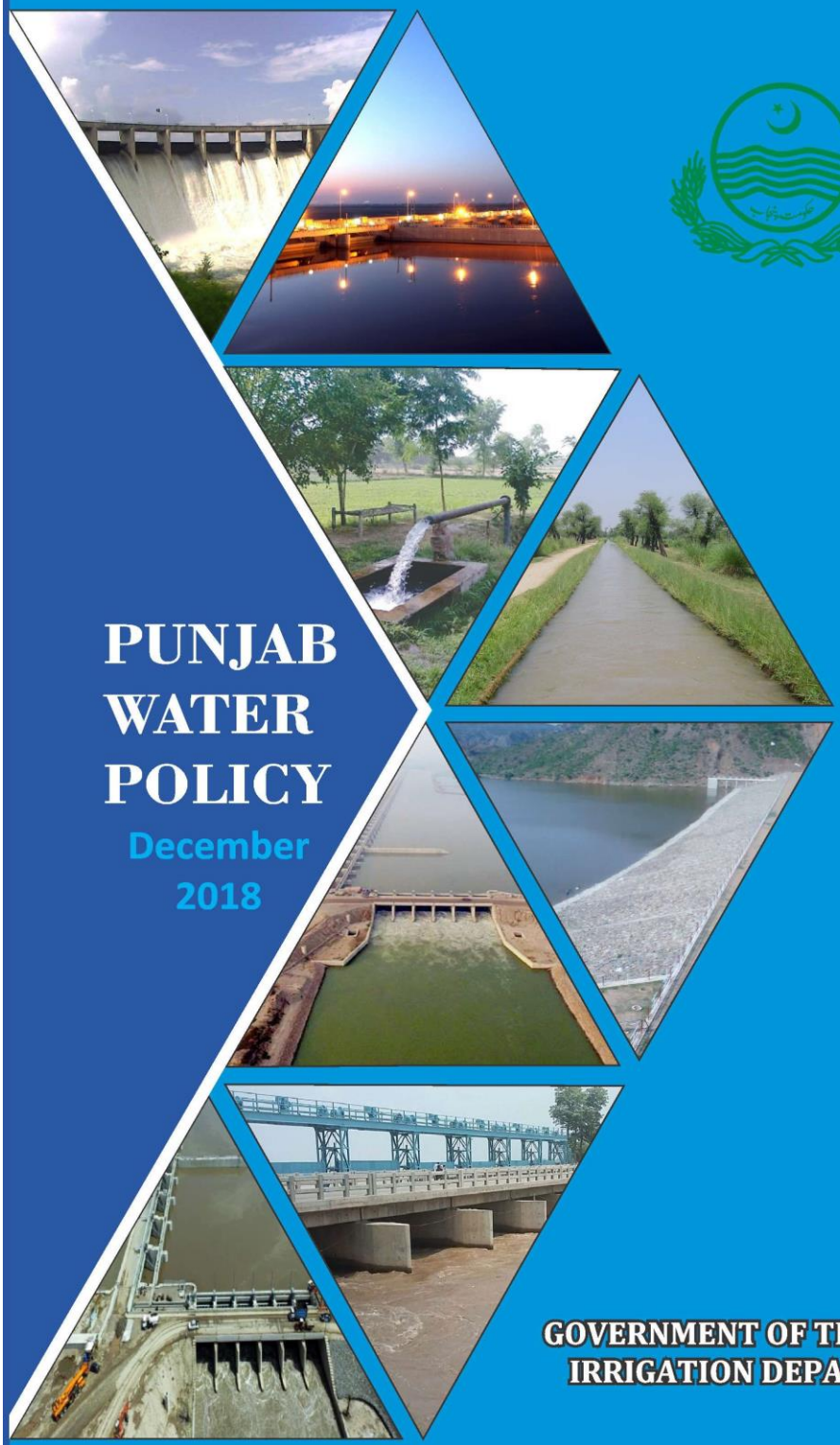

# PUNJAB WATER POLICY

December 2018

GOVERNMENT OF THE PUNJAB
IRRIGATION DEPARTMENT

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# ABBREVIATIONS

| | |
|---|---|
| ADB | Asian Development Bank |
| AWBs | Area Water Boards |
| Bcm | Billion cubic meter |
| CCA | Cultureable Command Area |
| EPA | Environment Protection Agency |
| ET | Evapo Transpiration |
| FAO | Food and Agriculture Organization |
| FOs | Farmer Organizations |
| FRAU | Flood Risk Assessment Unit |
| GIS | Geographical Information System |
| HUD | Housing and Urban Development |
| IRBM | Integrated River Basin Management |
| IRI | Irrigation Research Institute |
| IRSA | Indus River System Authority |
| IWMI | International Water Management Institute |
| IWRM | Integrated Water Resources Management |
| KPs | Khal Punchayats |
| $M^3$ | Cubic Meter |
| MAF | Million Acre Feet |
| Mha | Million Hactare |
| NESPAK | National Engineering Services Pakistan |
| NWP | National Water Policy |
| O&M | Operation and Maintenance |
| PARC | Pakistan Agriculture Research Council |
| PCRWR | Pakistan Council of Research in Water Resources |
| PDMA | Punjab Disaster Management Authority |
| PHED | Public Health Engineering Department |
| PIDA | Punjab Irrigation and Drainage Authority |
| ppm | Parts per million |
| PWC | Punjab Water Council |
| SOP | Standard Operating Procedures |
| SPRU | Strategic Planning & Reform Unit |
| TDS | Total Dissolved Solids |
| WAPDA | Water and Power Development Authority |
| WASA | Water and Sanitation Agency |
| WHO | World Health Organization |
| WUAs | Water User Associations |
| WWF | World Wide Fund for Nature |

# 1 INTRODUCTION

## 1.1 Preamble

The rapidly growing population of Pakistan with an average annual growth rate of 2.4%, now highest in the South Asian region and projected to cross 300 million in year 2050, poses the gravest of all threats to its water security. Punjab being the most densely populated of all the four provinces is affected the most with its water resource base of surface and groundwater now severely depleted. The spiraling population growth has also aggravated the water supply and sanitation sector particularly in urban centers where sewage disposal and solid waste, the principal cause of pollution of surface and groundwater, defies best of solutions for its management. To further compound the problem, industrial waste often with heavy metals, is disposed of untreated into river streams. The water availability and its quality have reached a crisis point, which if not addressed in a timely manner may have catastrophic consequences for the coming generations. Unlike shortages in other sectors like power etc. water has no alternative.

Even if few more mega dams (Bhasha etc.) are built and other remaining small storages within Punjab are mobilized, the Falkenmark water stress index is unlikely to improve, population being the denominator. Surprisingly, in most water strategy reports written since 2002, while population increase is recognized as a threat and demand management is stated as an objective, the measures proposed are restricted to water availability alone with no mention to suppress water demand by population control. Drastic population measures like China's one-child policy are unthinkable in a Muslim Pakistan, but other traditional measures like birth control, advocated with much success in 1960s, are now propagated with much restraint. Indirect but more feasible methods like universal education and women employment that will reduce population growth are wanting because of lack of resources and economic conditions. Demand management is a more pressing challenge than the water availability and unless water sector strategy is directly linked with population control, all other measures to enhance water security are likely to fail.

## 1.2 The Challenges

The challenges to Pakistan's water security and measures to cope with it are well known and have been well documented in many recent reports.

WAPDA's Vision 2025 report (2003), Asian Bank Water Sector Strategy Report (2002), John Brisco's 'Pakistan's Water Economy Running Dry' report (2005), WWF's 'Development of Integrated River Basin Management (IRBM) for Indus Basin(2012), Friends of Democratic Pakistan's ' A Productive and Water Secure Pakistan' Report(2012), have found their way into The National Water Policy (2018). The NWP also addresses many of the issues which after the passage of 18th Amendment now lie exclusively within the provincial domain. A need is therefore felt that a Provincial Water Policy may be formulated that addresses the peculiar concerns of the province. However, since the development of mega storage projects still lie in the Federal domain and the contiguous nature of Indus Basin makes purely a provincial approach untenable. The Federation is also the Sovereign Guarantor of all foreign loans and hence this policy is in line with National Water Policy.

