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FUTURE WATER MANAGEMENT PROBLEMS IN ASIAN MEGACITIES

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Abstract

Today, about half of the world population lives in urban areas and in the coming 20 years, urbanization is expected to increase steadily, especially in the Developing World. Based on UN data and projections, about 4 out of the 5 billion world urban population will live in developing countries by 2030. Large cities in the Developing World face the problem of unplanned growth, coupled with the financial and operational inability to offer the public services needed to sustain a decent life in urban environments. Water is one of those essential commodities which is often short in supply and/or of low quality. Additionally, flood poses a threat to urban dwellers during rainy season. The water management challenges in tropical urban areas today and in the decades to come can be characterized by (1) fighting physical shortcomings in water resources, (2) coping with contamination of groundwater, rivers, lakes, and reservoirs by domestic, agricultural or industrial waste and waste water, (3) mitigating environmental impacts of water extraction (such as loss of wetlands, subsidence and seawater intrusion) , (4) preventing / mastering flood situations and (5) overcoming administrative and financial strains and operational incapacities. Solutions to the problems of urban water in 20 years time are to be found in supply side and demand side measures. The first group includes (1) optimal use of surface water and groundwater resources, (2) pollution protection, (3) watershed management and (4) more water storage. The second group includes (1) educational training, (2) technological innovation, (3) water conservation and (4) water pricing.

1. Introduction

Asia is experiencing rapid economic and population growth and migration from rural to urban areas (urbanization). Many urban areas in Asia are growing in population so fast that economies, services and infrastructures cannot cope. This results in an upsurge in crime, violence, environmental degradation, pollution, poverty, unhealthy lifestyles and probably, the outbreaks of diseases.

Urban areas worldwide are gaining an estimated 67 million people a year, or about 1.3 million every week. By 2030, about 5 billion people are expected to live in cities - 60% of the projected global population of 8.3 billion. The urban poor are more vulnerable to environmental and health hazards because they are more likely than others to lack adequate housing, sanitation and other basic services (Prinz 2005).

About 2.3 billion people worldwide suffer from diseases linked to water problems, such as diarrhoea, schistosomiasis, trachoma, ascariasis and hookworm. Water-related diseases kill millions of people each year, preventing millions more from leading healthy lives, and undermining development efforts.

The supply of water sufficient in quantity and quality is therefore one of the basic facilities required in an urban living. On the other hand the quantity of water per capita becomes less every day, namely in the Developing World (Fig. 1), asking for excellent management of this scarce resource.

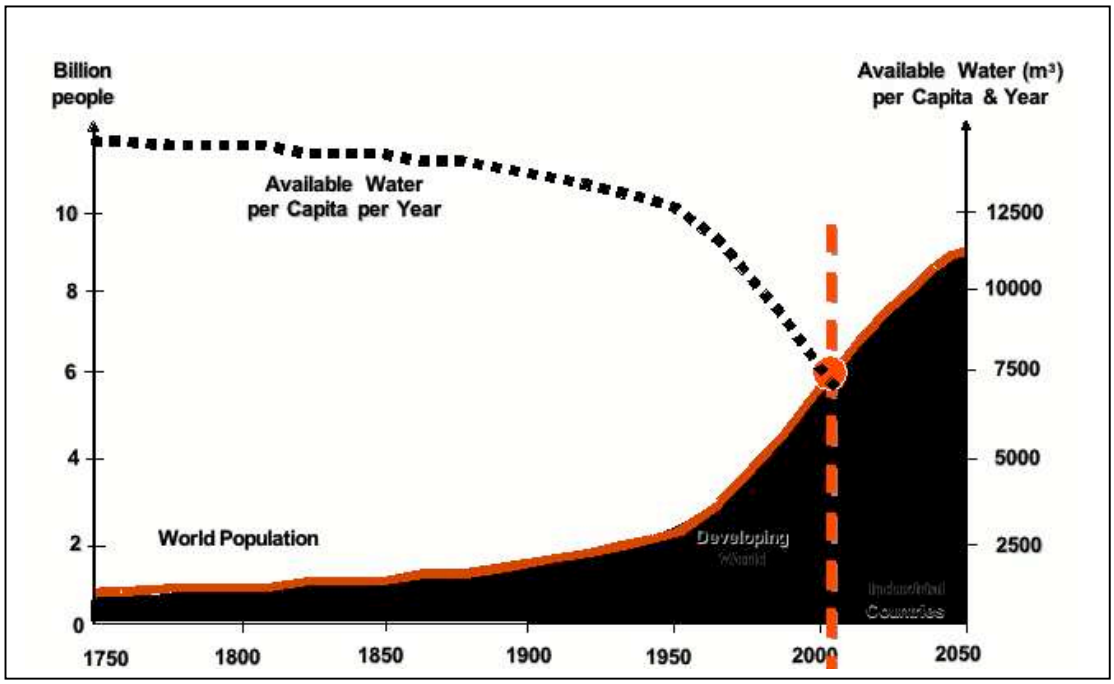


Figure 1. Population vs. Water Availability
Sources: UN PRB 2004 (population data), Rosegrant et al. 2002 (water data)

Availability of water is essential for sustainable growth and poverty reduction in developing countries. The steadily growing demand for more water severely stresses urban water supply and sanitation systems, increases the competition for surface and ground water resources and contributes to the deterioration of water quality. Water scarcity problems are increasing in the proximity of large and medium sized urban areas throughout Asia. Water quality is deteriorating due to heavy uncontrolled point source and diffuse pollution. The damages and threats posed by floods and droughts are becoming more

severe as development and population pressures mount, and are exacerbated by climate change.

