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FORMULATING A SUSTAINABLE URBAN GROUNDWATER ENVIRONMENTAL POLICY UNDER INCREASING POPULATION DEMAND

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ABSTRACT

This paper provides an overview of Pakistan's water-related problems in an urban context and how environmental policies have failed to address water quality degradation. The urban water problems include droughts, floods, water pollution and deterioration of water-related ecosystems. In this paper evolution of water law and policy to protect environment and its links with the water quality are explored in an urban setting of Lahore – the capital of the Punjab province of Pakistan. About 75% of Lahore's water requirement is met by groundwater which is recharged by the River Ravi. The Ravi River is also a recipient of urban and industrial waste waters of Lahore as well other urban and industrial waste on its way to Pakistan from the Indian part of the catchment. The River Ravi once a river that could sustain life and livelihoods for tens of thousands of people, is now one of the most polluted river in the world. The river Ravi presently receives 47% of the total municipal and industrial pollution load discharged into all the rivers of Pakistan. Due to very high dependence of river recharge to groundwater a better understanding of the surface-ground water interactions is highly important to maintain the quantity and the quality of the urban supplies. Environmental policies which link urban, agricultural and industrial water cycle especially the surface-ground water interactions are important to help formulate sustainable management of Lahore's water supplies. In this paper institutional reforms linked with the objectives of sustainable water resources management have been proposed.

KEY WORDS: Environment, groundwater, Lahore, Pakistan, policy and urban.

INTRODUCTION

Pakistan is situated in the North-West of the South Asian Sub-Continent, lying between 24^{o}-37^{o} North Latitude and 61^{o} -75^{o} East longitude. It is bounded on the East by India, on the North and North-East by China and North-West by Afghanistan, on the West by Iran and in the South by Arabian Sea (Figure 1). Currently Pakistan is a country of over 160 million people, which is expected to grow to over 220 million by the year 2025. The most pressing need over the next 20 to 30 years will be provision of minimum standard of basic amenities such water, food and sanitation to the rapidly increasing population while preserving its environment.

Despite Pakistan's achievement of record growth rates, buoyant levels of investment and sustainable fiscal balances through economic reforms, the natural resource base is stressed and environmental costs are very high, threatening to undermine growth prospects. The urgency of addressing Pakistan's environmental problems has probably never been greater.

The World Bank Report (2006) suggests that environmental degradation costs the country at least 6 percent of GDP or about Rs. 365 billion per year (US $ 6.05 billion per year). The future growth and maintenance of existing life functions are threatened by Pakistan's low, unreliable rainfall averaging 250 mm a year. Classified as water stressed, the country uses almost all of its available water supplies in most years. Population growth coupled with the demands of industrialization and urbanization are already creating conditions of water scarcity. Water shortages are further compounded by urban pollution leading to poor water quality. Untreated pollutants from industrial, agricultural and urban sources are released directly into surface and ground water bodies intended for human consumption, with little regard for assimilative capacity of eco-systems. This has resulted in heavily polluted water around towns and cities and a high incidence of disease, especially among the urban poor.

Figure 1: Map of Pakistan

To capture the ecologically sustainable development principles there is a need for strict protection policies that address environmental issues. To provide for sustainable development and healthy environment water is the key element of a nation's development needs. In case of Pakistan water resources are facing pollution challenges. This paper provides an overview of Pakistan's water problems and the evolution of environmental policies to promote conservation and longer term sustainability albeit with a very poor track record of implementation. In the later part of this some paper policy options for managing urban water cycle in Lahore are outlined.

AN OVERVIEW OF SUSTAINABLE WATER MANAGEMENT ISSUES IN PAKISTAN

Pakistan is dependent on a single river system - Indus River System (including the Indus, Jhelum, Chenab, Ravi, Beas and Sutlej rivers) which receives on average about 180 billion

cubic meters (BCM) of freshwater annually from glacier melt, snowmelt and rainfall. Despite the enormous size of the Indus Basin system, water availability on a per capita basis is declining at an alarming rate, from about 5,000 cubic meters per capita in 1951 to about 1,100 in 2006, which is just above the internationally recognized scarcity rate, and is projected to be less than 700 by 2025 (World Bank Report, 2006).

