

The Water Supply of Varanasi — The Oldest City of India

M. Schalekamp, *Dr. sc. techn. h.c. ETH Zurich, Chalet 'Marco-Franco', CH-9651 Ennetbühl, Switzerland*

Abstract: During the first five years of the UNO Decade for drinking water 600 million people world-wide were newly connected to a water supply.

Of the newly industrialising countries, Western Asia receives best marks with reference to the situation of the water supply. India, for instance, today supplies 80% of the urban population and 47% of rural inhabitants with irreproachable water. As far as the realisation of the Decade is concerned, India stands at the very top of all the countries in the world. By the year 1995 it will have fulfilled the target of the Decade. The oldest city of India, Varanasi, with about 1 million people, has already reached the Decade target today. The municipality provides each of its inhabitants with 240 l of water per day. This is 90 l more than the acknowledged standard for India.

La distribution d'eau à Varanasi, la plus ancienne ville de l'Inde

Résumé: Au cours des cinq premières années de la Décennie de l'eau potable des Nations Unies, 600 millions de personnes dans le monde ont été reliées pour la première fois à un réseau de distribution d'eau.

Parmi les pays s'industrialisant depuis peu, l'Asie de l'Ouest a enregistré les plus grands progrès en matière de distribution d'eau. L'Inde, par exemple, dessert en une eau irréprochable 80% de la population urbaine et 47% des habitants ruraux. L'Inde arrive en tête de tous les pays du monde en ce qui concerne la réalisation des objectifs de la Décennie. En 1995, elle aura totalement atteint cet objectif. La plus ancienne ville de l'Inde, Varanasi, qui compte près d'un million d'habitants, a déjà atteint l'objectif de la Décennie. La municipalité fournit à chaque habitant 240 l d'eau par jour, soit 90 l de plus que le niveau reconnu de l'Inde.

General

The Indian Water Works Association (IWWA) held its 18th Annual Meeting from 13 to 16 February 1986 in Nagpur, India (Fig. 1). Within the frame of this event, the author was able to present, on behalf of the Swiss IWSA/IOA Committee, for the second time, a cheque for the amount of US\$ 2500 to the President of the IWWA, Mr B. V. Rotkar. This money serves to translate into their own language, print and distribute one of the IWSA-booklets, which, in easily understandable terms, informs the newly-industrialising countries about the technology of the water supply (Fig. 2). During this Annual Conference an entire day was devoted to the discussions of the aims of the UNO Decade. The treatment of projects for the emergency water supply as well as the problems of water supply to the industry was given much attention. Furthermore, the condition of the rural water supplies and their problematic nature was also thoroughly discussed. The niveau of this well-attended Conference was very high.

The present state of the water supply and waste water disposal in the newly-industrialising countries, is shown in Fig. 3. The countries of Western Asia supply 76% of their population with good water. This places them at the head of the countries in that area. In India 77% of the urban and 31% of the rural population were already supplied with healthy water by 1980. In 1983 this percentage had risen to 80% for the towns and 47% for the countryside. During the first five years of the Decade 600 million people, world-wide, were newly connected to a water supply. Half of them already living in 1980: the other half, again 300 million, have been added since. Of the 1.5 billion people, or 33% of the total world population which had no water supply whatever in 1980, there are today only 1.2 billion left who have no proper water supply.

Should the improvement of the last five years continue in the same way, the aim of the Decade, in the author's opinion, can be reached by the year 2010 (Fig. 4). A problem of the Decade, however, remains, in that not only the world population of 1980, namely 4.5 billion, will have to be supplied with irreproachable water, but also the expected population of 2010 which will then be about 6.3 billion. The aimed for target of the Decade, to make available to everyone impeccable water by 1990, will, unfortunately, not be realised except by only very few countries. As was already mentioned in a lecture given by

Mr M. K. Desai in Gabon in 1985 and clearly shown during the IWWA Conference, until quite recently India definitely expected to fulfill the aims of the Decade by 1990 (Fig. 5). In fact India is not very far from this target. It may thus be quite possible that it will reach the target by 1995, especially as it takes top place of all other countries in the world

A town which already today fulfills the aim of the Decade in India, is the City of Varanasi (Benares). The author was given the opportunity, subsequent to the Annual Conference, to visit the water supply facilities of this city. Only thanks to the assistance of Mr A. R. Doshi, Chairman of the IWSA Committee for the Co-Operation in Newly-Industrialising Countries and the support of Mr P. C. Kapoor, Managing Director of the monthly journal *Civic Affairs*, could this visit have taken place. Sincerest thanks to Mr S. P. Misra, General Manager of 'Varanasi Jal Sansthan', Water and Sewerage Corporation of Varanasi, as well as to all of its employees

The drinking water supply of Varanasi

According to Indian tradition, Varanasi is the oldest City of India and the Mecca of Hindus. For them, it is the most sacred of places on the Ganges. It is the wish of every Hindu once in his life to wash away his sins in the 'holy' Ganges water and, if at all possible, to be cremated there and his ashes strewn into this river (Figs. 6 and 7).

