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WATER AVAILABILITY IN PAKISTAN AND WASTEWATER

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By

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INTRODUCTION

Increasing demand of water for agricultural, domestic, industrial and municipal purposes has rendered it imperative to take stock of water availability in Pakistan and present scenario of wastewater generation and its ultimate environment friendly recycling for use. The economy of Pakistan to a large extent depends upon the Indus River system inflows. Pakistan can be classified as one of the arid countries on globe with average rainfall of 240 mm a year. Agriculture sector uses lion's share of available water. Much of the available surface and groundwater, approximately 200 MAF, on the average, is predominantly used for agriculture, which contributes about 25% of GDP of Pakistan, and almost 60% of export earnings. The other utilizations are domestic water supply and sanitation and industrial sectors. There are scores of factors that appear to threaten the present precarious availability of freshwater. The major driving forces that threaten future sustainable water availability in Pakistan include; droughts, climate change, low water use efficiency and untreated disposal of wastewater. To cope with this situation, we need water storage / water retention facilities on war footing. Other sustainable water management measures include: water conservation, efficient use of water, rainwater harvesting and grey water treatment.

The quantity of wastewater produced in Pakistan is 962,335 million gallons, including 674,009 million gallons from municipal and 2,88,326 million gallons from industrial use.

The total wastewater discharged to the rivers is 392,511 million gallons, which includes 316,740 million gallons of municipal and 75,771 million gallons of industrial effluents. If we look at percentage composition of various contributing sectors; then 73% wastewater is of residential origin, 16% is contributed by agriculture sector, while 6% & 5% is respectively shared by the industrial and commercial sectors.

There is no national policy on sustainable use of wastewater in Pakistan. A negligible portion i.e. 8% of wastewater in Pakistan is treated through sedimentation ponds to a primary level only but most of the treatment plants are not functional, therefore, the figure can be estimated around 1%. There is no existing concept of treatment at secondary and tertiary level. The problem of industrial water pollution has remained uncontrolled because there have been little or no incentives for industry to treat their effluents. In villages the wastewater is disposed of by drains to open ponds or soakage pits resulting in unhygienic conditions. The municipal open drain water disposal also leads to health & hygiene problems in major urban centers. Irrigation brackish water is disposed of through LBOD & RBOD.

We need to inculcate awareness and commitments to reduce the lavish use of water and its pollution, treat wastewater and reuse.

2. Water Availability in Pakistan

Pakistan was once water surplus country i.e. per capita surface water availability in 1951 was 5260 cubic meter / annum. This has gone down to below 1000 m^3 in 2017 which is a state of water stress. The existing insufficient water storage capacity and gap between demand and supply is further aggravating the situation. Precipitation in Pakistan is temporally and spatially variable and unpredictable. The average annual rainfall is about 240 mm. On the whole more than half the country receives less than 200 mm of annual rainfall. It is estimated that almost 9.9 million acres of the area is rain-fed. The direct rainfall contributes less than 15% of the water supplied to crops. River flows in Pakistan are seasonal with 82% occurring in Kharif and 18% occurring in Rabi season. Presently, about 104 Million Acre Feet (MAF) out of 144 MAF (Post Tarbela Average) of surface water is being, annually, diverted to the Indus Basin Irrigation System. The country has a large cultivable land base of 85.81 Million Acre. Out of which 36 MAF is irrigated. Live storage capacity of three major reservoirs i.e. Mangla, Tarbela and Chashma has reduced to 13.87 MAF in 2016-17. Groundwater caters for above 40% crops water requirements annually. There are more than one million tubewells installed by the private sector.

3. Sustainable Water Management

Need based distribution and sound management of available water resources remains an important issue in maintaining sustainable use of water. Sustainability management is aimed at taking necessary steps to ensure that while the needs of the present generation are satisfied, the needs of the future generation are not compromised. A better solution is to economize the consumption of available resources and devise ways and means of increasing the production of such resources. Also encouraging the use of recycled water. Due to spatial and temporal variations in water availability, sufficient water storages are required for sustainable water management of available water resources.