Environmental degradation, e.g. negative impacts on watersheds, wetlands, riverine and lake systems, and coastal and marine systems is widespread. Biodiversity and human health have been severely impacted. As the most visible water problems occur in and around cities, especially the megacities, effective, integrated water management of the water (and land) resources in urban environments is urgently needed.

2. Population Increase and Urbanisation

Approximately 6.7 billion people are living on our globe in November 2008 (Wikipedia 2008); in 2050 this figure is expected to be around 9 billion (Fig. 1). More and more people worldwide do not find a livelihood in rural areas and therefore move to cities. Today, about half of the world population lives in urban areas and in the coming decades, urbanization is expected to increase in alarming rates in Developing Countries (Fig. 2). In 2030 it is expected that about 4 billion people will live in urban areas of the Developing World. From the mid sixties to the mid nineties of last century the Asian urban population has nearly tripled from 400 million to 1.1 billion and there has been a correspond-ing increase in the level of urbanization. The number of Asian megacities – urban areas with a population of over 10 million – will increase from presently 12 to 20 in the year 2030.

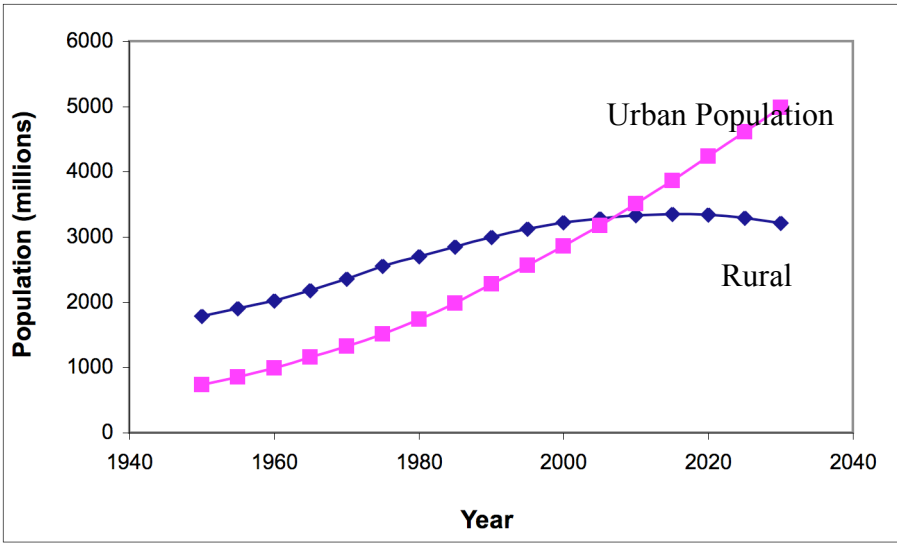


Figure 2. Urban and Rural Population of the World (1950-2030) (Source: UN 2005)

There are great differences between the Asian countries in regard to urbanisation (Fig. 3). According to UN (2005), in the year 2030 urban population in the Philippines would reach about 76 %, China about 60 %, Indonesia 67 %, Pakistan 49 %, but Vietnam only 43 %. Those differences reflect state policy, general standard of living, but also the equal or unequal distribution of population over the total area of the country. The Philippines and Indonesia, which are archipelago countries, are famous for their unequal distribution of population within their islands (Baiquni, 2004).