The water sector challenges highlighted in various reports are summed up as follows:

***Water Stress***: The often quoted Falkenmark water stress index with threshold value of 1000 $m^3$/capita/year hangs over Pakistan's current index of 861$m^3$/c/year which is further going to fall below the threshold. For Punjab, it is still worse at 770 $m^3$/c/year with total water availability (surface plus groundwater) of 92.5 bcm (75 MAF) and a population of 120.11 million.

***Groundwater Exploitation***: More than any other province, Punjab is blessed with one of world's largest fresh groundwater aquifers. Leiftink Report (1965) mentioned only a pumpage of one MAF in 1965, mostly through Persian wheels. It outlaid a program to develop groundwater pumpage to balanced recharge of 43 MAF through public wells; considering, but rejecting the option of private tubewell development. Public tubewell development peaked at 12 MAF in 1970s and then faltered. Incidentally, private tubewell development gathered pace and the benefits of supplemental groundwater at farmgate by individual farmers became all too obvious. In fact, the economic value of a unit of groundwater far exceeded the canal water because of its availability on demand even though its quality was less and was far more expensive. The number of private wells in Punjab has grown to 1.2 million (Punjab Development Statistics Report 2017), pumping in excess of balanced recharge of 43 MAF.

***Degradation of Land and Water Resource Base***: The groundwater provided a much needed relief from water shortages and Pakistan's agriculture economy grew at impressive rates even in the drought period

of 2000-2007, that is until now. The falling water tables and deposition of excessive salts has now put Pakistan's agriculture at tremendous risk. In Punjab, out of 14 million ha of irrigated area, 6.2 million ha are being irrigated with groundwater having TDS of 2000 ppm or more (ACE & Halcrow, 2011). The problem is further aggravated by extensive use of fertilizers and pesticides, improper sewage disposal and zero treatment of industrial effluent; all of which have degraded the quality of surface streams around urban centers, housing nearly half the population.

***Flooding and Drainage:*** Despite heavy investments in Flood Protection structures since independence, the flood damages continue to rise. The 2010 Flood alone caused damages worth $10b, more than the cumulative flood damages in the period 1947-2009. The Mangla Reservoir whose operation is controlled by WAPDA is yet to devise fool proof Standard Operating Procedures (SOPs). The 1992 flood and again in Flood of 2014, improper operation of Mangla Reservoir caused heavy damages in River Jhelum floodplain and caused breaches at right bank of Trimmu Barrage. The uncontrolled development in the flood plains due to increasing demographic pressure is the principle cause for rising flood damages even when flood peaks have not exceeded their historic highs. Early Flood Warning Systems and enactment of River Act to regulate activities in flood plain is essential. In addition to flood damages in the plains of Punjab, the DG Khan Hill Torrents inflict tremendous flood damages. DG Khan Canal and Kachhi canal block the drainage path of these hill torrents to River Indus causing heavy silting in canals and inundation in the adjacent areas.

***Low Water Productivity:*** Pakistan's crop yields are much below world's average and also lag behind neighboring India. The main reason for low yields is inefficient irrigated agriculture which includes tenant based farming (as against corporate farming), unreliable supply of canal water especially for tail end farmers, inefficient irrigation application, low seed quality, low use of fertilizer & pesticides and financial issues of the farmers etc. Significant room for improvement in productivity exists which needs to be tapped.

***Climate Change:*** Pakistan has been declared as a high risk country under various climate change scenarios. The Glacial retreat of Himalayas over next 50 years will increase river flows after which a reduction of 30-40% is expected. Increased variability of rainfall is also likely to increase flood and drought conditions. The climate change may affect our supply and demand management system.

***Transboundary Water Issues***: Impact of India's hydropower development on River Chenab, the unresolved issue of Kalabagh dam, complaints of Sindh on canal releases in Chashma-Jhelum Canal and Greater Thal Canal and its emerging complaints on disposal of drainage surplus from Punjab into Sindh require greater attention.

***Poor Governance and Trust:*** The issue of governance and trust relate to equitable distribution of water between provinces, within provinces, upper- lower riparian's and head- tail farmers and participation of all stakeholders in decision making. While the Irrigation Department has served well the initial need of developing and maintaining the irrigation infrastructure, a transition is now required from building to managing, from development to conservation, from supply to demand for which institutional reforms, strengthening and capacity building are now required not only in line departments but also a new approach towards implementation of Integrated Water Resource Management (IWRM) methodology is required.

***Financial Sustainability:*** Pakistan's water infrastructure consisting of dams, barrages, canals and other works amounts to US$ 60 billion, out of this Punjab's share is US$ 20 billion (2005-06) for its irrigation infrastructure. Currently, there is no Asset Management Plan and maintenance is carried out on ad hoc basis. Lack of maintenance of distributaries, minors, water courses and associated gates and structures results in reducing hydraulic efficiency by as much as 30%. Assuming a 4% maintenance cost, the financial requirement works out to US$ 800 million a year. The low water charges at Rs. 135 per acre annually, and even at 100 % recovery rate, is only US$ 20 million a year which is grossly insufficient resulting in deferred maintenance creating a vicious cycle of 'build-neglect-rebuild'.

***Knowledge Database and Water Informatics:*** Punjab currently lacks an integrated database for water and environment, water balance and real time simulation models, the use of which could tremendously enhance in resolving water allocation and equity issues. With emphasis now on a demand management approach, the use of latest technologies such as, remote sensing, GIS, internet and mobile technologies call for building of extensive knowledge databases for monitoring of equitable water distribution from head to tail, monitoring of crops, water reallocation, water trading, groundwater monitoring, flood hazard assessment etc.

## 1.3 Strategy

Having laid out the challenges to Pakistan's water security, the future water policy now must strike a balance between 'productivity' and 'conservation', 'infrastructure development' and 'environment' and 'supply' and 'demand'. Similarly, the institutions need to transit from 'building' to 'managing'. The stakeholders pie need to enlarge to encompass all sectors and all people, women especially. Information technology needs to be harnessed and conflict resolution need to inspire trust and confidence. Adaptation to climate change hazards and financial sustainability of resource (water) and its management need to be ensured.

**The Strategy for water policy focuses on the following:**

- **Balancing productivity and conservation**
- **Balancing infrastructure development and environment**
- **Balancing supply and demand**
- **Enlarging stakeholders participation**
- **Adapting to climate change hazards**
- **Achieving financial sustainability**
- **Harnessing information technology and creating knowledge**

## 1.4 Approach

Implementation of above strategy requires the adoption of Integrated Water Resource Management (IWRM) approach. The IWRM is defined as 'a process which promotes the coordinated development and management of water, land and related resources in a hydrological basin in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems'.

The approach requires defining hydrological basins and sub basins with fully represented and empowered basin / sub-basin authorities, with sustainable financial resources and an IWRM Framework.

## 1.5 Objectives

The overall objective of Punjab's Water Policy is to "provide clear policy directions to the Government of Punjab on the sustainable management and development of water from all sources of water (surface water, groundwater and rainwater), for all sub-sectors of water use (domestic, stock water, agriculture, industry, commercial and environment) and for all regions (Indus basin canal commands and outside the canal commands) at the basin level through equitable water allocations, management and development". The specific objectives are to:

- ***Increase Water Availability*** through advocacy of construction of large dams at Federal level, construction of small and medium dams , beneficial use of flood waters, reallocation between sectors and recycle and reuse of wastewater
- ***Manage Groundwater Abstraction*** to balanced recharge levels through regulation, reallocation of canal allowances, induced recharge and monitoring
- ***Improve Water Quality*** of surface and groundwater through control of pollutants discharge from agriculture, industrial, municipal wastes and over abstraction of groundwater near saline groundwater zones
- ***Enforce Drinking Water and Sanitation Standards*** in urban and rural areas through construction of water treatment plants, sewage disposal, solid waste management, proper landfills siting and management
- ***Adapt to Climate Change, Floods, Drought*** through combination of structural and non-structural measures under short, medium and long term scenarios
- ***Maintain the Land Resource*** through control of waterlogging and salinity, soil conservation, afforestation, watershed management, protection of wetlands and Ramsar sites
- ***Rigorously pursue Demand Management*** through water conservation, improving irrigation efficiency, increasing water productivity, adjusting cropping patterns, developing water-food-energy nexus and population control
- ***Improve Water Governance*** through adopting IWRM approach, institutional reforms, strengthening and capacity building, farmers and other stakeholders participation
- ***Ensure Financial Sustainability*** through adequate and regular maintenance of water infrastructure, proper water pricing and effective project management of rehabilitation and new works

- ***Adroitly Address Transboundary Issues*** with other provinces and internally through structured negotiation and dispute resolution methodologies
- ***Develop Knowledge Database and Water Informatics*** through basin/sub basin wide development of GIS databases for water and environment, water balance and simulation models, hydro-meteorological network, real-time data acquisition and operational models
- ***Awareness Raising and Capacity Building*** through media campaigns, educational programmes, and research and development

## 1.6 Relative Priority of Water Uses

**The priorities for the consumptive and non-consumptive uses of water shall be as follows:**

1. **Drinking and Sanitation (WASH)**
2. **Irrigation**
3. **Livestock, fisheries and wildlife**
4. **Hydropower**
5. **Industry and mining**
6. **Environment, river system, wetland, aquatic life**
7. **Forestry including social forestry**
8. **Recreation and sports**
9. **Navigation**

# 2 ENHANCING WATER AVAILABILITY

## 2.1 Surface Water

Surface water available in the Indus System annually on average is 147 MAF (WAPDA, 2010). Canal diversions amount to 106 MAF with outflows to sea 30 MAF. There is large temporal variability in Annual River flows where the highest river flows are almost double of the lowest based on the analysis of the historical data of river flows during the period of 1937 to 2014.