Pakistan has tremendous groundwater storage potential available in the form of aquifer system of Indus Plain and mountainous valleys of North West Frontier Province (NWFP) and Balochistan province. The alluvium occupies 505,000 sq. km against the total geographic area of 804,000 sq. km of the country (Bhatti, 2002). At present, groundwater resources are heavily over exploited to fulfil the demands of irrigation and urban utilization. Overall figures indicate that estimated conservative figure for safe yield is 6.78MHM (55 MAF), whereas 15.9 MHM (48 MAF) are being extracted (Bhatti, 2002). There are clear evidences that groundwater withdrawal is more that annual average recharge in certain parts of the country. As a result watertable is continuously depleting in all the urban areas and in a larger part of countryside.

Contamination of fresh water due to lateral and horizontal movement of saline water (due to mining in fresh water zones situated close to salt-water zones), drainage effluents and disposal of saline water into canals are becoming a great threat. Industrial effluents, municipal effluents and agricultural runoff are the principal sources of pollution. Disposal of untreated 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 urban centres are the permanent source of organic and biological pollution. Untreated liquid and solid domestic waste are not only causing environmental hazards, but also becoming the source of all sorts of epidemics.

There is presently very little private investment in the urban water sector utilities, especially in the larger towns and cities. The Water & Sanitation Agencies (WASAs) and municipal bodies are generally financially weak and do not generate capital for urgent rehabilitation, improvement and expansion of the existing infrastructure and facilities. Some of the causes of the poor performance of the public sector organizations for urban water and sanitation sector include: i) political influence in management and staffing resulting in overstaffing with the wrong type of employees; ii) rampant unionism; iii) widespread theft of water due to the connivance of water vendors, local politicians and the staff; and iv) poor recovery of bills, especially from governmental water users.

OVERVIEW OF ENVIRONMENTAL POLICIES & LAWS IN PAKISTAN

In response to the changing national needs and international obligations Pakistan has progressively developed a number of policies & laws and for the protection of the environment at the Federal and the Provincial levels. These laws include overarching environmental protection principles but fail to details with the protection of surface and ground water resources in an urban environment.

Some of the environmental laws in Pakistan have their origin in the colonial times e.g. i) Canal and Drainage Act 1873; ii) the Explosives Act 1884; iii) the Ports Act 1908; and iv) the Forest Act 1927. The post independence key environmental laws include (Hagler, 2000):

- The Fisheries Ordinance 1961
- The Punjab Wildlife (Protection, Conservation and Management) Act 1964
- The Fire Wood and Charcoal (Restriction) Act 1964
- Motor Vehicles Ordinance 1965
- The W. P. Regulation and Control of Loudspeaker and Sound Amplifier Ordinance 1965
- The Agricultural Pesticide Ordinance 1971
- The Antiquities Act 1975
- Environmental Protection Ordinance 1983
- Pakistan Environmental Protection Act (PEPA) 1997

Under the Pakistan Environmental Protection Act 1997 (GOP, 1997) a number of rules, standards and institutional have been implemented (Ahmad, 2002). However the implementing agencies do not have the capability and capacity to fully implement the legal provision. This is due to factors such as:

- Political instability and lack of multi-sector commitment
- Corruption and weak governance
- Absence of a strong policy framework
- Limited institutional technical and legal capacity
- Poverty and external debt resulting in conflicting growth policies e.g. subsidies on fossil fuels and establishment of new industry without proper environmental safeguards

The other instruments for protection of environment are: i) National Conservation Strategy (NCS) 1992; ii) National Environmental Action Plan (NEAP) 2001; and iii) National Environmental Policy (NEP) 2005. The top priority of the National Water Policy (NWP), approved recently by the Federal Government, is the provision of safe drinking water for all, along with hygienic sanitation for urban and rural populations. The NWP establishes important basic principles including protection of sources, monitoring and maintenance of drinking water quality, and progressive upgrading of facilities for the provision of water and sanitation, on a sustainable basis. Though the National Water Policy (NWP) provides a framework within which to establish a single set of rules and regulations for Pakistan's future water management but there is need for harmonising it with the Pakistan Environmental Protection Act (PEPA) 1997.

The national environmental laws and policies have not effectively implemented due to range of reasons such as: i) lack of political will; ii) influence of industrial lobby groups in the government sectors; iii) inability to describe implementation pathways; iv) disconnect between the legislative and implementation bodies; v) inadequate monitoring, reporting and implementation infrastructure; and vi) lack of capacity building programs for the regulation and implementation bodies. These issues are further elaborated taking the example of Lahore city's water resources.

