Systemic Analysis of the Problem Situation of the Hydraulic Service of Mexico City

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Abstract

Practically, since its foundation, Mexico City has had serious problems with the supply of water for its residents, problems such as the lack of near and abundant sources of water and the lack of a culture of water.

In this work the problem of the water supply to Mexico City is treated from a holistic perspective by identifying and analyzing the most meaningful problems, those which greatly impact the quality of the water service.

Firstly, some of the main characteristics of the hydraulic system are presented, so that anyone might have an idea of the origins of the current problems and the difficulty of arriving at real solutions.

Then, the most relevant problems are identified and classified into two categories, the first category includes the most outstanding problems. Later the first category problems are described in order to carry out an analysis of them. Some alternatives of solution are suggested for these problems.

Key words: hydraulic system, Mexico City

Introduction

Mexico City and its metropolitan area are seated in the valley of the same name, located at about 2300 m above sea level. It doesn't have natural outlets to drain water that comes from pluvial precipitation and/or that already used by the population, nor does it have a deep and permanent river that provides of enough water for its inhabitants. The pluvial precipitation on this region is abundant for the months of June, July, August and September and scarce for the remaining months.

The population of this area are ruled by two independent political entities: there are approximately 20.2 million permanently settled people (CONGUA, 2005 c) and a floating population of about 1 million. This population continually grows at a rate of 2%, basically due to immigration.

The sources of water supply for all services are the aquifers of the same valley, some springs which are fed by not very deep underground glides, the basin of the valley of Lerma and the basin of Cutzamala, both in the state of Mexico.

Historically the operation of the hydraulic service for the biggest and most important city of the nation has been plagued with many difficulties and, unfortunately, it is not possible to visualize the end for those anomalies. Two examples are given: first, in the beginning the lack of natural outlets for draining the periodical rainfalls caused several light and severe floods. Second, more potable water sources were required when the population grew and waters production from the available sources diminished.

The appearance of severe floods made necessary the construction of a deep cut for draining the valley and so the city would be safe, but a few years later, when the population expansion took place, this deep cut was not enough and tunnels and big aqueducts have had to be built.

For the first years of the city, the supply of water came from nearby springs through aqueducts. Many years later, the lack of enough supply for the increasing population impelled the water extractions from Mexico City's underground and from the basin of the Alto Lerma, Estado de Mexico.

In the beginning, the extraction from aquifers of the valley was carried out by observing the balance extraction-infiltration: but it didn't take too long to break such a balance, more water was pumped. This situation caused differential sinking of land, and consequently, malfunction of structures such as buildings, monuments, aqueducts and, underground facilities in general, as piping nets for water distribution or for drainage of used water. In last decades, it has had to import water, once more; this time from the basin of the Cutzamala river, State of Mexico, located approximately 150 Km away from Mexico City.

In this work, a number of problems that affect the functioning of the Mexico City's hydraulic service are identified, classified and then analyzed. General alternatives of solution for the most meaningful problems are suggested.

Problems that affect the system

From a list of more than 100, the most important problems observed in the operation of the hydraulic system of the Mexico City are shown in Table 1.

Description of problem areas

The simplified descriptions of the problem areas have the purpose to show the conflicting situation that is present in the operation of the system and one way or another affects the quality of the water service. In this way, the analysis of the problems is facilitated and some solution alternatives can be visualized for them and consequently, to alleviate the situation of the hydraulic system in its entirety.

PHYSICAL /HYDROLOGICAL CAUSES

Num	Area	Problem
1	Supply sources	Reduction of recharge areas
2	Supply sources	Over exploitation and differential sinking
3	Supply sources	Import of water from near basins
4	Distribution nets	Water leaks
5	Pluvial precipitation	Low pluvial storage
6	Treatment of residual water	Scarce volumes of treated water

SOCIO-POLITICAL CAUSES

7	Population	Faster growth of population and urban area
8	Politics	Faulty administration of the basin
9	Culture of water	Inadequate uses of water
10	Financial resources	Low tariff recovery

Table 1. Supply sources. Outstanding problem: Reduction of recharge areas

The exploitation of the aquifers of the valley is the main source of supply of water for the population of Mexico City and its metropolitan area, which has had an enormous growth, as much in population as in territory. The great amount of civil constructions, the limitation of green areas and the paving of most of the city streets have caused a severe reduction of recharge areas for the valley aquifers.

Supply sources. Outstanding problems: over exploitation and differential sinking

For the last decades, the underground mantels are being over exploited. This is due, on one hand, to the growing demand and, on the other hand, to the more and more accented lack of recharge areas. Also, given the prevalent environmental conditions, the aquifer mantels are more vulnerable to the contamination. The over exploitation, given the characteristics of the land, has had as a serious consequence, differential sinking in several areas of the city, affecting constructions and underground facilities. In future, it will be recommended to explore extraction of water from the deep aquifer which theoretically will not affect the superficial ground and its differential sinking. (Santoyo et al , 2005)

Supply sources. Outstanding problem: Import of water from near basins

Approximately, the 70 % of the water for the supply to Mexico city comes from the underground of the valley of Mexico (SACM, 1990 – 2006), a great portion of the rest is imported from the basins of High Lerma and Cutzamala, both of the Estado de Mexico. This importation of water causes serious difficulties as high operating costs, social conflicts and, in the case of the Cutzamala source, high electric energy consumptions. As example of the generated conflicts, there is a legal controversy between Estado of Mexico Vs Distrito Federal (D.F.) related with the exploitation of the aquifer of the Alto Lerma (CONAGUA, 2005c Chap. 2).