This town was already important for Western India in 600 BC, shown by the fact that Buddha, after his enlightenment in Bodhi Gaya, delivered his first sermon in Sarnath (Fig. 8). The most sacred spa of the Hindus is situated there, where, according to tradition, the 'Ten Horses Sacrifice' was carried out exactly in conformity with handed down rites by an intelligent Radjah at the behest of Shiva — ordered by Brahma. Very close by is the Temple of Vishwanath which was destroyed by Muslims. On its ruins the Gyan-Vapi Mosque was built. In the 18th Century the Temple of Vishwanath was rebuilt somewhat closer to the banks of the Ganges. Both, the mosque and the temple can be seen in Fig. 9. At sunrise the spectacle on the Ganges is very impressive (Figs. 10 and 11).

Up to 1892 the inhabitants along the Ganges took their water untreated from the river. The population living in the hinterland obtained their water from ground-water wells.

Then followed the gradual construction of the water supply.

It really is no small matter to supply a city like Varanasi with water. Figures 12 and 13 show in what multifarious ways the narrow streets and alleys are congested. It is easily understood that only during the night can work be carried out for the concerns of the water supply.

Varanasi is a city with a population of almost 800 000. Counting the suburbs there are roughly 1 000 000 people living in this area. Ninety per cent of the inhabitants are supplied by the Municipal Water Supply, the 'Water and Sewerage Corporation' which employs about 1200 people to take care that everybody receives healthy water. The other 10% of the population possess their own groundwater supplies with vertical filtering wells. The water is drawn by means of hand-operated pumps. Fifty per cent of the population receive their water from the 'Municipal Water Supply' by means of a pressure water supply directly to their homes. The rest have to obtain their water from hydrants. Of the total of about 47 000 domestic connections, 60% are equipped with water meters. Furthermore, there are about 9000 industrial connections whose water is, without exception, being measured. There is a total of 1380 supply hydrants. The total consumption of the city is at present 240 000 m³/day and should rise to 270 000 m³/day by the year 2000. The production of 240 000 m³/day barely covers the daily requirement. It is foreseen to produce, by the turn of the century, 320 000 m³/day (Fig. 14).

80 000 m³ of the daily requirement is taken directly from the River Ganges. The rest, about 160 000 m³ is groundwater which is drawn from 60 vertical filtering wells. The groundwater is pumped into 16 different, self-contained zones. Even though there is basically no need for any treatment of the water, chlorine is added for safety reasons. Each of the 16 zones can at any time be connected to another zone by opening of valves, should one or more groundwater pumping stations fail. The water of the Ganges is extracted at two points in the river and pumped to the treatment facility 2.5 km away (Fig. 15). For this purpose two intake towers were constructed, whereby one of them dates back to 1928. The latter has a capacity of 50 000 m³/day whereas the more recently constructed one has a capacity of 30 000 m³/day. Of late a provisional pumping station was constructed in the Ganges, having a capacity of 30 000 m³/day, in order to be able to renew still this year the older intake and increase its capacity to 70 000 m³/day.

Three large settling basins, each with a capacity of 10 000 m³, 5 m deep, are available for the water treatment. Depending on the time of year, 25–50 mg/l of aluminium sulphate are added. Flocculation takes place only during the rainy period from June to the end of October, because the Ganges then contains up to 3000 mg/l of turbidity instead of only 25 mg/l during the dry season. Half of the preliminary clarified water is filtered by means of 14 slow filters, each having an area of 2000

m². The filtering velocity is 1.7 m³/m²/day. The filters have to be cleaned every six weeks. Half of the water to be treated is subsequently passed through nine rapid filters of 80 m² each. Here the filtering velocity is 4 m³/m²/h. The cleaning of these filters is carried out every day, whereby the speed of the backwash water is 20 m³/m²/h.

At the end of the treatment process the water is mixed and chlorinated with 1.0–1.5 mg/l Cl₂. The groundwater as well as the treated Ganges water is hygienically irreproachable. By means of pumps and a ring main, the water is delivered into the network. This pipeline has mostly a diameter of 90 mm. A smaller part of it has one of 60 mm. The distribution pipes are made of PVC and the domestic connections consist of PE.

The standard for India, the provision of 150 l/day/inhabitant, is far surpassed in Varanasi where already today each inhabitant receives 240 l and it is expected that this will be raised to 270 l per capita by the year 2000. The author dares to assert, that no city in the world has as many problems with its water as has Varanasi. Alone 500 000 people per year come here to the Ganges bank to die and be cremated. Their ashes are strewn into the river (Fig. 16).

The drinking-water catchments for the water supply lie upstream outside the city limits. Varanasi is always being visited by many pilgrims. The sick too, come to this city in great numbers. They come to die. For these ill people almost 100 hospitals were built. However, contrary to former times, now one sees only 'healthy' individuals drink from and bathe in the Ganges. Not only is the Ganges water used for bathing, but also for washing clothes. To the author it is a mystery, that not many more people become ill, because the results of tests show that 100 cm³ water of the Ganges contains *innumerable* intestinal germs. The river has an oxygen content of 20–60%. According to experts, it exhibits no chemical pollution, but the bacteriological contamination is enormous. The Indian Government is aware of this problem and a rehabilitation programme for the Ganges is foreseen. Despite all these shortcomings, the Ganges water, compared with the Rhine at Dusseldorf, looks much better.

Concluding observations

India is a country which entirely provides for itself, be it with agricultural or industrial goods. Up to 1947 very much agricultural land lay untilled and the people went hungry. Today the country is for a great part cultivated. It is true that the people are poor, but they do not have to go hungry, i.e. there is sufficient food.

India, especially Varanasi, is a good example of how the problems of water supply can be solved. The colleagues of the Indian Water Works Association are to be congratulated on these results.