Management of entitled water of 55.94 MAF for the Punjab's canal commands (perennial and non-perennial) is needed for efficient utilization of scarce freshwater resources in the canal commands. The entitled water as per Pakistan Water Apportionment Accord of 1991 has already been fully allocated to the existing canals in the province. Thus, in future, the new water resources in canal commands will come from saving of existing losses and re-allocation of canal water allowances – largely in the domain of water management.

In addition to the perennial water, the Accord also allocated 37% of floodwater to the province of Punjab. If we assume annual median flows of Indus River System of 134 MAF and leaving the average canal deliveries of 103 MAF, the balance available floodwater per annum is around 31 MAF in a median year.

The Potohar plateau is having runoff availability of around 3.6 MAF in a median year. Small dams have been constructed or planned to have gross storage capacity of only 0.30 MAF. This indicates a large potential of storage of runoff in small dams, which demands to initiate a crash program to construct cascades of small dams for introducing high value agriculture in the province along with strong components of watershed management and command area development. These dams can be managed on demand basis as the water releases can be controlled at the gates installed at the head of the canal, in contrast to the fixed-rotation and continuous-flow irrigation system in the canal commands. The studies conducted by PARC and IWMI during 90s around Shahpur, Mirwal and Bughtal dams indicated that these dams have contributed significantly in recharging the localized shallow groundwater.

The studies conducted by NESPAK during 1998 identified that around 2.71 MAF of flood water is available from the hill-torrents in the Suleiman ranges for the development of Spate irrigation in the districts of D.G. Khan and Rajanpur. The flood water from hill-torrents severely damages infrastructure and settlement almost once in 5 years.

In the Cholistan and Thal deserts localized runoff is also available, which can be used for storage of flood water and to mitigate the impacts of droughts when there is hardly any water available in the small ponds locally called 'Tobas' for domestic and stock water purposes. The Cholistan Development Authority and Pakistan Council of Research in Water Resources (PCRWR) have constructed runoff harvesting ponds for multiple uses but these ponds are less sustainable compared to the indigenous ponds constructed by the community. PCRWR estimated that 0.350 and 0.200 billion $m^3$ of runoff is available in Cholistan and Thal deserts, respectively. The dew and fog can also be harvested for domestic uses.

The riverine area is another potential region comprising of almost 0.5 million hectare of land located along the rivers and streams flowing in the province. These areas are prone to flood disasters during the flood season and droughts during the winter season. The communities living in these areas are most vulnerable and need to be capacitated to manage the disasters of floods and droughts.

**To enhance the availability of surface water, the following policy should be adopted:**

- **Continue efforts vigorously for construction of Kalabagh, Bhasha and other mega projects on Indus Basin**
- **Enhance canal capacities to utilize balance flows**
- **Construct small dams in Pothohar and other region of Punjab**
- **Conduct feasibility studies for dam construction in DG Khan Hill Torrents**
- **Construct flood channels to divert flows to Cholistan and Thal deserts during monsoon period**
- **Harnessing information technology and creating knowledge base**

## 2.2 Groundwater

The safe potential of groundwater abstractions in the province is around 43 MAF, out of which 60% is in the fresh groundwater zone and rest is within the marginal to brackish quality zones. Nearly 50% of irrigation requirements in Punjab are now being met by groundwater. Currently, around 45 MAF of groundwater is being abstracted annually in the province indicating net over abstraction of 2 MAF. The lowering of water table is more severe in large urban centers (e.g. Lahore) and the fragile regions outside the canal commands, where groundwater is already at premium – Potohar plateau, Soan valley of Khushab, Cholistan desert, etc.

To ensure sustainable groundwater abstraction, monitoring measures need to be rigorously implemented. Groundwater GIS maps need to be developed at large scale and groundwater budgets need to prepared at sub-basin (doabs) and canal commands level to monitor discharge and recharge. Possibility of movement of saline zones into fresh zones needs to be checked and technologies promoted for undisturbed extraction and skimming of fresh groundwater layers overlaying saline zones. Groundwater recharge measures need to be promoted and as 40% of recharge comes from irrigation system, the lining of canals, distributaries need not be done without proper feasibility.

To control over abstraction in critical zones, regulatory mechanisms need to be put in place and enforced. A Water Resources Commission should be established which will be responsible for allocation and management of water resources for different purposes.

**To develop sustainable groundwater abstraction, following policy should be adopted:**

- Groundwater abstraction should be optimized at balance recharge
- Water Resources Commission should be created to manage groundwater abstraction
- Artificial recharge of groundwater through flood channels, rubber dams, detention ponds, rainwater harvesting etc.
- Incentives should be given to households, communities for rainwater harvesting and artificial recharge
- Seepage through canal system in saline zones should be restricted through lining
- Urban groundwater pumpage in major cities e.g Lahore, Gujranwala etc. should be managed and supplemented by surface water
- Awareness raising and capacity building of the stakeholders must be ensured

## 2.3 Flood Waters Beneficial Use

While floods are often viewed as natural disasters, its beneficial aspects such as, deposition of nutritiously rich sediment on land, recharging ponds, lakes and wetlands and groundwater recharge are often overlooked. Floods also reduce drastically pollution levels in lakes and water bodies. Presently, flood water is channeled within flood embankments through the barrages into the sea. When unplanned breaches occur during emergencies, flood waters spread on land causing huge flood damages. These damages can be reduced through early warning systems, floodplain regulation and also pre-planned and predetermined breaches, where flood waters follow their natural pathways. Also flood escape channels can be provided to open, un-inhabited areas such as deserts, wetlands and lakes which will not only reduce flood hazard downstream but provide much needed surface and groundwater recharge to upstream areas.

This method will achieve the dual purpose of reducing flood damages and spreading flood waters overland. Of course, the infrastructure such as roads, buildings will have to withstand flooding and people evacuated or housed in flood protection shelters and flood damages paid through flood insurance and other measures. In Mississipi River Basin, flood embankments and levees have been either removed or their heights lowered to allow flood waters to follow the natural floodways.

**For beneficial use of flood waters, following policy should be adopted:**

- **Construct flood channels to divert flood waters to desert areas like Cholistan, Thal, etc**
- **Allow flood waters to spread overland through pre-planned breaches**
- **Harness flood waters in Hill Torrent areas like DG Khan through construction of storage and delay action dams, dispersion and diversion structures**
- **Augment artificial recharge of aquifer from flood water**

## 2.4 Water Use and Allocation

Total water use by the major sub-sectors of water use (domestic, industrial, commercial, and agriculture) is around 99.86 MAF.Agriculture is the largest user of water consuming 95.3 MAF or 95.4% of total water use in the province during 2015. Thus, only 4.56 MAF or 4.6% of water is used for domestic, industrial and commercial sub-sectors. However, any further increase in the use of domestic, industrial and commercial sectors would come largely from agriculture sector, through adjustments by shifting water from canal supplies and/or increased abstractions from groundwater. Canal supplies can be provided to those urban areas having access to the irrigation system network.

