Water quality in semi-arid Brazilian reservoirs

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THE BASIC POPULATIONAL demand of having water in good quality and sufficient quantity is one of the major concerns of governmental authorities all over the world. In the particular case of countries situated totally or partially in arid or semi-arid zones the guarantee of an adequate water abstraction is severely damaged through the dominance of unfavourable climatic conditions. One of the most frequent solutions found to face the problem is the construction of artificial water reservoirs. In the Northeast part of Brazil, which is the main region where arid and semi-arid conditions are found, hundreds of reservoirs have been built in order to store water for human consumption and for irrigation purposes. The total volume of stored water is at present about 21 billion m^3. Most of these water bodies have small areas and volumes, generally under 1 km^2 and 10 million m^3, but some of them are very large reservoirs, as is the case of *Orós*, with an area of 350 km^2 and a volume of 2,1 km^3. It is estimated that a 10000 m^3 reservoir is able to provide water for 300 inhab./a or for the irrigation of about 1500 ha/a. Unfortunately the majority of these reservoirs (about 80 per cent) are not connected to distribution systems for human consumption.

Besides the obvious need of a sufficient *quantity* of water, there are serious concerns related to the water *quality* in these reservoirs. The main problems that may affect this quality are: **eutrophication** (bloom of aquatic plants, caused by the discharge of nutrients), **silting** (accumulation of inorganic material, such as silt, clay, sand) and **salinization** (elevation of the salt content in the water body when evaporation exceeds precipitation). The occurrence of these polluting processes causes a serious constraint in the utilization of water for irrigation and for human consumption.

Case study: Jequitinhonha Valley

The Jequitinhonha Valley, situated in the Northeast part of the State of Minas Gerais, is considered as one of the poorest regions in the whole country. Its is inhabited by a very low income population, with a dramatic lack of proteins in its daily diet. Due to the unfavourable climate, classified between arid and semi-arid, with mean yearly precipitations under 800 mm and mean temperatures ranging from 30 to 32^0 C, its population is subjected to severe problems related to the chronic lack of water. The groundwater flow, originated from a tertiary rock system, is not significant due to the small thickness of the saturated layer. The wells drilled in the region rarely present water flows over 25 m^3/h. There are consequently inherent difficulties in developing agricultural activities and in providing an adequate sanitation structure.

At the beginning of the 90's the local government initiated the construction of six *perennialization* reservoirs. They have been built in order to maintain a minimum water flow in the rivers situated downstream. These reservoirs were planned to act as multiple-use water bodies, which should also provide appropriate conditions for several utilizations: human supply, irrigation, fishery, navigation and leisure. The perennialization reservoirs were constructed in the region drained by the Jequitinhonha River, whose hydrological characteristics are influenced by the precipitation pattern of semi-arid regions. At the initial stretch of the river the mean specific flow reach values in the range of 8 to 10 l/s.km². At the middle course of Jequitinhonha River, where the reservoirs were built, the specific flow oscillates between 3 and 4 l/s.km². The main morphological and hydrological informations about the reservoirs are given below:

M. Mineiro:	21,3 km²,mean depth of 9,5 m, water residence time of 0,3 a
Salinas :	12,7 km²; 6,7 m ; 1,2 a
Bananal :	3,3 km² ; 7,6 m ; 1,2 a
Samambaia :	3,2 km² ; 8,0 m ; 1,2 a
Calhauzinho :	2,7 km² ; 11,9 m ; 1,1 a
Caraíbas :	1,3 km² ; 7,6 m ; 1,2 a

It is interesting to point out that these reservoirs, in spite of the variable surface areas, present approximately the same water residence time (with the exception of the first one). The mean residence time is a very important hydrological parameter for defining the trend of the water body in suffering from eutrophication processes (Vollenweider, 1976). Generally the reservoirs where the water flows quickly (i.e. with low residence periods) are less susceptible to become eutrophic.

The six perennialization reservoirs have been monitored at quarterly intervals. The staff of the Department of Sanitary and Environmental Engineering of the Federal University of Minas Gerais collaborates in the monitoring process and in the interpretation of the collected data. The results point out to a satisfactory water quality in all the reservoirs. Since they are situated outside urban areas, they don't receive the impact of the discharge of untreated waste waters. Nevertheless the phosphorus concentrations during the rainy period (October-April) is high (about 0,1 mg/l), indicating that its compounds are washed out from the easily erodible soil surface. In most of the cases, in the

Jequitinhonha reservoirs, the phosphorus is the limiting nutrient. This means that it is possible the onset of the eutrophication process due only to natural causes.

The thermal pattern of the reservoirs shows that they are generally stratified during most part of the year. The circulation occurs only during some weeks in the winter period (June-July). Consequently there is an intensive accumulation of sedimented organic matter, originated from soil and vegetation, in the deep waters of the reservoirs. Due to the decomposition process that takes place in the bottom layers, there is the generation of reduced compounds, such as hydrogen sulphide, which is well known by its very bad odour. Since the stratification period of the waters is very long, these compounds accumulate in the deep region of the reservoir. It is important to emphasize that the storage of reduced compounds in the bottom layers is related only to natural processes, independent from any human influence. At the time were the first deep water discharges took place, in order to provide a minimum water flow downstream the reservoirs, the sulphur compounds volatilized in contact with the atmosphere, generating, for some five or ten minutes, a very offensive, but harmless, smell. This fact was sufficient to disseminate among the local population the general idea of the existence of a *rotten water*. The lack of a previous information about the existence of these natural processes (stratification + accumulation of organic matter = temporary generation of bad odours), which are absolutely not related with pollution, led to a curious or even dramatic situation **: the population needs protein in its daily diet, but refuses to catch the fishes from the reservoirs since their water quality is *supposedly* not reliable.** This problem stresses the imperative necessity of the previous development of educational programs before the operation of this kind of reservoirs.

Conclusions

The main conclusions to be drawn from this paper are related with the management of water reservoirs situated in arid and semi-arid regions. Since they are very precious resources for the local population, the absence of a sound management can lead to the occurrence of severe problems, as related here in the case study of Jequitinhonha Valley. In a general approach the management of reservoirs should be based in two aspects : water quantity and water quality. While the **quantity** is nearly independent of man action, being more influenced by the natural climatic and hydrological factors, the **quality** in its turn is dependent on human activities. This means that the adoption of a multiple-use strategy is only feasible by taking into account the knowledge of the behaviour of water quality indicators. Moreover the information of these technical aspects to the affected population should be undertaken in a comprehensive way and in a periodic basis, avoiding the occurrence of misunderstandings and improper interpretations.

References

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