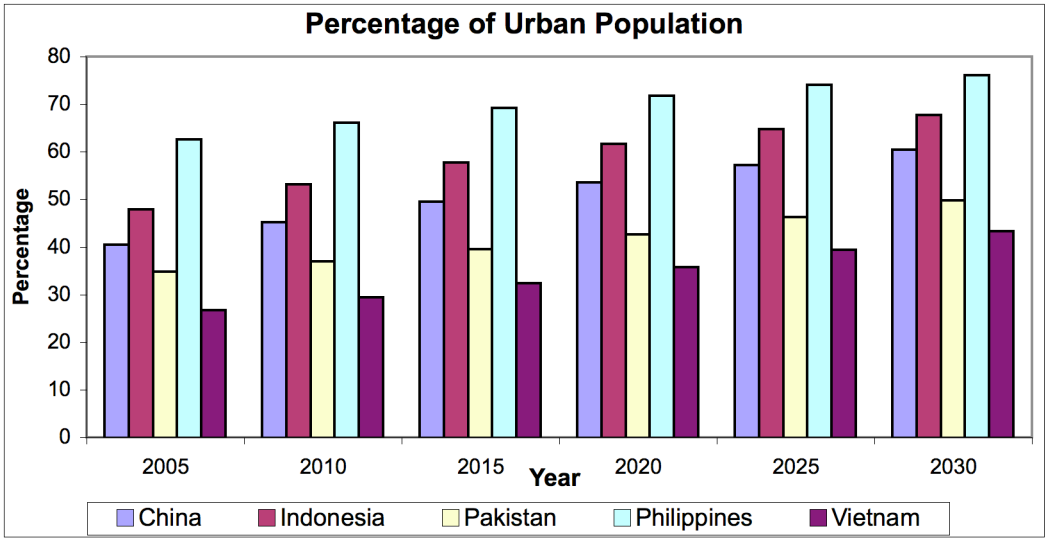


Figure 3. Percentage of Urban Population in Some Developing Countries (UN 2005)

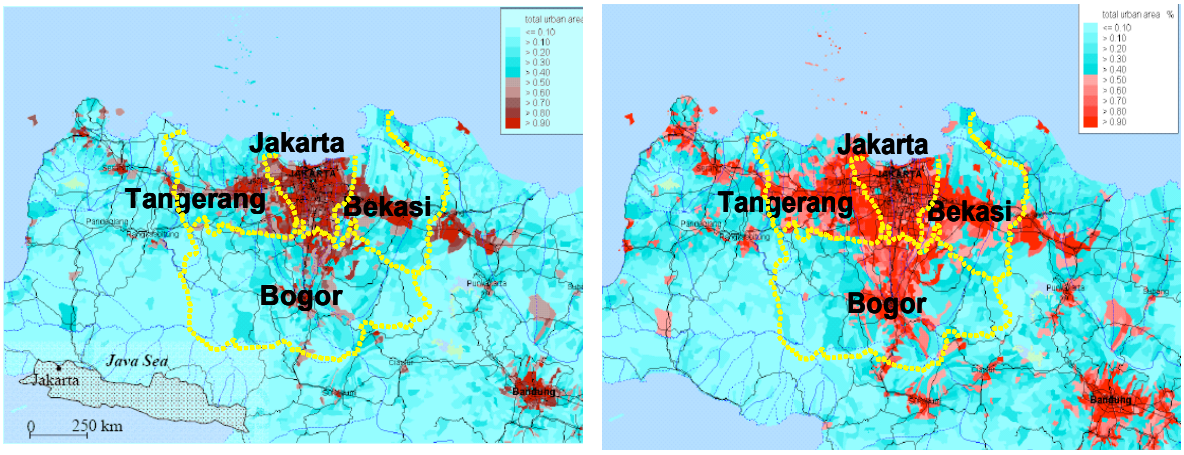
One example is the development of 'Jabotabek' in Indonesia (Fig. 4). Jabotabek is the term for a conglomeration including Jakarta, Bogor, Tanggerang and Bekasi (the latter three are cities around Jakarta). In the year 2000 this area had about 20 million inhabitants, in 2025 the population is expected to be around 50 million (Verhaeghe et al. 2005).

Another element of urbanisation in developing countries is the extension of slums areas. Today it is estimated that there are almost 1 billion people living in slums around the world making up to 32% of the global urban population. Asia accounts for some 60% of the world's slums residents.

3. What Pressing Water Problems in Future Decades?

The water management challenges in tropical urban areas today and in the decades to come can be characterized by (1) fighting physical shortcomings in water resources, (2) coping

with contamination of groundwater, rivers, lakes, and reservoirs by domestic, agricultural or industrial waste and waste water, (3) mitigating environmental impacts of water extraction (such as loss of wetlands, subsidence and seawater intrusion) , (4) preventing / mastering flood situations and (5) overcoming administrative and financial constrains and operational incapacities.



2000 2025

Figure 4. Urban development in Jabotabek area in 2000 and 2025
(Source: Verhaeghe et al. 2005)

4. Fighting physical shortcomings in water resources

There are two main sources of water that are commonly used for water supply in urban areas; surface water and groundwater. Groundwater is mainly used as drinking water source because it is normally less polluted than surface water, so that, it can meet the quality requirements. Surface water is used for larger variety of purposes; it is usually treated and distributed by the municipality.

It is expected that the urban water demand in 20 years will rise to about 230% of the present demand assuming 3,5 % growth rate (Fig. 5). The values are obtained by considering population, urban, and economic growth as important elements affecting water demand, for example by increasing water consumption per capita. Improvement in the standard of living mostly results in increasing water consumption.

In urban areas, corresponding with the level of economical and social development, the water consumption can reach 200–300 l/head/day. Industry usually consumes lots of water for its processes; therefore it contributes significantly to the increasing water demand especially in urban and peri-urban areas.