Currently around 3.06 MAF (3.78 billion $m^3$) water is used for domestic purposes. The projections made for 2025 indicate that increase of 0.54 MAF (0.667 billion $m^3$) would be required to meet the demand in 2025. Water allowance of 100 liters per capita per day is used while estimating the current utilization and projections based on the current average water

allowances fixed by WASA and PHED (GOP and World Bank 2006). This is the water allowance also recommended by WHO and World Bank considering the health hazards of very low level and adequate to meet the requirement of population in the province.

Currently, agriculture sub-sector of water use consumes 95.3 MAF. This would increase to 112.3 MAF in 2025 under a strategy of increasing the irrigated area. The increase in the next decade would be around 18% than the current water use using a growth rate of 1.66% and 1.65% for the periods of 2020 and 2025, respectively. It is not possible to provide additional amount of water because new resources of water are harder to find. The expansion in irrigated area will not be a feasible strategy. The sustainable option is to enhance water productivity of existing irrigated areas at a growth rate of 1.66% per annum against the annual growth rate of agriculture sector which ranges between 2 to 3% per annum in the last decade, which requires enhancement of crop productivity and reduced water use to mature a crop. This is possible by adoption of water efficient technologies and improved production practices.

The current water use in industrial and commercial sub-sector is 1.50 MAF or 1.85 billion $m^3$ or 1850 billion liters, which is a sizable amount of water. The projections for 2025 indicated that the industrial water use will be 2.44 MAF having an increase of 0.94 MAF or 1160 million $m^3$ per annum, representing an increase of 62.7%. The growth rate of industrial sector in Punjab was 5% during 2001-2011 and the Punjab Growth Strategy suggested a growth rate of 8% in the next decade. However, water projections for 2020 and 2025 are based on increase in water demand of 5% per annum, as these industries have to be water efficient in the next decade. The additional water required for the industrial sub-sector of water use will be met out of the savings made in water use in the agriculture sub-sector.

The Indus basin irrigation system is a fixed-rotation and continuous-flow irrigation system and water is available to farmers under a rigid system of water distribution - 'Warabandi'. There is also wide variability in design water allowance of various canals of 2.9 to 8.0 cusecs of water per 1000 acres, which resulted in waterlogging and salinity in canal commands having higher water allocations e.g. Muzaffargarh canal and increase in soil salinity in canals having lower water allowances e.g. Lower Bari Doab canal. Conversion of non-perennial canal commands to perennial canal commands has also resulted in creating waterlogging and salinity.

The current system of water distribution among the water users on a Mogha command is based on 'Warabandi, which is a system based on 'time-equity. The 'Warabandi formula is based on an assumption that there are no water conveyance losses in earthen channels, which is completely a false assumption. The concepts of *'Bharaie'* and *'Jharaie'* are meant for taking care of initial losses till the full discharge of water is available at Nacca or adjusting dead storage in the water allocation time for the tail-end farmers. This is always confused with the water conveyance losses.

Farmers at tail reaches are not receiving their due share and their lands are subject to salinization due to fallowing of land and accumulation of salts in the root zone. The research conducted by USAID, IWMI and PARC indicated that farmers at tail-end are receiving 30-40% less water than their allocation in terms of volume-equity.

**For water use and allocation, following policy should be adopted:**

- **Assess the water requirements for different sectors and assign priority for allocation of water for various sub-sectors of water use in the order of domestic water, livestock, water for agriculture, water for industry and commercial uses, water for environment, forestry and recreational uses**
- **Gradually shift to volumetric supply of warabandi instead of fixed time warabandi system**
- **Reassess water allocation of different canal systems and reallocate water among different canal command areas accordingly**
- **Enforce measures to reduce, reuse and recycle water in domestic, commercial and industrial sub-sectors**
- **Harnessing information technology and creating knowledge**

# 3 IMPROVEMENT IN WATER QUALITY AND ENVIRONMENT

## 3.1 Surface Water

The Indus River is polluted as quality parameters are now having higher concentration than the safe limits. Even the coliform level, which should have not been present in water bodies at all, averaged eight per ml. The Indus River is polluted due to disposal of untreated domestic, industrial and commercial effluents. The pollution in the river flows increased during periods of low flows (December-January) due to concentration of domestic, industrial and agricultural effluents.

Water pollution in the Indus River system results from three major sources: a) entry of untreated domestic effluents from the large urban towns; b) untreated industrial effluents; and c) return-flows from agricultural lands through agricultural drainage system. Most cities and towns dispose their untreated domestic effluents into the Indus river system. Even if the treatment facility is provided, lack of monitoring results in lack of effectivity of the treatment process. None of the treatment plant in Punjab provides 'Zero-Risk Treated Water', which can be safely disposed in to the freshwater bodies. Even the standards for disposal of treated wastewater to freshwater bodies are not available.

The major concern is the disposal of organic substances in to the river system. This causes depletion of dissolved oxygen in river water. In extreme cases, when assimilative capacity of river is exceeded, anaerobic conditions result. This could be a problem in the Indus river, during months of low flows (December, January, April and May), or, when there are water shortages in the Indus River system. Under anaerobic conditions, iron and manganese become more soluble and become a potential source of groundwater pollution. Due to high coliform contents, use of water for drinking without treatment would result in water-borne diseases like malaria, typhoid, cholera and dysentery.

Disposal of untreated industrial effluents, depending upon the nature of industry, comprise wide-ranging variables - organic substances; cations in the form of sodium, potassium, calcium and magnesium; anions in the form of carbonates, bicarbonates, chloride; other inorganic substances like fluoride, silica, cyanide; heavy metals like cadmium, chromium, copper, mercury, lead, zinc, nickel, etc. The return-flows from agricultural lands include total dissolved solids, total suspended solids and pesticide

residues. In case of thermal power plants, the major concern is temperature and mercury poisoning of water, which is extremely dangerous.

Salinity, in case of return-flows from agricultural lands, is an important property and, in the present case, is of major concern. Disposal of saline effluents in the Indus River degrades its water quality. The groundwater quality in the Indus Basin is impacted by water quality of river and vice versa because Indus River gains from groundwater in the dry season. The disposal of drainage effluents back to the river system further add salts in to the soils and purpose of drainage is lost.

Water quality variability also depends on hydrological regime of the Indus River. Dissolved substances in river water are highly variable from one location to another, depending on their sources, pathways and interactions with particulates.

The chemical quality of river water is estimated in Punjab at various points. In the northern areas of the basin, the water quality is around 250 ppm which deteriorates from north to south to the extent of 450 ppm during the winter season, whereas it improves during the Kharif season due to five-fold increase in the river flows. Furthermore, all sewage and industrial effluents ponded in the river system is flushed to the Indus basin irrigation system. Most of the laboratories available with the public-sector institutions are not accredited from the accreditation institutions. The laboratories available in the Punjab are well equipped for chemical and physical analysis but hardly few laboratories are fully equipped for bacteriological and eco-toxicological parameters.

There is huge variation in the chemical quality of groundwater from one hydro-geologic basin to another. Within the Indus basin, in general, water quality deteriorates from north to south. The groundwater surveys and monitoring data indicated that areas close to recharging sources, along the rivers in the Indus basin and aquifers recharged through rainfall, have good quality water.

Surface water quality standards for stock water, poultry and freshwater fisheries are not available in Pakistan. FAO guidelines are available for stock water and poultry water for chemical concentrations alone. The water quality standards provided by the Australian Department of Agriculture and Food are more comprehensive for stock water and can be adopted for Punjab Australian water quality standards for poultry.

Philippines water quality standards for fisheries can also be adopted for Punjab province considering the local realities.

## For improving quality of surface waters, following policy should be adopted:

- Refine existing water quality standards for drinking water, domestic water and irrigation; develop water quality standards for specialized uses (stock water, aquaculture and poultry); and develop water quality standards for treated wastewater (sewage, industrial and agricultural effluents) to ensure disposal of zero-risk treated water in to the Indus river system
- Formulate and enforce regulations for water quality standards
- Maintain health of Indus river system through monitoring of surface water quality and enforce legislations to plug entry of untreated effluents in to the river system in collaboration with EPA
- Minimum environmental flows be studied and provided for dry reaches of rivers
- Enforce a system of separate disposal of sewage, industrial effluents and storm water in the urban towns and rural areas, wherever feasible and possible, to ensure cost-effective treatment and safe use of tertiary treated wastewater as a resource
- Enhance the analytical capacity of laboratories
- Create awareness and initiate programs for mass education of civil society to make 'water as business for everyone

## 3.2 Ground Water Quality

About 5.6 million tons of fertilizer and 70 tons of pesticides are being consumed in the country annually [Brisco, 2005]. A major portion of it is consumed in Punjab. The use of pesticides is increasing 6% annually. A study by EPA Punjab [2005] collected 280 samples from all over the province and found that 25% of samples contained concentration of heavy metals beyond WHO limits. Groundwater includes water from shallow dug wells, shallow tubewells and deep tubewells. The quality of shallow wells and tubewells around cities and in peri-urban areas is affected by domestic and industrial effluents, because these effluents are disposed in to ponds and waterways. Seepage of these effluents affect the quality of shallow groundwater and majority of samples analyzed for large cities and peri-urban areas are polluted with bacteria, heavy metals and chemicals. Poor quality of groundwater and intrusion of brackish groundwater into thin layer of freshwater in Cholistan, Suleiman ranges and in Southern Punjab has been observed.