STUDY AREA DESCRIPTION

Lahore is located on flat alluvial plain on the left bank of River Ravi (Figure 2). Lahore District lies between 31°-15' and 31°- 42' north latitude, 74°- 01' and 74°-39' east latitude. The general altitude of the area is 208 to 213 meters above sea level.

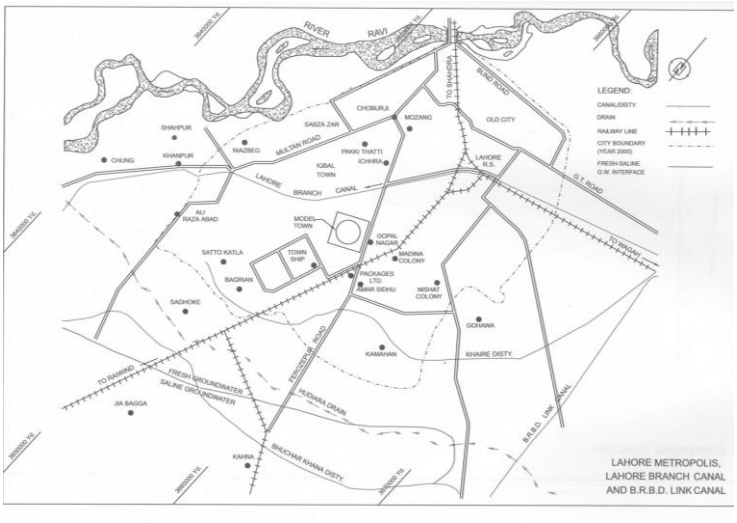

Figure 2: Map of Lahore Metropolis, Major Canals and Drains (Mashhadi and Muhammad, 2000)

Lahore is the provincial metropolis and the largest urban district of Punjab. It is also a second urban center of Pakistan after Karachi. Lahore encompasses a range of commercial, social, cultural, industrial and educational activities. According to census 1998 the population of Lahore was 5 million which has now increased to 6 million.

The Water and Sanitation Agency (WASA), Lahore is responsible for providing water supply, sewerage and drainage facilities to 90% population of Lahore. The remaining population of Lahore is served by other agencies like Lahore Cantonment Board, Model Town Society etc.

Ground water is the main source of water supply in Lahore. The main sources of Lahore aquifer recharge are River Ravi, BRB Canal, Lahore Branch Canal and some major drains carrying agricultural runoff, domestic and industrial effluent. WASA has installed 316 tubewells of varying capacity in Lahore, which operate for an average duration of 16 - 18 hours a day. The depth of these tubewells, vary from 150 m to 180 m. These tubewells provide water directly into the main water supply system. With the help of these tubewells WASA is supplying 720 mgd of water to 5,31,336 connections. WASA water supply system is designed to provide water at an average rate of 80 gallons per capita per day (gpcd).Water abstraction rate by WASA is estimated to be around 1.45 million cubic meters per day.

The ground water levels under the Lahore City are decreasing due to increasing use of water for drinking and cleanliness purposes while the recharge to the aquifer remains very low. The Wasa authorities are now sinking tube-wells from 600 to 700 feet (185 m to 215 m) depth due to decline in the underground water level. Table 1 shows the average annual rate of water table decline in the area.

Table 1: Average annual rate of water decline

Period	Rate of Decline (m/year)
1960 – 1967	0.30
1967 – 1973	0.55
1973 – 1980	0.60
1980 - 2000	0.65

Source: (PCRWR, 2004)

As a result of heavy groundwater abstraction from underground aquifer of Lahore, a cone of depression has been formed under CBD (Figure 3) of Lahore (Mashhadi and Muhammad; Niaz, 2005). The deepest point of the depression is located around Mozang area, and has laterally spread towards BRB Canal in the east, Hudiara drain in the south and towards (possibly across) Ravi river in the west. The levels of the lowest and the highest points on watertable depression indicate hydraulic gradients directed towards the centre of the well field in Mozang area. This also indicates that groundwater is being drained towards the well field from marginally saline areas located beyond metropolis boundary or/and from deeper water bearing formations or from upper bacteorologically polluted soil horizon (Mashhadi and Muhammad, 2000).