Distribution nets. Outstanding problem: Water leaks

The water leaks of the whole supply system, including all of its components from the sources up to the small residential nets, they are approximately 30 % of the total volume that enters into the system for its distribution, (SACM, 1990 – 2006). This means a volume of losses of 10.5 m3/s, which would be good for a population of approximately million and half of inhabitants. The causes of these losses of water are very varied, but the most important are in the deterioration of the distribution nets, during its lifetime.

Pluvial precipitation. Outstanding problem: Low pluvial storage

Generally, the pluvial precipitation in the rainy season is presented quite abundant in a short period of time, (DGCOH, 1982). As consequence, for its abundance it has to be evacuated with readiness to avoid floods in downtown, and due to its little duration, it is not possible to store it to be used in the recharge of the aquifer or for an eventual direct use. It is allowed to be slippery outside of the valley.

Treatment of residual water. Outstanding problem: Scarce volumes of treated water

The reuse of the served water, previously treated, is of approximately 24% (8.3 m3/s) of the total volume of water that enters into the system, it is very low in comparison with treated volumes in other towns of the world. Several reasons exist for which this volume of treated residual water is too low. (SACM, 1990 – 2006).

Population. Outstanding problem: Faster growth of population and urban area

Obviously, the growth of population and territory are directly connected with the water demand. Since both population and territory of Mexico City are in continuously growing, the demand of water, drinkable and not drinkable, it is also growing in the same proportion. Unfortunately, the volumes of water, economically available, don't grow the same rate.

Politics. Outstanding problem: Faulty administration of the basin

The basin of the valley of Mexico, which serves as a main source to supply water to Mexico City, it is shared by three political entities (Distrito Federal, Estado de Mexico and state of Hidalgo). This situation causes serious conflicts among those entities, which avoid an integral administration of the basin and an efficient use of the hydraulic resources of the valley. Other important irregularities caused by this situation are: the lack of a reliable census of the real number of users, the total extracted water, among others.

Culture of water. Outstanding problem: Inadequate uses of water

In general terms, the population doesn't have enough care with the supplied water, and this way, the water is used to wash street sides, walls, cars, etc. Most of the time slight leaks are not repaired and the faucets are not completely closed, etc. In addition, water consumers make important water wastes (CONAGUA 2005c, Chap. 3).

Financial matters. Outstanding problem: Low tariff recovery

Many of the problems previously mentioned require much capital to reach important solutions, as for example, elimination of a biggest portion of water leaks of the whole System. The lack of enough financial resources is caused by the scarce recovery due to low tariffs and high subsidy. This poor financial situation has avoided carrying out new works, introducing improvements, realizing regular preventive/predictive maintenance, equipment replacement, etc.

Systemic Analysis of the Problem Situation

Five possible proposals of solution are perceived, from various studies carried out, to alleviate the problem situation of Mexico City and its metropolitan area. These five proposals are:

1. Change of residence, partially or totally, of the federal government, or the industrial sector, or a combination of both, to another state of the Republic.
2. Increase storage of rainwater. At the present time, only one fifth of the rainwater is stored. (DGCOH, 1982).
3. Increase the use of treated water in all activities that can use it. Of course, it is necessary to build several modern treatment plants and to separate sewage water from rainwater.
4. Realization of necessary works to minimize water leaks. Also, increase the number of crews equipped with appropriated technology to eliminate leaks.
5. Strict surveillance on the use of water, so that wastes and improper uses of water be avoided. Permanent campaigns of consciousness should be carried out concerning the care of water.

The first two points must carry out for a single time, while the rest should be carried out permanently during the lifetime of system, provided that the current conditions are maintained.

These five points are necessary to improving the quality of the current hydraulic service and making it sustentable for the future generations.

The setting in practice the first of the outlined points (solutions), the change residence to selected places, should be made step by step up to the hydraulic balance input – output is reached.

An excellent solution to have more potable water would be to store big volumes of rainwater, to be used later. This would mean the construction of two conducts, one for draining wastewater and the other for rainwater. In this way, rainwater would not be contaminated and it could be stored and conveniently treated.

The treatment of the residual water, i.e., the purification and partial or total innocuousness of the water should be made permanently in order to avoid pollution to the environment and, consequently, damage to human health and health of other living beings.

In what refers to water leaks, it is clear these should be controlled and corrected with great opportunity and effectiveness. To reach this purpose, it is required to use modern techniques for detection of water leaks in pipes without having to destroy the pipe.

The last suggested point, it has to do with the culture of the use of water and, also, it constitutes a permanent activity for each citizen and each authority. This culture should begin in the schools and to be continued with adults.

Conclusions

The supply of water is fundamental for the life of all community and especially in the big concentrations. The city of Mexico is supplied in two ways: from its own aquifer and from foreign aquifers, being this last resource necessary, because the capacity of its own aquifer is not enough to satisfy the needs. The importation of water, for obvious reasons, will bring severe social and economic consequences sooner or later.

However, one can affirm that the lack of water for the supply of the capital city owes more than anything to that it has not been possible to take advantage of the rain water that abundantly precipitates on the valley year after year. It is necessary to wait for a hydraulic and geological engineering solution.

Fortunately, the present responsible authorities of the service, and a part of the population, as well, have already perceived the gravity of the problem. Thus, they are taking consciousness of the possible solutions.

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