Groundwater resources of Punjab are being contaminated in many ways. Industrial and municipal effluents are recognized as major sources. Contamination of freshwater due to lateral and horizontal movement of deep-seated saline water, drainage effluents and disposal of saline water into canals are becoming a great threat. Disposal of industrial waste is continuously adding heavy metals and trace elements into groundwater aquifers and surface water bodies that also are indirect sources of contamination for groundwater. Solid municipal waste sites in all the cities are the permanent source of organic and biological pollution. Liquid and solid domestic wastes not only causing environmental hazards, but also becoming the source of all sorts of epidemics.

EPA is actively working and issuing guidelines to the urban authorities to manage their hazardous and domestic waste problems. Similarly, industrial units are being pursued to install treatment plants so that their liquid waste should not contaminate the groundwater, directly or indirectly. These management measures are being partially exercised in the province because of two main reasons: firstly, lack of information about nature of existing industry and secondly, illegally installed industrial units. At present, there are only few heavy industrial units, which have functional waste treatment plants working on international standards. Chemical factories, of any capacity, are directly contaminating water resources and there is no check on them.

In Kasur, Lahore, Faisalabad, Rahim Yar Khan, Rawalpindi and many other cities, the Government of Punjab either commissioned treatment plants for sewage and industrial effluents or in the process of completing the construction. Projects have been initiated in other cities, towns and rural areas to provide sanitation facilities, which is a first step in the right direction. However, cost-effective systems for treatment of sewage water need to be developed so that municipalities can maintain these systems on sustainable basis.

Quality of groundwater varies widely, ranging from less than1,000 ppm to greater than 3000 ppm. Some 5.75 million ha are underlain with groundwater having salinity less than 1000 ppm, 1.84 million ha with salinity ranging from 1000 to 3000 ppm; and 4.28 million ha with salinity greater than 3000 ppm.

**For groundwater quality,
following policy should be adopted:**

- **Maximum efforts to be under taken to prevent salt water intrusion into fresh groundwater zones**
- **Introduce biological control methods for Pest Management instead of use of pesticides for crops**
- **Control and monitor use of brackish water for agriculture**
- **Ensure effective enforcement of regulations for managing the health of aquifers in collaboration with EPA**
- **Integrate Solid Waste Management Plan and siting of Landfill sites to prevent seepage into groundwater**

# 4 DRINKING WATER AND SANITATION

## 4.1 Drinking Water

According to WHO, 80% of diseases are caused by unhygienic conditions and unsafe drinking water. Access to drinking water has increased from 85% in 1990 to 92% in 2010. In the same time, sanitation coverage increased from 27% to 48%. The water supply network in urban areas is in dilapidated condition requiring huge replacement / up-gradation costs. Tube wells are the primary source of drinking water and in some areas, like Lahore, a deep cone of depression has developed due to excessive pumping. Alternate sources of surface water need to be provided for drinking purposes. Sources of drinking water whether surface or groundwater need to be protected from all sorts of contamination.

Urban Water Supply and Sanitation systems need to operate on financially sustainable basis for which reduction in wastages, non-revenue water and theft is essential. Private sector is now also a huge source of bottled drinking water which is pumping groundwater free of cost. Regular monitoring of drinking water standards needs to be rigorously enforced.

## 4.2 Disposal of Wastewater

The most questionable system prevailing in the urban towns and rural areas is that same network of waterways is used for the disposal of domestic, industrial and agricultural effluents and thus the treatment become difficult as the volume of effluent increases and different qualities of effluents are mixed. The cost of treatment is also increased. There is a need to separate the domestic, industrial and agricultural effluents and separate treatment system needs to be developed for three types of effluents. The storm water can directly be used for recharging groundwater and irrigation without much treatment, whereas tertiary treatment system is needed for domestic and industrial effluents. The industrial effluents have presence of heavy metals along with chemicals and bacteria, therefore the treatment process is costly.

## For drinking water and sanitation, following policy should be adopted:

- Provide clean and safe drinking water to all urban and rural communities
- Prepare Master Plans for safe drinking water and sanitation of major cities
- Protect surface and groundwater sources of drinking water from all sorts of contamination
- Build, maintain water supply and sewerage infrastructure on financially sustainable basis
- Provide surface water for drinking purposes to reduce pressure on groundwater pumping for major urban center's
- Regulate, monitor private sector for over exploitation of groundwater, compliance with water quality standards and proper disposal of water containers
- Adopt all measures to achieve Sustainable Development Goals (SDGs)

# 5 FLOODS, DROUGHT AND CLIMATE CHANGE

## 5.1 Floods

The issue of managing floods and droughts is becoming complex. In the last decade the province has experienced frequent and severe floods and droughts. The activities are still focused on the control of floods and very little effort has been made to manage and use floodwater on sustainable basis.

In line with the current practices worldwide, the Punjab Provincial Policy for Floods should focus on integrated flood management planning laying more emphasis on the non-structural measures, like reservoir operations, flood forecasting and early warning, flood risk zoning, watershed management, flood proofing and insurance, disaster management and other measures aimed at mitigating flood damages rather than completely controlling floods- an impossible task as experienced worldwide. However, considering the uniqueness of Indus Basin with its large integrated network of dams, barrages and canals, which is the lifeline of agriculture economy of the country, the protection of this infrastructure as wells as the irrigated area that it feeds must also be given due consideration.

Encroachments on floodplains for agricultural purposes, associated settlements and other infrastructure are main reasons for increasing flood damages. Judicial Flood Enquiry Report following the flood of 2010 also highlighted the need to setup and effectively manage the floodplains. Well informed community role is also required so that permanent settlements in the floodplain areas are avoided.

Deforestation in the uplands of rivers at an alarming rate needs to be addressed immediately. This is one of the causes of global warming/climate change, silt erosion and landslides.

The planning strategy or coping with floods should have following three elements:

- Reducing the flood peaks and inundation extents
- Reducing susceptibility to damage
- Mitigating the flood impacts

**For flood management, following policy should be adopted:**

- An Integrated Flood Management approach embedded within IWRM is to be adopted
- Flood protection facilities (embankments, spurs) should be regularly maintained annually and new structures constructed where required on the basis of model study for higher return periods
- Design, maintenance standards and operation rules for barrages should be reviewed and updated
- Flood Plain Maps and Flood Protection Plans should be updated regularly
- Coordination be enhanced with WAPDA for reservoir operation of Mangla Dam
- Hill Torrents Flood Management Plans be developed and implemented. Watershed Management Plans be prepared and integrated with flood management
- Drainage plans of urban and rural areas be developed
- River Act be enacted and flood zoning carried out and implemented along all rivers
- Coordination with PMD be carried out for early flood forecasting and warning
- Community participation be encouraged for flood zoning, disaster management and relief
- Increase revenue for maintenance and management of flood infrastructure

## 5.2 Drought Management

Drought is a slow creeping phenomenon with no clear beginning or end. When it occurs, it affects a large area and persists for long duration of several years. Pakistan suffered a 10-year drought from 1999-2008. It caused wide spread damage in Baluchistan, Thar desert and other dry areas. Punjab suffered heavily in Potohar and Cholistan areas. It was

availability of groundwater which saved Punjab's agriculture during this period. Surface storages alone do not provide safety against drought. Groundwater recharge measures are more effective in dealing with drought. Small dams in Potohar region and drought management plans focusing on planned economic activities in Cholistan are necessary.