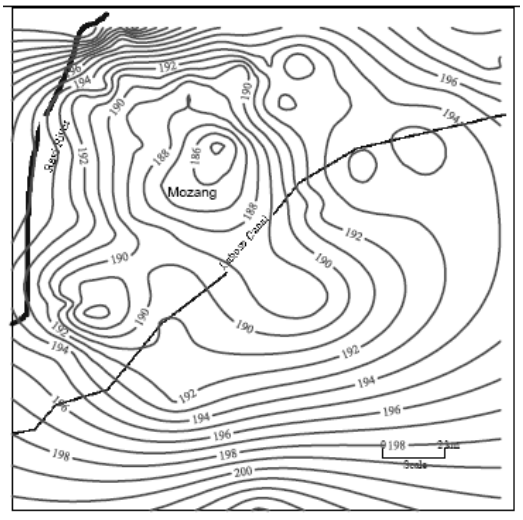

Figure 3: Water table contours above mean sea level (meters) in Nov. 1998 (Niaz, 2005)

The main source of recharge to Lahore aquifer systems is the River Ravi, winding its way through the western Pakistani city of Lahore for thousands of years. The River Ravi originates in India, and by the Indus Water Treaty its flow is curtailed by dams built in India. The flows in the River Ravi are highly variable with time during the year. They also vary along the length of the river due to link canals discharging into the river and water withdrawals at head works through canals.

The pollution in River Ravi is the highest of all the rivers in Pakistan. Most wastewater discharges in the river reach between Lahore and Balloki, a length of 62 km. The river presently receives 47% of the total municipal and industrial pollution load discharged into all the rivers of Pakistan. The BOD in the river after receiving Lahore municipal discharges is estimated to be 77 mg/l on the basis of mean annual flow. Between Lahore and Balloki, under low flow conditions, the river is completely devoid of Dissolved Oxygen (DO) and simply acts as a sullage drain. At Balloki the river water quality improves through augmentation of flow from the Qadirabad-Balloki Link canal. Here the Biological Oxygen Demand (BOD) values are low (2.3 - 3.9 mg/l), DO ranges from 6.2 to 8.2 mg/l, Total Dissolved Solids (TDS) are between 98 and 225 mg/l and sodium absorption ratio (SAR) varies from 0.1 to 0.55. At Balloki the river water meets the quality requirements for irrigation water. The high levels of faecal coliform are, however, of concern for other water uses. Data collected for the last 20 years indicate a decreasing trend in DO level and an increasing trend in BOD and TDS levels (Sami & Kheiri, 2000). The quality of water in a river varies with flow. As mentioned earlier, there are considerable variations in the River Ravi flows. The clear picture of the water quality of the river can therefore be obtained only from a regular monitoring programme. Unfortunately, the River Ravi is not being regularly monitored for its quality in a highly polluted stretch near Lahore.

The Hudiara drain is also a major source of pollution for the river Ravi. It enters Pakistan loaded with pollution from India, is diluted with agriculture runoff and mixed with some industrial pollutants in Pakistan. The drain carries mainly industrial and agricultural waste from both India and Pakistan. It may also be mentioned that the average effluent flow in Hudiara is much higher from India and hence the total quantity of pollution in Hudiara drain from India is much more compared to that from Pakistan (Sami, 2001).

Water quality samples were collected by Pakistan Council of Research in Water Resources (PCRWR) from 16 locations covering the major part of the Lahore city area and sources i.e. Tubewells (16) (Table 2). Out of the 16 locations none of any source was found to be supplying safe drinking water. In each case one or more parameter(s) was non-acceptable

Table 2: Water Quality Parameters in Drinking Water of Lahore Pakistan

T/W	Alk m.mol	HCO_3	Ca	Mg mg/l	Hard mg/l	Cl mg/l	Na mg/l	K mg/l	SO_4 mg/l	NO_3 mg/l	PO_4 mg/l	TDS mg/l

	/l	mg/l	Mg/l									
Min	3.00	150	20	13	140	11	11	1.40	19	0.40	0.17	226
Avg	5.90	295	34	26	193	29	87	3.99	83	0.56	0.24	539
Max	8.80	440	64	36	300	99	142	6.00	186	0.85	0.34	763

Source: PCRWR (2004)

according to the WHO guideline values. The data was computed and processed which showed that 43% samples were polluted with Coliform Bacterium. The overall picture of other parameters was depicted as 100% water samples were possessing higher concentrations of As compared to WHO guide line values. The higher concentration of Fe was found in 50% water samples (PCRWR, 2004).

