuable lesson that the Aztecs gave us is that of integration in the environment: no matter how hostile their environment, they developed their culture in complete harmony with the existing natural conditions, keeping always the subtle equilibrium of the environmental conditions of the valley.

Probably no other culture of the world has been marked so firmly with the sign of water as has the Aztec culture.

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