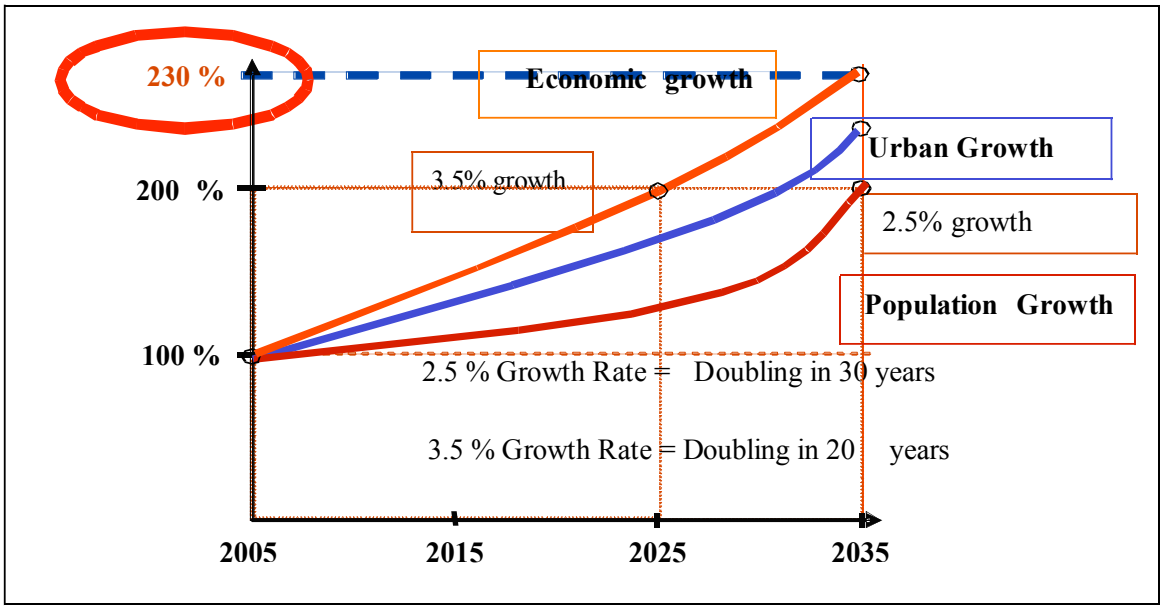


Figure 5. Development of water demand in 20-30 years time in urban areas of tropical Asia

There are 3 reasons why this larger demand will most probably not be met in many urban agglomerations. These are physical shortcomings, administrative/financial problems and missing operational capacity (Fig. 6).

Figure 6. Supply side problems, indicating, why the growing water demand in Asian tropical agglomerations will most probably not be met in future.

The physical shortcomings are mostly related to surface sealing which is due to urban housing and infrastructure development, which reduces groundwater recharge by avoiding infiltration. The existing problems will be aggravated by the impacts of Global Climate Change (Prinz 2004).

5. Coping with contamination of groundwater, rivers, lakes, and reservoirs

One main urban water problem is the contamination of water resources by many sources of pollutants. Solid waste and waste water of domestic, agricultural or industrial origin and soil erosion causing siltation in water bodies, are major sources of water resources contamination. Contamination of groundwater, rivers, lakes and reservoirs by domestic or industrial wastes is becoming a serious problem throughout the world. Missing or insufficient sanitation and household waste collection are contributing to this grave problem. It is estimated that only about 5 % of municipal wastewater in the tropics is treated before disposal. Many more treatment plants will be constructed but the total pollution level will hardly be reduced. In future especially in Asia, the problem will be even more serious. This will result in low water quality and will affect strongly the health situation.

6. Mitigating environmental impacts

Urban water problems are also related to the environmental impacts mostly caused by human activities. The over-exploitation of groundwater causes further problems on disturbing the hydrological balance - falling groundwater tables - often followed by land subsidence and in the coastal zone it can cause seawater intrusion into aquifers (Fig. 7).

The urban expansion does very often lead to a destruction of forest areas in nearby catchments, resulting in irregular flow of rivers and reduction of available rechargeable groundwater resources, which furthermore leads to flood and supply problems. Loss of agricultural areas due to increasing demand of space for settlements or reservoir areas means less food and fibre. It will also probably occupy wetland areas, which means a reduction in biodiversity and loss of land and habitats. Related to this, global climate change will give additional contribution especially to flooding as well increasing average temperature, which leads to the increasing water demand. Furthermore, increasing global temperature will make the ice layer melted, which results in the raise of the sea level. It will cause losses of fertile land and further seawater intrusion.