NEED OF AN EFFECTIVE URBAN ENVIRONMENTAL POLICY LINKED WITH WATER CYCLE

Environmental policies all over the world are undergoing a fundamental change as governments, businesses and non-government organizations are exploring new ways of strengthening environmental protection and restoring environmental quality. The need to re-examine and build upon traditional policy approaches is being fuelled by the recognition that narrowly prescribed command and control-based systems, while essential to the early efforts at environmental protection, have not fully achieved the desired results. Advancements in technology and gains in ecological efficiency have been offset by increased population and per capita consumption. New concerns, such as climate change, biological diversity and persistent organic pollutants, have emerged, requiring new approaches in policy design and implementation.

In recognition of the changes that are occurring, a conceptual framework to guide environmental policy development during the next decade and beyond, with the objective of developing a new policy framework for environmental sustainability needs to be based on the principles of effectiveness, credibility, transparency & accountability and efficiency. Beside these principles being embedded in the policy, the policy needs to address the core design criteria of i) senior-level commitment from participants**;** ii) clear environmental objectives and measurable results; iii) clearly defined roles and responsibilities; iv) consultation with affected and interested stakeholders**;** v) public reporting; vi) verification of results; vii) incentives & consequences; and vii) continual improvement. The new policy needs to be based on the factors such as cost-effective & efficient, fair, dynamic efficient, political acceptable and easily enforceable (World Bank, 2006).

DISCUSSION

The Water and Sanitation Agencies (WASAs) and municipal bodies remain responsible for the management of water supply and sanitation services in the urban areas. While many of these are run relatively well, they all suffer from inadequate funds due to the way they are financed. In very few cases do they collect enough money from water tariffs to cover O&M costs, let alone funds for replacement, improvement and extension of services. All are run down with very large backlogs of maintenance. In the absence of raising their own money, WASAs must rely on ad hoc inputs of money from central government reserves which are infrequent and inadequate. Hence, most urban water systems are in a poor state of repair without real ability to improve the situation.

In addition, there is no central body to assist and support WASAs in planning, development and management of their systems. Instead, they compete with one another for funds and plan and implement on their own, not always most efficiently. A central body would help in the strategic planning for urban water supply and be able to more easily regulate tariff levels, collection mechanisms, planning, etc. While there is general agreement that the quality of water in rivers is poor and deteriorating, there is only a limited amount of information to support this. Water quality monitoring is carried out regularly at only a few locations and there is no real water quality monitoring network or information system.

There is a dire need for the development of Sectoral National Environmental Quality Standards (NEQS), which should provide allowable pollution limits for major industrial sectors i.e. textile, pulp & paper, sugar, fertilizer, cement and chemicals. The implementation of the general NEQS is practically impossible as some of the standards in some industrial sectors are very stringent while those are very lax in other sectors (World Bank, 2006). The Federal EPA has been considering suggestions regarding sectoral pollution limits but development and enactment of such standards is still awaited.

Lahore needs an urban water reform to optimise the use of water supplies and water industry infrastructure in the context of frequent droughts, urban population growth and increased supply variability due to climate change. There are several aspects to this. First, efficiency of WASA, Lahore providing water services need to be improved. Second, the demand for water should be managed in a way that is compatible with waste minimisation and the most efficient use of current and proposed water and wastewater assets. Third, cost effective ways to augment water supplies are essential to meet anticipated demand growth.

CONCLUSIONS

Urban water sector in Pakistan is facing major environmental and water scarcity crises due to rapid population growth. In response to rapidly degrading environment, Pakistan has formulated a number of environmental policies. However, these policies do not clearly provide means for the effective protection of water quality in urban areas. A review of Lahore's water quality indicates multiple types of pollution from the industrial and non-

industrial sources. The present water policy and the associated environmental policies have failed to secure long term water quality and quantity for the citizens of Lahore.

In this paper institutional reforms linked with the objectives of sustainable development in the urban water sector are proposed. This institutional reform should lead to a sustainable water policy through active public participation and involvement of private investment. A key aspect of this policy should be water auditing, water accounting, water management and ensuring an inter-generational equity. The roles and responsibilities of various institutions involved in protection of water sources, water supply & sanitation service provision, and regulation of drinking water quality should be clearly defined. The current National Environmental Quality Standards (NEQS) provide standards for emissions and effluent from selected sources, but do not establish standards for the ambient quality of water in an urban water cycle management context. In addition, aspects of these standards are out-of-date, no longer reflecting current understanding or technologies.

Pakistan urgently needs harmonization of its growth needs with sound environmental policies and urban water cycle. This will require transparency and accountability of institutions responsible for water supply and wastewater management through the empowering of key stakeholders.

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