**For drought management, following policy should be adopted for drought prone areas:**

- **Drought Management Plans be prepared, especially in Cholistan and Thal desert areas focusing on construction of water ponds**
- **Deep groundwater wells be drilled in selected areas**
- **Groundwater recharge measures be taken with construction of detention ponds etc**
- **Flood waters be diverted in desert areas**
- **Non-water related activities be planned in desert areas**

## 5.3 Climate Change

Pakistan is a high-risk country with respect to climate change. It is predicted that glacial retreat of western Himalayas which feed the Indus will cause a 50-year increase in flows followed by eventual reduction of flows. There will also be increased variability of inter and intra annual rainfalls resulting in increasing flood and drought situations. Flashier floods may also increase making the Hill Torrent regions more prone to increasing damages. Flooded area is likely to increase and water scarcity issue may become more aggravated.

The measures to be adopted should consist of more mega storages to provide flexibility in water distribution and adaption measures to cope with flood and drought situations.

## To adapt for climate change, following policy should be adopted:

- Local Climate Models should be developed from Global Climate Models to better understand the local impacts of Climate Change
- Surface and Groundwater carryover storages be developed
- Policy proposed for flood and drought management be implemented
- Adaptive measures be worked out to mitigate impacts of Climate Change
- Strengthen capacity of universities and research centers to study Climate Change and collaborate actively with national and international organizations
- Policy measures related to water resources, applicable to Punjab, in line with National Climate Change Policy 2012 be adopted

# 6 WATERLOGGING AND SALINITY CONTROL

## 6.1 Waterlogging

Waterlogging and salinity is not as severe an issue as it was in the 1980s, thanks to the proliferation of private tubewells which are pumping today about 45 MAF of groundwater in Punjab [ACE&SMEC 2011]. However, total CCA area in Punjab (14 mha) with less than 3.0 m depth has increased from 2.58 mha in post monsoon 2006 to 2.63 mha in post monsoon 2009 while simultaneously registering an 8% decrease in good water quality at these depths. Nearly 12.6% area is being irrigated with TDS greater than 3000 ppm which is increasing salinity in the soils.

Currently, 2.15 million ha of land is waterlogged having water table depth of less than 3 m, as per WAPDA estimates of 2010. Thus, quite a sizable area within the canal commands is facing problem of waterlogging and in most of these areas' groundwater is normally of brackish quality. Around 32% area in the canal commands of the province is classified as saline, saline-sodic or sodic. Rest of the 68% area is salt free in terms of profile salinity.

## 6.2 Salinity

The salt balance of Indus Basin is precarious and does not bode well for long term sustainability of its land resources. About 29 million tons of salts (concentration 130 ppm) are annually carried by Indus River System. Out of this only 10 million tons are carried to the sea and the remaining are accumulated in the soils and in the root zone. In addition, 49 million tons are added by groundwater with average concentration of 1200 ppm. In Punjab, 15 million tons are added by Indus River System and 28 million tons by groundwater, out of which about 40 million tons (93%) are retained by soils. This means that 3 tons of salts are being added per hectare annually in Punjab which is alarming. An upside of low irrigation efficiency is that a large portion of this salt is leached down in the aquifer increasing the aquifer salinity as stated above.

The salts brought by pumped groundwater represent basically recycling of salts in groundwater and in the root-zone. However, there are localized cases, where recycling of salts in groundwater and in the root-zone has degraded the soil to the extent that salt built-up is beyond the threshold levels, which adversely affects the productivity of agriculture. Although, in certain cases saline groundwater is mixed with irrigation

water, yet, salts enter into the soils as a result of irrigation. Sustainability of groundwater for irrigation and municipal needs demands to maintain salt balance in groundwater and canal supplies.

## For waterlogging and salinity management, following policy should be adopted:

- Canal water allowances should be rationalized according to field conditions
- Surface drainage system be provided in basin/sub basin areas and connected with national surface drainage system
- Sub surface drainage patterns should be marked to mitigate the hazard of water logging
- Drainage effluent should be reused at local level to minimize need for disposal depending upon the water quality
- No irrigation scheme should be built without connected drainage scheme
- Afforestation measures should be carried out to control water logging and salinity
- Waterlogged areas should be explored for aquaculture, fisheries etc

# 7 DEMAND MANAGEMENT

## 7.1 Population Control

According to last Census in 1998, Pakistan's population stood at 132 million and currently (2017) is estimated at 208 million with annual growth rate of 2.4%. At this rate, it is projected to 251.2 million by 2025, 283 million by 2030 and 455 million by 2050. With mean annual flow, post Tarbela (1978-2015), of 145 MAF (179bcm), the Faulkner Water Stress Index is currently861 cubic meter per person per year (179 x $10^3$/207.8= 861), projected to drop to 712by 2025 and to 394 by 2050. At 1800, the country is considered as 'water stressed' and below 1000 as 'water scarce'. Pakistan has already become a water scarce country and the situation for Punjab, being the most densely populated province, is still grimmer.

Population of the province was around 20.6 million in 1951, which has increased to 110 million in 2017. In 66 years, the provincial population has been increased five folds. Punjab is an urbanized and industrialized province of Pakistan, after Sindh. The population density is 536 persons per $km^2$. The urban population is 40 million and rural population is 70 million. The population growth rate is 2.13%. At this rate, it is projected to 130 million by 2025, 145 million by 2030 cross and 221 million by 2050.

Low literacy rate is the single most reason for population increase. Child labor provides income to the unemployed and keeps children out of school which currently stands at 5.6 million, the second highest in the world. Drastic measures like China's one child policy cannot be adopted. The only remedy is to put children in school and correct gender biases. Educated and employed women will have less children.

In the context of IWRM, Ministry of Population & Welfare, Ministry of Education and Ministry of Religious Affairs are direct stakeholders for reducing demand on water. Their participation should be elicited on investments in water sector. A benefit cost analyses is required on whether investments in water sector on supply side is better than a similar investment in schools or women employment on the demand side.

**For population control, following policy should be adopted:**

- Invest more in education to put every child in school
- Ban child labor and increase women employment

## 7.2 Water Conservation

Water conservation may be defined as any beneficial reduction in water loss, use and waste of resources, avoiding any damage to water quality and improving water management practices that reduce the use or enhance the beneficial use of water.

One strategy in water conservation is rain water harvesting. Digging ponds, lakes, canals, expanding the water reservoir, and installing rain water catching ducts and filtration systems on homes are different methods of harvesting rain water. Harvested and filtered rain water could be used for toilets, home gardening, lawn irrigation, and small scale agriculture.

Another strategy in water conservation is protecting groundwater resources. Contamination of groundwater through storage tanks, septic systems, uncontrolled hazardous waste, landfills, atmospheric contaminants, chemicals, and road salts need to be controlled.

A fundamental component to water conservation strategy is communication and education outreach of different water programs. Developing communication that educates science to land managers, policy makers, farmers, and the general public is another important strategy utilized in water conservation. Communication of the science of how water systems work is an important aspect when creating a management plan to conserve that system and is often used for ensuring the right management plan to be put into action.

The concept of 3-R in the context of reduce, reuse and recycle of wastewater can also be introduced in the domestic, commercial and industrial sub-sectors of water use in the province of Punjab.

Currently, water table in urban towns e.g. Lahore, Rawalpindi and Murree is lowering at a rapid rate. Municipalities and industrial states are

facing difficulty to meet their water needs solely from groundwater. In certain localities, the quality of groundwater is also a serious concern. These localities are more dependent on surface water at least for drinking.

The projections made for domestic/commercial and Industrial sub-sectors indicated that their demand of water in the next decade (2016-2025) will increase by over 18 and 63%, respectively; and for the large urban towns and metropolitans, and part of this demand would be met from the canal water supplies.

Water metering is another measure that reduces demand. Urban water users normally pay a fixed amount for unlimited water use. Indiscriminate washing of cars in Rawalpindi/ Islamabad where in dry or even average years, Rawal Dam and Khanpur Dam are unable to meet domestic demand poses a serious problem. Water saving fixtures can be used to save water for which industry can be given incentives.

Water trading is also now being used as a management measure. In California which is facing severe drought, cities have purchased water from farmers to meet cities demand. The internet technologies today make it easy for individual farmers to sell their water and not grow crops. Locally farmers sell canal water to other farmers if for some reason they don't require it. Farmers in some areas sell the canal water at half the price of tubewell rate, another indicator of actual price of canal water.