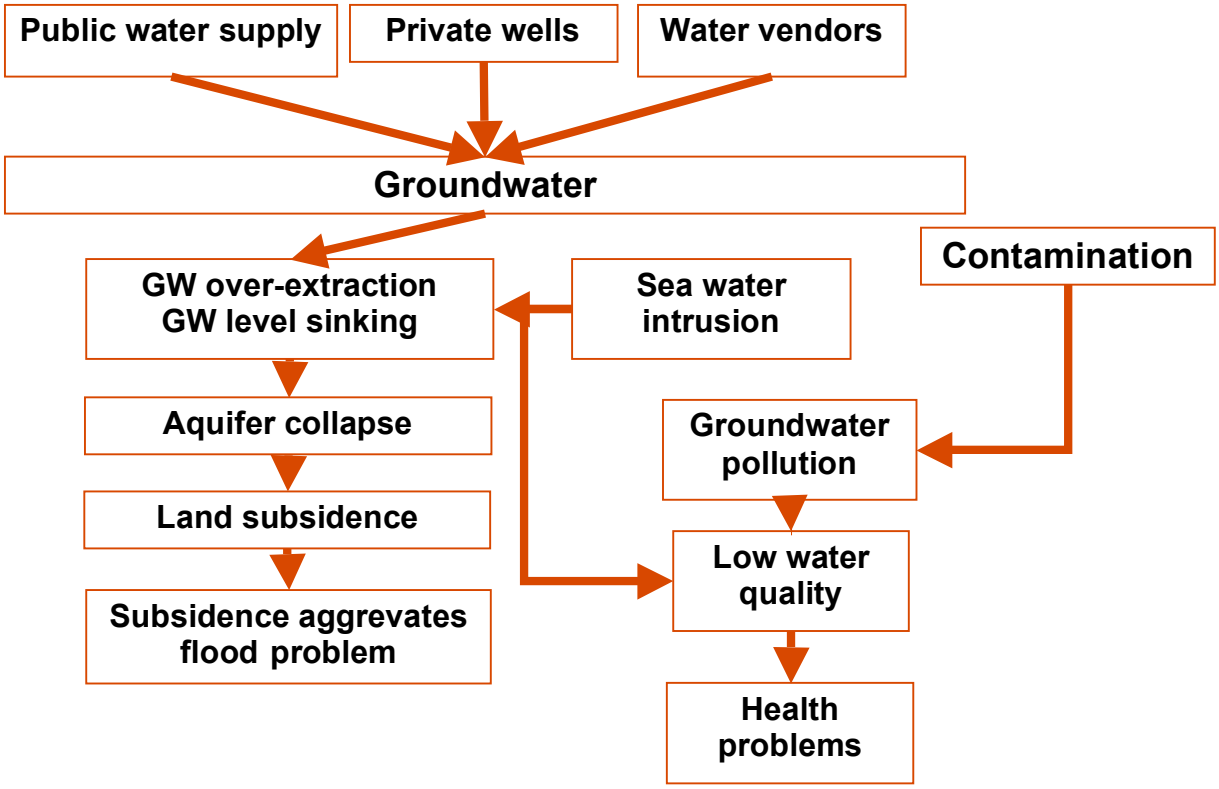


Figure 7. Groundwater problems in South Asian coastal areas

7. Preventing / mastering flood situations

A further water-related problem, occurring regularly during the monsoon season, is flooding, either caused by rising rivers or just by rainfall falling on sealed surfaces with insufficient drainage system. Topographic features and a bad watershed management also contribute substantially to floods. As mentioned above, urban expansion does very often lead to a destruction of forests in upstream catchments, resulting in irregular flow of rivers, causing flood problems downstream.

Furthermore the flood risk is worsened by inadequate drainage which might be due to lack of planning and/or of maintenance. In many Asian urban areas, rivers served earlier as drainage lines, but are now often used for dumping or housing.

Preconditions for mastering flood situations are e.g. (1) the availability of an emergency action plan (which should include a rescue and accommodation plan, a commodity transport and distribution plan, etc.), (2) the provision / storage of equipment and material needed in case of emergency and (3) training of staff and information of the public to keep losses low.

8. Overcoming administrative and financial constrains and operational incapacities

In developing countries, urban water problems are also related to poor system performance of public (or public-private) water service (Fig. 8).

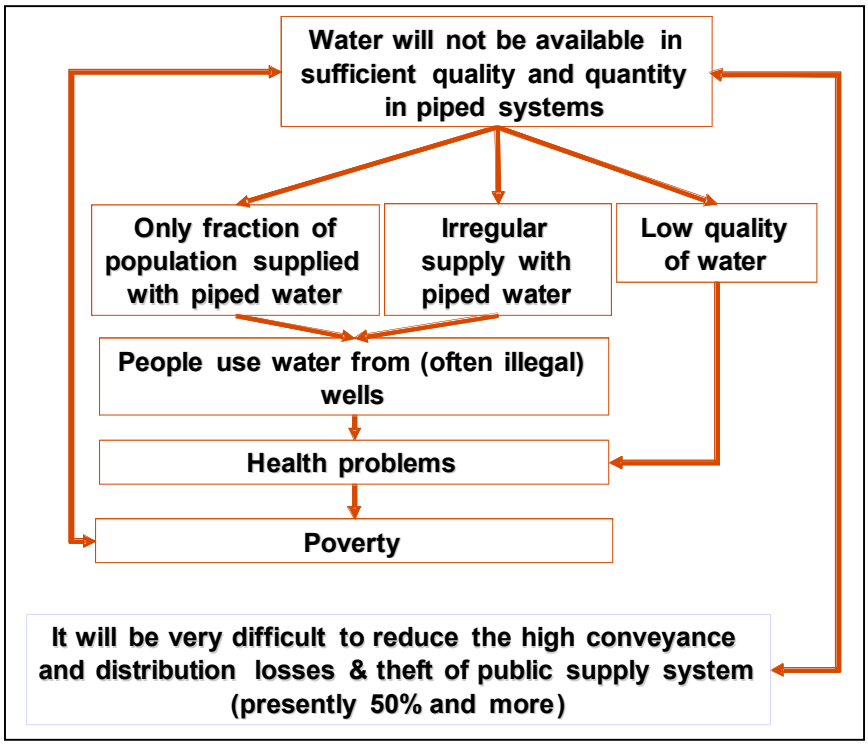


Figure 8. Interrelationship of factors, indicating why water will (most probably) not be available in future in sufficient quality and quantity in piped systems