3.1 Storages

Consequent to Indus Water Treaty, three storage reservoirs, namely; Mangla, Chashma and Tarbela were completed in 1967, 1971 & 1974 with gross storage capacities of 5.88, 0.87 and 11.62 MAF respectively. Mangla live storage capacity has been enhanced to 7.40 MAF after raising of Mangla Dam. Due to progressive sedimentation of these reservoirs, their live storage capacity has substantially reduced. Presently, Pakistan stores only 10% of its average annual flows against 40% world average. Our carryover storage is only 30 days of average use against 120 days of India 600 days of Australia and 900 days of USA. This underscores the importance of water storage.

3.2 Water Conservation

Pakistan has the oldest and the largest contiguous irrigation system. It has two mega storages, 19 barrages, 54 canal commands, 60,000 km of canals and distributaries and 1.6 Million km of water courses. Out of 104 MAF water diverted through barrages at the canal heads, only 60 MAF reaches the farm gate and 44 MAF is lost in seepage and

evaporation during conveyance. Although seepage in sweet ground water area contributes to its recharge but it is lost in saline area. This loss must be curtailed by lining of canals. In domestic sector also due to dilapidated infrastructure, a lot of water is lost during conveyance. Lavish use of good quality water also needs to be checked.

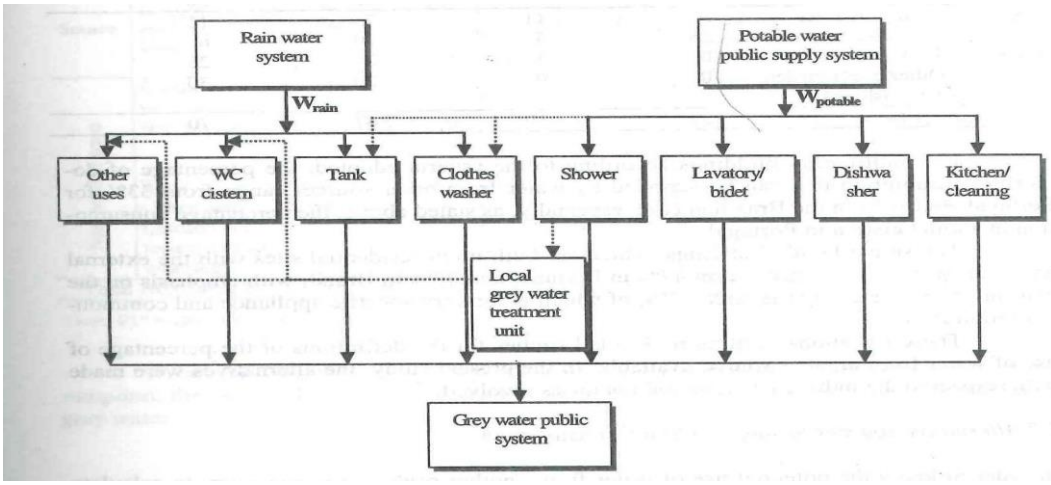
3.3 Efficient Use of Water

Pakistan's farmers use traditional flood irrigation system. This inefficient water application results in wastage of two thirds of farm gate water. If this state of affairs continues unchecked, the consequence will be further aggravation of already occurred water scarcity. Now-a-days, most of the water short countries are turning to more efficient use of water. Drip and sprinkler irrigation in semi-arid areas and trickle irrigation in arid areas can reduce water use to a large extent. These systems will save 50 to 70% of water as compared to flood irrigation

3.4 Rainwater Harvesting

Pakistan is already at the threshold of water crises. We need to adopt innovative techniques to take stock of this situation. At present, major portion of the runoff is wasted due to one reason or the other. The indigenized rainwater harvesting techniques can conserve this runoff for future use.

The rainwater harvesting (in cities) at rooftops and in arid rural areas in non-porous clayey soils in small ponds can pay dividends. However, reservoir in Cholistan with substantial storage capacity for catchment of 20 to 50 hectares, created at lowest point of catchment, with average runoff of 20 to 60 mm annually will be more appropriate. Following figure shows the water inputs and outputs in a building, considering proposals for the replacement of potable water by rainwater harvesting and reuse for internal consumption.