**For improving water conservation, following policy should be adopted:**

- Efficient use of water for agriculture, domestic, livestock, industrial, commercial and other uses should be given top priority
- Push for construction of mega dams at national level
- Construct medium and small dams where feasible in DG Khan Hill Torrent areas, Potohar region, and wherever feasible etc
- Carry out watershed management in DG Khan and Potohar areas including afforestation and increasing vegetative cover
- Seepage through distribution system in saline zones should be controlled with canal lining
- Volumteric system of 'warabandi'should be introduced instead of current time system
- 3R system(reduce, recycle, reuse) should be implemented in urban areas
- Water metering should be introduced in urban areas
- Include water education awareness in text book and curriculum

## 7.3 Irrigation Efficiency

Efficiency and water productivity will be the two important instruments/ tools to be used in agriculture sub-sector to reduce existing losses as new water resources for inter-sectoral shifts. Efficient use of water in agriculture demands the use of innovative technologies like laser land leveling, furrow-bed irrigation and precision planting on beds resulting in 30% savings in water and 20% increase in yield of crops other than rice. Private sector service providers in rural areas can be encouraged to establish small-scale enterprises for provision of these services to the water users. In areas outside the Indus basin canal commands, like Potohar plateau and deserts, drip-irrigation based farming for high valued crops is a feasible option.

**For improving irrigation efficiency, following policy should be adopted:**

- **Laser leveling, sprinkler, drip irrigation (high efficiency systems) should be introduced at farm level with subsidies**
- **Non beneficial evapotranspiration should be reduced**
- **Water measurement and reporting should be done in real time throughout the network upto minor level**
- **Hydraulic structures like falls, outlets, regulators should be maintained and kept in working condition**
- **Desilting of canals, distributaries, minors should be done regularly**

Introduce water efficient technologies and 'best practices' for optimal land use for irrigated agriculture to enhance water productivity and save water for re-allocations to other sub-sectors of water use.

## 7.4 Water Productivity

Pakistan's crop yields are much below world's average and also lag behind neighboring India. The main reason for low yields is inefficient irrigated agriculture which includes tenant-based farming (as against corporate farming), unreliable supply of canal water especially for tail end farmers, inefficient irrigation application, low seed quality, low use of fertilizer and pesticides etc. An equitable and transparent water distribution, extensification rather than intensification (spreading water over more land rather than increasing cropping intensities), rational support price structure, reducing non beneficial evapotranspiration (from weeds, shrubs etc.) are some of the measures required to increase crop yields.

**For improving water productivity, following policy should be adopted:**

- Possibility of corporate farming may be explored
- Introduction of drought resistant and water efficient crops
- Promote Research & Development (R&D) to develop new seeds to enhance crop yields
- Bring new virgin lands under cultivation (Cholistan, Thal etc.)
- Extensification over intensification should be encouraged
- Resolve the problem to have equitable distribution between head and tail farmers
- Have proper crop price support structur

## 7.5 Cropping Patterns

Pakistan is an arid country and it makes little sense to grow such high delta crops as sugarcane which consumes 8 times more water per acre than that required for wheat crop. Over the past 70 years, sugar industry under political patronage has grown 80 times and has even taken over the cotton belt of Southern Punjab and Sindh. Since South Punjab has non-perennial canal water, groundwater is being over exploited for sugarcane and is depleting at alarming rates. Besides, sugar factories generate a large amount of industrial pollutants which are not treated or disposed of properly. This policy is having a devastated impact on use of scarce water resource.

**For ensuring proper cropping patterns, following policy should be adopted:**

- Crop zoning need to be defined and approved. Sugarcane production be minimized in cotton belt areas such as South Punjab
- Low delta crops with high value should be encouraged

# 8 FINANCIAL SUSTAINABILITY

## 8.1 Water Infrastructure Financing

Pakistan's water infrastructure consisting dams, barrages, canals and other works is estimated to have a replacement cost of US$60 billion [Briscoe, 2005]. Out of this Punjab's share is US$ 20 billion for its irrigation infrastructure. Currently, there is no Asset Management Plan and maintenance is carried out on ad hoc basis. Assuming a 4% maintenance cost, the financial requirement works out to $800 million a year. The water charges recovery at 100 % recovery rate is only US$ 20 million a year which is grossly insufficient resulting in deferred maintenance. This requirement is bare minimum. If the infrastructure has to be kept in good condition, more funds are required. Lack of maintenance of distributaries, minors, watercourses and associated gates and structures, results in reducing hydraulic efficiency by as much as 30%.

Current Expenditure in Water Sector is less than 10% of the annual development budget. Year wise allocations for the last 4 years federally and for the province of Punjab are shown below:

**Table 1: Funds Allocated to Water Sector from 2014-2018**

| Year | Allocated Funds for Water Sector, Pakistan (Million Rupees) | Allocated Funds for Water Sector, Punjab (Million Rupees) |
|---|---|---|
| 2014-2015 | 47,030 | 46,175 |
| 2015-2016 | 57,482 | 46,400 |
| 2016-2017 | 95,820 | 53,800 |
| 2017-2018 | 105,575 | 59,100 |

**(Source: Citizen Budget Book 2014-2015 to 2017-2018 by Government of Punjab)**

## 8.2 Water Pricing

The rate of Abiana for Rabi crops is Rs. 50/acre and for Kharif crops it is Rs. 85/acre using a system of fixed-rate of Abiana per acre. The charges for fruit orchards are Rs. 850/acre and same is charged for fisheries on per acre basis for an allocated discharge.

The Abiana is a fraction of the non-water input costs (seed, fertilizer, pesticides, seed bed preparation, planting and harvesting) and thus needs revision of abiana rates to recover the O&M cost. This is possible only if the Department can provide quality and cost-effective delivery of volume-equitable water supply to the water users.

The recovery of Abiana meets only 10-12% of the current O&M cost. Even the shortfall in financial terms is provided by the Government of Punjab, but this does not mean that the irrigation system is maintained at the optimal level. Due to inadequate budget for O&M, part of the maintenance works is deferred. In certain cases, the deferred maintenance resulted in deterioration of the irrigation system to the extent that Punjab Government takes loans from the World Bank and ADB for rehabilitation of the irrigation system.

The cost of effluents disposed in to drains is very low. It is difficult to understand that why the untreated effluents are allowed to dispose in the drains at almost a free price. The current price does not mean anything for the commercial and industrial sub-sectors for supply of canal water or disposal of effluents in to the drainage system therefore the Department of Irrigation shall revisit the current prices and bring these to a level which motivate industrial and commercial sub-sectors to efficiently use water and reduce the effluents through recycling.

## For financial sustainability, following policy should be adopted:

- Abiana rates should be increased to recover O&M costs of Irrigation Infrastructure
- Agriculture income tax should be enhanced to cover rehabilitation works
- Reliance on foreign loans should be minimized and own resources should be mobilized
- Commercial/industrial water users should be charged separately

# 9 WATER GOVERNANCE

## 9.1 IWRM Approach

Integrated Water Resource Management (IWRM) is a process which promotes the coordinated development and management of water, land and related resources in a hydrological basin in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

The IWRM approach moves away from single sector water planning to multi-objective planning and integrated planning of land and water resources, recognizing the wider social, economic and development goals and entailing cross-sectoral coordination. It is a dynamic approach.

The process of policy making for IWRM requires extensive consultation as well as raising the awareness of the importance of integration among policy makers, stakeholders, and the general public. The sustainability of resources and policies should be the central goal.

## 9.2 Water Informatics

Access to information regarding canal water allocations and actual delivery of water at main canal, distributary and Mogha level is time consuming and not available in functional and relational forms. The Department of Irrigation is measuring data at main canal, distributary and minor heads and are available with the Department largely in data sheets. The Department is not measuring data at the Mogha level; therefore, water users are not getting any information on the available water in their respective watercourses. The water users are thus facing difficulty in managing any shortfall in the availability of canal water.

The only option available for sharing of data is to provide real-time and processed data on the website so that all the stakeholders can access the data on regular basis. Rather six-monthly reports on water availability (Kharif and Rabi seasons) at the level of main canal, distributary canal and Mogha commands be published and available on the website so that water users and their institutions are fully aware how the canals are being managed by the Department.

Internet and mobile phone technologies, remote sensing and GIS, drones with multiple sensors and very high ground resolution have

opened up a vast potential of real time data acquisition. When fed into simulation models, they not only provide information on theft, losses but provide valuable information on quick decision making.