The system cannot provide water for all urban water consumers, for example in the Philippines in 1999 only 47% households in urban areas have already been connected to municipal water service, in Indonesia it was even less with only 37 % (WHO/UNICEF, 2004). This is worsened by the fact that about 40-60 % of distributed water is lost due to leakage, theft, and poor accounting.

On the financial side, limited budgets, corruption, low financial contribution from water users etc. lead to deficient supply systems, insufficient water reservoir volume, and also deficiencies in operational and maintenance quality of the system.

In parallel to financial measures,

- lack of attention on water systems,
- lack of knowledge and skill of all related parties,
- low commitment,

- inefficient and fragmented water management

have also contributed considerably to urban water problems.

The continuous increase of urban population will lead to growing demand for water and sanitation services. The gap between the demand and supply of the services is continuously widening (UN-Habitat 2003). "The battle for water and sanitation will have to be fought in human settlements, particularly in the slums and shanties of the growing urban areas of Developing Countries" – This statement by Mrs. Anna Tibajuka, the Executive Directory of UN-Habitat, points to the problem: the world's slums are continuously growing.

9. Outlook

The above mentioned challenges in water management became already problems, as none of them got solved. These problems will not only persist, but increase in magnitude. Numerous, concerted counteractions are needed today to master the water problems in 20 years time.

10. Are Solutions at Hand?

As urban water **problems** are part of general urban development, the same holds true for the solutions: they should be in harmony with the development of the urban area as a whole. Development efforts should be directed to "human development" as defined by the UN-Millennium Goals. General improvements in the education system, health care, housing, water supply and sanitation are few points that should be central elements of all development efforts.

There will be no development without major efforts in curbing population growth. Therefore, development in Third World countries implies dealing with this issue as a major phenomenon. Peconditions for curbing population growth are:

1) Improvements in education, especially of girls and women
2) A substantial increase in the living standards of the poorer strata of the society
3) Knowledge on birth control and availability of contraceptives.

Integrated water resources development has to be applied in solving urban water problems, too. It needs strategic thinking and long-term planning. Wrong or missing decisions today might have fatal effects on future development. The decision makers, as well as the general public, should take utmost care on the right legislation and its enforcement. One important

goal of the planning is sustainable, long-term water resources development. The planning itself serves local and regional level, national level and trans-national level.

A few fields in local and regional level of planning are e.g. wastewater treatment, developing and implementing regulations on groundwater pumping, support to water harvesting, and monitoring. At the national level, some fields of planning are watershed management (incl. afforestation), environmental education, training activities, and reservoir planning and construction. On trans-national level, the fields of planning are for example international consultation and international agreements.

The product of planning would be water resources management. AS with other resources, we have to go beyond "Integrated Water Resources Management", but head for "Integrated Resource Management" (Fig. 9).