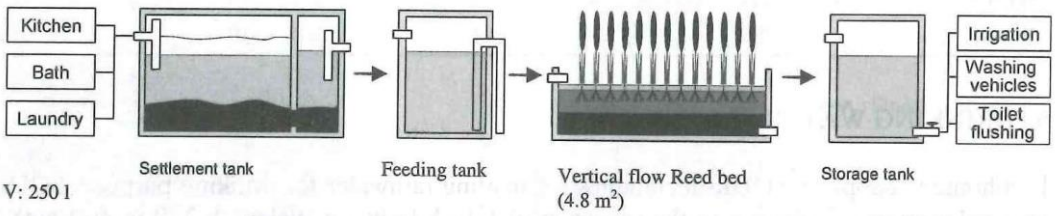


Schematic Water Flow in Building Indicating Alternative Sources for Domestic Water Use

3.5 Grey Water Treatment

In a typical household, about 5% of the total water consumption is used for drinking and cooking, 52% for hygienic purpose like bathing, laundry and dishwashing and remaining

43% is used for toilet flushing, gardening and cleaning etc. Mostly clean drinking tap water in urban areas is used for this purpose. At-least 40% of this, which is used for bathing, laundry and kitchen is disposed as grey water. This can be recycled for non-potable uses. It indicates that considerable amount of clean drinking water which is utilized for non-drinking purpose can be simply generated by treating grey water. Grey water usually contains low concentrations of nutrients (N&P) and pathogens, since it is not contaminated by human excreta; therefore, it can be treated and reused that can save more than 40% of domestic water. The schematic diagram of greywater treatment is given below.



Schematic Diagram of Greywater Treatment

4. Wastewater

Recent estimates reveal (PWSS, 2002) that total quantity of wastewater produced in Pakistan is 962,335 million gallons (4.37 BCM/yr) including 674,009 million gallons (3.06 BCM/yr) from municipal and 288,326 million gallons (1.31 BCM/yr) from industrial use. The total wastewater discharged to the major rivers is 392,511 million gallons (1.78 BCM/yr 1/3rd of all wastewater), which include 316,740 million.gallons (1.44 BCM/yr) of municipal and 75,771 million gallons (0.34 BCM/yr) of industrial effluents.

The percentage wise sectoral production of wastewater reveals, 73% share of residential, 16% agricultural, 6% industrial and 5% by commercial enterprises. Ten large urban centres of country produce more than 60% of total urban wastewater including household, commercial and industrial sources. Almost negligible 1% is being treated through sedimentation ponds to a primary level only. In 2015, the estimated liquid waste dumped into sea from Karachi stood at 350 million gallons daily (Dawn, Feb.2017)

4.1 Urban, Industrial Wastewater

By 2050 the world urban population is expected to nearly double. This poses massive sustainability challenges in terms of infrastructure, basic services, food security, health, education, jobs, water and sanitation systems. Cities today occupy only 2% of total land, but contribute about 70% of the global economy (GDP) and consume over 60% of the global energy, while emitting 70% of greenhouse gases and producing 70% of global waste. The very nature of urbanization contributes to water stress, scarcity and exposure to climate change related risks.

Although cities tend to have better access to safe water and sanitation facilities than their rural counterparts, they struggle to keep up with population growth and sprawl. About one third of the world's population lives in slums which tend to emerge near rivers,

streams and coastlines that offer informal access to water. Slums are characterized by inadequate access to safe water and sanitation and allied infrastructure.

Potable surface water supplied to Karachi city having population of more than 20 million is of the order 650 million gallon per day from Indus River and Kinjhar Lake, but requirement of the city is 1100 MGD according to WHO standard, 54 gallons/capita/day. That means Karachi gets almost 50% of its requirement. At-least one third of it is lost during transmission and at supply end. After the consumptive use, about 60% of the water goes to the sewerage system. Sewerage system built thirty years back in certain parts of the city is inadequate and also not operative. The untreated sewerage is thrown into drains and to sea. Layari and Malir River receive a large amount of effluent discharge approx. 450 MGD of raw municipal as well as industrial effluents convey them to sea.