IBMR Model located at WAPDA has recently been revised by NESPAK with latest technologies and platforms which provide information on cropping patterns in the 13 agro-ecological zones of Pakistan for maximizing economic benefit with available water. Similarly, models have been developed with World Bank funding for IRSA for equitable distribution of water between provinces in real time. Another on-going project is being implemented by NESPAK for Irrigation department for developing a state-of-the-art Water Resources Management Information System (WRMIS) for a canal command which in the next phase will be extended to whole of province.

## 9.3 Institutional Reform

Since 1973, the Irrigation Department has been engaged in water resource development with the establishment of Small Dams Organization and the construction of small dams for multiple purposes – irrigation, domestic and stock water. The Department of Irrigation has also been involved in provision of water to industries and municipalities from the existing canal water supplies. Therefore, the Department has already moved from 'irrigation' to 'water development'.

In 1997, with the promulgation of PIDA Act, the Department has also introduced the concept of participatory irrigation management in the canal commands on pilot basis. The institutional reforms under the Punjab Irrigation and Drainage Authority (PIDA) in the form of Area Water Boards (AWBs) at the canal level and Farmers' Organizations (FOs) at the distributary canal level were introduced without considering the socio-political setting of the province and without ensuring full ownership of the staff of the Department of Irrigation. Reforms are only possible if there is an ownership. In reality two parallel systems of management of canal irrigation are now in place – 5 canals managed under PIDA and 20 canals under the Department of Irrigation. Therefore, the desired objectives of reforms could not be achieved and the experiences are of mixed nature. It is the right time to review the lessons learnt from the institutional reforms in the five pilot AWBs and develop a system of reforms which suits the socio-political situation of the province and acceptable to the Department of Irrigation and the water users. A

new setup at provincial and canal circle level has been proposed within the IWRM framework in order to implement the water policy.

## 9.4 Strengthening and Capacity Building

Capacity Building of all water related Public Sector Organizations at Provincial level has been highlighted in National Water Policy. Punjab Irrigation Department has taken significant measures by adding various units, such as Strategic Planning & Reform Unit (SPRU), Flood Risk Assessment Unit (FRAU), Program Monitoring and Implementation Unit (PMIU). Similarly, Groundwater cell and GIS unit have been added in Irrigation Research Institute. Other departments have also undergone institutional reforms with capacity building. There is need to integrate these efforts towards implementing water policy within the IWRM framework.

## 9.5 Water Legislation and Licensing

Currently, there is no comprehensive legislation regarding water governance, allocations, use and management. Further, there is no regulatory mechanism for abstraction of water which is causing depletion of water resources. The Government will accordingly enact legislation to comprehensively regulate use of water and disposal of waste water. The comprehensive legislation will also address sustainable use of water, water conservation and recharge.

## 9.6 Public Awareness

Mobilizing public opinion is critical in successful implementation of water policy objectives. Recent campaign on the media for Bhasha and Mohmand Dams at behest of the Chief Justice of Pakistan has considerably raised public awareness about water scarcity in the country. This campaign needs to be sustained over long period of time and spread vertically and horizontally across all segments of society, government, all ages young and old, gender etc.

## For water governance, following policy should be adopted

- IWRM Implementation framework should be developed
- IWRM support tools e.g. GIS database for water & environment, water balance models, water quality models, decision support tools should be developed
- Environment and Social Management Guidelines for water sector projects should be developed
- The role and capacities of the departments and other stakeholders should be enhanced according to IWRM requirements
- Strengthening of the Department of Irrigation with change in mandate from 'irrigation' to 'water resources development and management'
- State of the art Water Resources Management Information system (WRMIS) need to be developed
- Capacity of water and agriculture related research institutions, universities, centers should be enhanced
- Formulate and enforce appropriate legislation for licensing regime of groundwater in the province to ensure sustainable use of groundwater; quality standards to ensure health of freshwater systems
- Appropriate amendments in bye laws, regulations for use of surface water where required should be done
- Reform and restructure Farmer Organizations/ WUAs to suit to local conditions
- Public awareness campaign needs to be launched over long period of time and spread vertically and horizontally across all segments of society
- The academia should include courses in their degree programs

# 10 TRANSBOUNDARY ISSUES, INTER-PROVINCIAL HARMONY

The impact of large-scale hydropower development by India on River Chenab raises concerns on its impact downstream in Pakistan even though they are run-of-river projects. The flows at Marala need to be put under greater scrutiny to detect any mal-operation.

Environmental flows were not part of Indus Water Treaty as a result of which serious environmental issues have emerged in Eastern Rivers.

Punjab should pursue the construction of Kalabagh Dam and seek to arrive at consensus with Sindh and KPK province. Mediation by neutral experts and out of box solution must be sought to break the deadlock.

## Water policy to address transboundary issues should include the following:

- **Monitor flows closely at Marala Headworks and other control points**
- **Monitor dry reaches of Eastern Rivers and other sites to estimate minimum water requirements for environment and ecology**
- **Strengthen the research capacity of Irrigation and other departments**
- **Monitor the groundwater flows across the border**
- **Out of box solution must be sought for the construction of large dams**

# 11 PROVINCIAL INSTITUTIONS

## 11.1 Punjab Water Council

A provincial body named as "Punjab Water Council" (PWC) shall be established with the following composition:

| | |
|---|---|
| 1. Chief Minister of Punjab | Chairman |
| 2. Minister for Irrigation | Co- Chairman |
| 3. Minister for Agriculture | Member |
| 4. Chief Secretary Punjab | Member |
| 5. Chairman P&D Board | Member |
| 6. Secretary Agriculture | Member |
| 7. Secretary Local Government | Member |
| 8. Secretary Irrigation | Member/Secretary |
| 9. Two Experts from Academia | Members |
| 10. Any other co-opted Member | Member |

The Punjab Water Council shall meet at least once a year and perform the following functions:

a) Review and coordinate implementation of the Punjab Water Policy and periodic updating of the same;

b) Recommend legislation, policies and strategies for water resources development and management;

c) Planning and coordination for water resources development and management activities at provincial level to achieve objectives of policy;

d) Review all major provincial water-related projects and activities in the fields of irrigation, drainage, flood control and hydropower;

e) Promote multi stakeholders' participation and integrated water resources management;

f) Review in consultation with concerned organizations the progress in controlling pollution of water bodies including rivers, streams, lakes and groundwater, canals, wetlands;

g) Coordinating water resources database service at different level;

h) Any other function for water resource development and management.

The Irrigation Department will serve as the Secretariat of the PWC. The Strategic Planning & Reform Unit of Irrigation Department will be strengthened to cope with the additional functions to be assigned to the existing organization.

## 11.2 Punjab Water Policy Implementation Committee

The following Committee is proposed which will be responsible for the implementation of Punjab Water Policy. The composition of the Implementation Committee will be as follows:

| | | |
|---|---|---|
| (i) | Chairman P&D Board | Chairman |
| (ii) | Minister for Agriculture | Member |
| (iii) | Minister for Industries | Member |
| (iv) | Minister for Environment | Member |
| (v) | Minister for Specialized H & M Education | Member |
| (vi) | Secretary, Irrigation Department | Secretary/Member |
| (vii) | Secretary, HUD Department | Member |
| (viii) | Secretary, Agriculture Department | Member |
| (ix) | Secretary, LG& CD Department | Member |
| (x) | Secretary, Environment Department | Member |
| (xi) | Secretary Energy Department | Member |
| (xii) | Secretary, Industries Department | Member |
| (xiii) | Secretary, Forest Department | Member |
| (xiv) | Secretary Specialized H & M Education | Member |
| (xv) | Director General, PDMA | Member |
| (xvi) | Three renowned water experts | Members |
| (xvii) | Any other co-opted member | |

The Implementation Committee shall meet twice in a year or more, frequently whenever deemed necessary to monitor the implementation of Punjab Water Policy.

# 12 WAY FORWARD

The Water policy needs to be approved on war footing and following steps need to be taken urgently:

**Way forward should consist of following steps:**

- **IWRM framework should be developed with detailed time bound implementation mechanism in the short, medium and long term along with roles and responsibilities of different stakeholders**
- **Punjab Water Policy Implementation Committee be formed consisting of members as outlined in Section 11 to support and monitor the implementation of water policy**
- **A water crisis awareness campaign be launched to apprise general public about impending water issues**
- **Monitor the groundwater flows across the border**
- **Out of box solution must be sought for the construction of large dams**

# Save Water for Future Generations

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