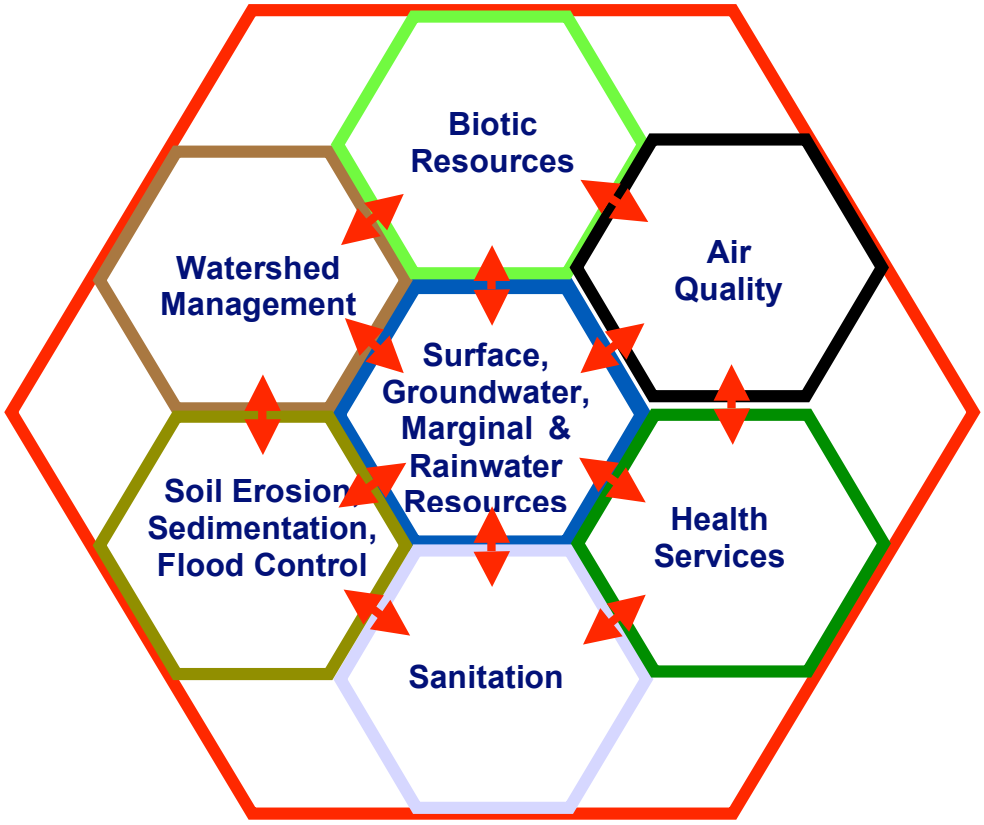


Figure 9. Example of Integrated Resource Management

Integrated resource management is carried out by implementing sustainable concepts such as multiple use, re-use and cyclic processes in using resources. The protection of watersheds (or their re-afforestation) to avoid irregular flow of rivers and flood problems downstream can improve biodiversity; the same holds true for the preservation of

wetlands. Better soil erosion in upland areas avoids sedimentation in middle and downstream reaches of rivers, contributing to higher yields on-site and lower water problems off-site.

Water quantity problems in urban environments can be solved either as supply side or demand side measure (or a combination of both types). The first group aims at making best use of all sources of water. Meanwhile, the second group aims at reducing the demand by avoiding wastage, changing the way of production, etc.

11. Supply side measures

Typical supply side measures are e.g.

(1) Making optimal use of available water resources, which includes

- Optimal, conjunctive use of surface and groundwater
- Multiple use of water: "Using any drop of water several times before it is drained"
- Collection and re-use of treated wastewater
- In-situ moisture conservation
- Use of low-quality water for tree cropping and aquaculture
- Application of rainwater harvesting techniques.

It is expected that in the future rainwater and other "marginal" water resources will need much more attention than in the past. So, any technique utilizing those marginal resources such as rainwater and fog and dew harvesting might be very valuable in the future. Rainwater harvesting is a method of capturing and collecting the runoff from surfaces on which rain falls, and subsequently storing this water for later use.

Instead of using rainwater for daily consumption, rainwater harvesting method also helps in utilising the primary source of water and prevents the runoff from going into sewer or storm drains, thereby reducing the load on treatment plants. It also lessens local erosion and flooding caused by runoff from impervious cover as some rain is instead captured and stored. For groundwater conservation purposes, rainwater harvesting can be used to recharge the aquifer to help improving the quality of existing groundwater through dilution. Rainwater may be charged into the groundwater aquifers through any suitable structures like dugwells, borewells, recharge trenches and recharge pits (Widodo et al. 2005).

(2) Pollution control

Water quality in surface water and groundwater has to be protected. Management of point-source and non-point source pollution should be carried out to meet the task. A bad water quality will lead to health risks and aggravate impoverishment.

(3) Watershed management

Watershed protection programmes include any efforts to maintain the quality and quantity of land, water and biological resources. Their application is indispensable for water management downstream.

(4) More water storage

Water storage is one solution to the urban water problems in regard to the spatial and temporaloral distribution of precipitation. The purpose of this effort is to capture water and reallocate it for future water demand. In future, more storage water would be needed either as water reservoir or artificial recharge.

12. Demand side measures

(1) Education and training

Education and training is a must in any purpose of management. For public, education is aimed to create or improve the awareness. Training is aimed for water resource authority to improve the skill and knowledge on better management of water resources. The actors involved in raising awareness and spreading knowledge belong to those of all elements of the society including general public, decision makers, and academician. The general public takes daily decisions, how much water is used and whether it is re-used, how much is wasted and to what degree it is polluted. Its decisions are strongly influenced by the price per unit water, which again is decided by the public (or private) decisions makers. All actors are challenged by the water crisis and are called upon to contribute to solve the water-related problems in a concerted way (Fig. 10).

(2) Technological innovations

New technologies, which support the efficient use of water are in high demand. A simple example is ‘smart flushing’ which enables us to save more water in flushing, or ‘smart shower and tap’ which automatically stops after a particular time.

(3) Water conservation

Water conservation, including reduction of losses either conveyance or distribution losses by repairing inter-urban water supply system, or losses due to dripping of taps

etc. by repair service. Water conservation also can be done by using collected rainwater for toilet flushing, floor cleaning and others which don't need a good water quality.