Lahore city having a population more than 12 million is supplied 700 million gallon per day from more than 750 tubewells. Lahore generates almost 8.0 million cubic meter of wastewater daily including; household, industrial and commercial wastewater. The sewerage treatment does not exist. Waste water is thrown into drains leading to river Ravi. Most of the Rain Water is also added to the sewerage system. In suburbs the untreated sewerage water is used for growing vegetable.

Groundwater aquifer in Lahore and Lower Bari Doab area, which had developed over centuries, is being mined extensively. The water table is lowering at a rate of 1 m per year. A few years back public tubewells (WASA) were pumping water from about 400 ft. depth. Nowadays their average depth is 700 ft. It is estimated that sweet water aquifer is 1000 to 1200 ft. deep. In a well drilled by WASA 400 ft. deep in Ravi Block, Lahore, sewerage water contamination was found. Most of the ground water recharge was from river Ravi. After IWT and stoppage of Ravi flows by India, now it is mainly a sewerage drain. The quality of water samples collected and tested from river Ravi from u/s of Shahdara to Mehmood Booti showed marked contamination due to sewerage addition.

WASA, Municipal Corporations, Cantonment Boards should treat its sewerage before throwing into river and also implement grey water recycling and its reuse where applicable.

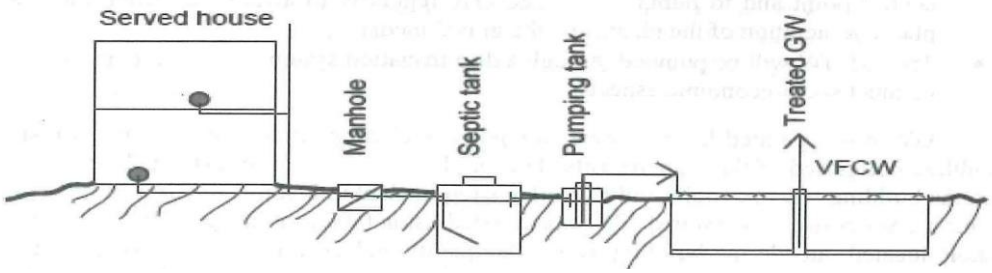
It should be compulsory for all the housing societies: Bahria Town, DHA, Wapda Town etc. to practice rainwater harvesting and grey water recycling.

4.2 Wastewater in Villages

In most of the villages in Pakistan, there is no piped water supply. In sweet ground water areas people use hand pumps, open wells or motored pumps to extract ground water for drinking and uses in bathrooms and toilets. In saline groundwater areas, canal water is stored in surface water tanks from where it is supplied either through pipelines or fetched by pitchers and buckets by women. The waste water from the house is either stored in the soakage pits for evaporation and infiltration into ground water or thrown on the dirt street. In better organized villages where streets have been paved and open drains built, the gray water is stored in an open low lying area. This water evaporates and percolates into grounds. Sometimes it is pumped and used to grow vegetables in the fields around

the villages. These open ponds are not only polluting the ground water aquifers but also breeding mosquitoes for malaria. The vegetables grown with it are not hygienic.

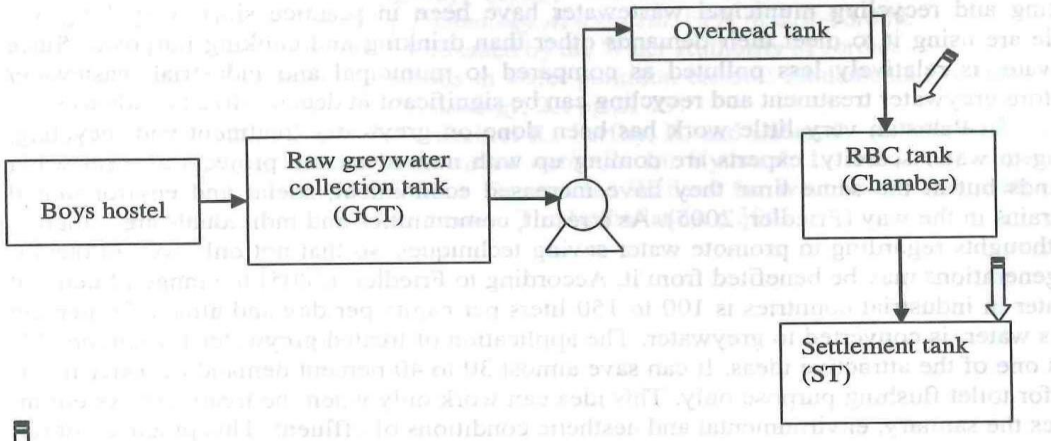
In some countries rural grey water is stored in septic tanks and treated by vertical flow constructed wetland. It would be useful to grow vegetables and create healthy environments. A simplified layout of the treatment plant is shown in following Figure.



Layout of the Treatment Process and Treatment Steps

Farmers should be advised and helped to construct these treatment plants. They would operate and maintain these plants themselves. Such treatment is being practiced in Jordan, Syria and many other countries.

Mehran Engineering University Sind had developed a pilot project “Continuous flow type rotating biological contractor (RBC) simulator for grey water treatment”. Below mentioned Figure shows the layout plan of RBC.



Schematic Diagram of RBC System

4.3 Agriculture Wastewater

The definition of agricultural wastewater is somewhat different from wastewater of other sources. It is actually discarded water or water which cannot be supplied to the future agriculture produce and is of compromised quality, particularly with enhanced dissolved salt contents. Flat topography, lack of sufficient natural drainage or blockage of natural drainage yields undesirable effluent. This causes menace of waterlogging and salinity. The drainage solutions applied so far comprise of tubewells, open drains and tile drains.

In sweet water zone areas, in order to meet the short canal water supplies, farmers installed tubewells. This has increased their cropping intensity and lowered the groundwater table. In saline groundwater areas the problem of waterlogging and salinity still persists. Out of total irrigated area of 16.69 mha (41.231 Mac), 7.55 Mha (18.643 Mac) has been covered under drainage and about 46% i.e. 9.14 Mhac (22.588 Ma) still needs to be provided with drainage facilities.

4.3.1 LBOD

Centuries old inundation canal systems in Lower Indus Plains were brought under barrage control between 1932-63. With the passage of time the problem of waterlogging & salinity forced to take steps sooner than expected. In 1966, through a study it was decided to control the water table by installation of tubewells, surface water drains. The saline effluent through these drains was proposed to be conveyed through Left Bank Outfall Drain (LBOD) on Left Bank of Indus. LBOD is almost 200 miles long with an outfall to the Arabian Sea with a capacity of 15000 cfs.

4.3.2 RBOD

The irrigation systems on the right bank of Lower Indus Reach were also originally constructed without provision for drainage. Drainage projects initially implemented has hitherto been facilitating disposal of saline effluent into canals or natural depressions and lakes. This leads to environmental degradation. To take stock of this situation it was decided to construct an outfall drain parallel to the Indus on right bank. The RBOD is being implemented in three stages. The effluent quantity for disposal has been estimated as 64 cumecs (2271Cfs).

RECOMMENDATIONS

- Increase national level awareness and commitments to solve badly neglected water pollution by increasing waste water treatment, restoring polluted water bodies and address pollution prevention at its source in all forms.
- Treatment of waste water would improve environment and health of the people.
- Once treated adequately, used water needs to be recognized as a valuable source.
- Encourage the use of treated water especially where it can mitigate the water scarcity.
- Increase support for water and sanitation investments, particularly the mobilization of local capital.
- The recovery and reuse of materials removed from used water (such as energy and nutrients) should be encouraged alongwith appropriate legislation adopted to encourage this form of circular economy.

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