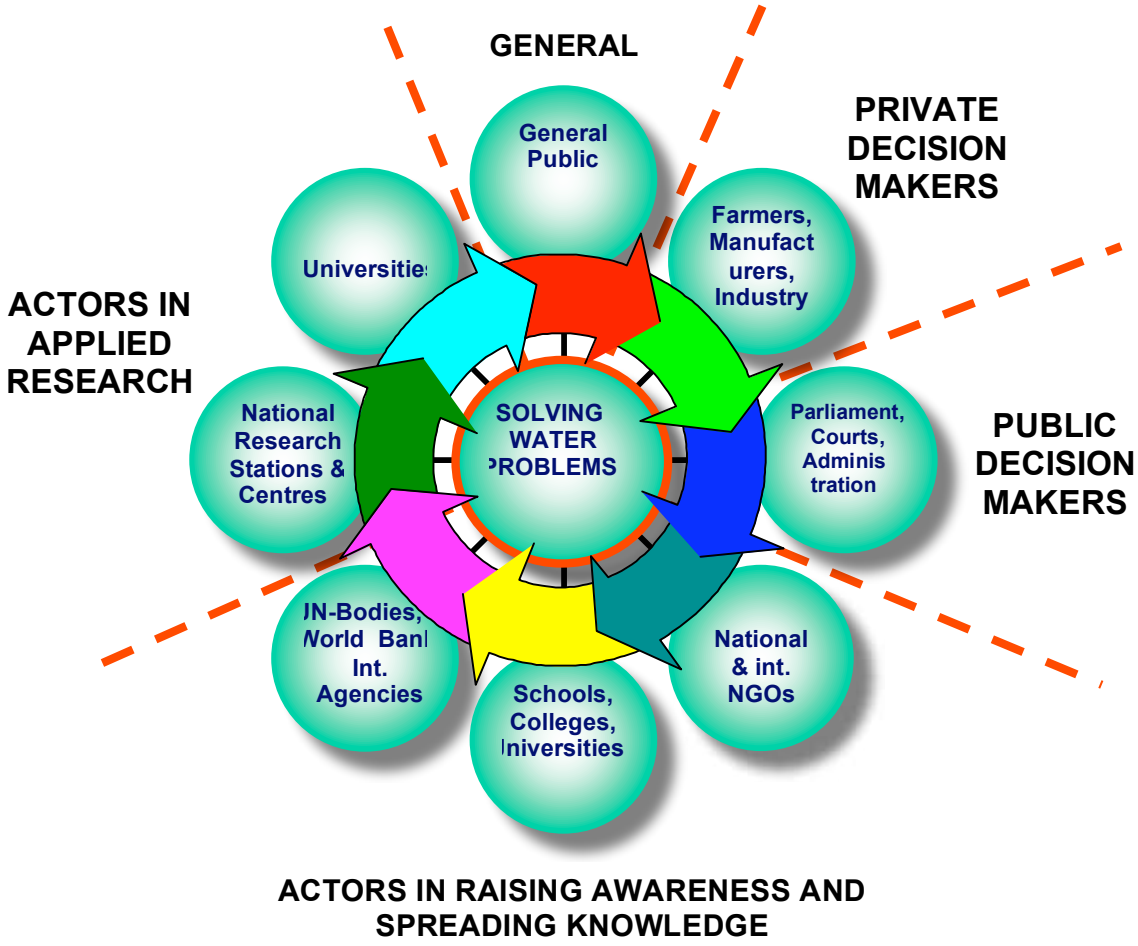


Figure 10. Actors in solving urban water problems

(4) Water pricing

A too low price does lead to water wastage. In many developing countries, water serves as free resource, which leads to a high degree of inefficiency in water use. On the other hand, a too high price for piped water will result in more drilling of tube or dug wells extracting 'free' groundwater.

13. Conclusions

Urban water problems in tropical Asia in coming decades, assuming 'business as usual' and a continuous growth of population, will not be different from the present ones, but

increase in magnitude, reflecting the general development. Water demand in 20 years will be in the range of 230 % of the present one, but this increase will hardly be met.

The solutions to the problems are to be found in supply side and demand side measures. The first group includes (1) optimal use of surface water and groundwater resources, (2) pollution protection, (3) watershed management and (4) more water storage. The second group includes (1) educational training (2) technological innovation, (3) water conservation and (4) water pricing.

The using of marginal water sources such as rainwater will play a more important role in the future, as well as the need for more water storage either as water reservoir for consumption or as groundwater storage.

Environmental problem due to increasing human activities should be reduced by proper watershed management and also more strict regulation of the possible contaminating activities.

On the demand side continuous education and training for all actors involved in urban water problems is a must as a tool to increase awareness and spreading knowledge on how to manage water as an important element of life.

Technological innovations are needed to reduce water wastage / water losses, and to increase water use efficiency. Reuse and recycle of water should be integral elements of a water conservation strategy.

Water pricing will play a certain, but limited role, as long as the extraction of 'free' water is feasible. An effect on water consumption will be given only, if the state controls any water extraction from surface or groundwater. It might be advantageous to give subsidies to the collection of rainwater to reduce pressure on the other water sources.

As mentioned above, numerous concerted counteractions are needed today to master the water problems in coming decades – and beyond.

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