ENVIRONMENTAL ISSUES OF WATER RESOURCES DEVELOPMENT AND INTEGRATED WATER RESOURCE MANAGEMENT IN PAKISTAN

By

Dr. Muhammad Nawaz Bhutta*

ABSTRACT

Pakistan has the largest contiguous irrigation system in the world, 16 Million ha. Environmental issue related to water resources development includes: (i) overall; (ii) watershed and reservoirs; (iii) domestic water supply and sanitation; (iv) power generation and (v) irrigation and drainage. This paper is focused towards irrigation and drainage. Lack of well-defined natural drainage in the Indus Basin is the cause of a surface drainage problem that has been further aggravated by construction of roads, railways, flood embankments and the irrigation system, while the existing surface drainage system is inadequate. The introduction of irrigation has resulted in an impressive production capacity, but also in widespread waterlogging and salinity. The groundwater levels have been steadily rising since the introduction of irrigation and is now in the root-zone at many places. Millions of hectares of agricultural land in Pakistan suffer from waterlogging, salinity, or both, thereby severely restricting agriculture. Because the economy and society depend on agriculture for 50% or more, waterlogging and salinity are not 'just' agricultural problems, but impact the environment and the 'social fabric' of the country as well. Irrigation and drainage are strongly inter-linked through several aspects, including: (i) irrigation as cause of waterlogging, and (ii) relationship between irrigation management and drainage effluent. To combat the irrigation-induced waterlogging and salinity, drainage was started since 1950s. Drainage has proved to effectively control water tables, but the effluent of deep tubewells has made some lands less productive due to mobilization of salts from deeper layers of the aquifer. Re-use is sometimes possible to reduce the quantity of drainage effluent, augmenting water shortages at the same time. The experience with evaporation ponds is not entirely positive in Pakistan. Groundwater mining and water quality deterioration are still outstanding environmental issues. Integrated water resource management is being propagated for sustainable use land and water resources.

1. INTRODUCTION

Environmental issues related to water resources development include: (i) overall; (ii) watershed and reservoir; (iii) domestic water supply and sanitation; (iv) power generation; (v) rainfed agriculture and (vi) irrigation and drainage. This paper is focused towards irrigated and drainage.

Lack of well-defined natural drainage in the Indus Basin is the cause of a surface drainage problem that has been further aggravated by construction of roads, railways, flood embankments and the irrigation system, while the existing surface drainage system is inadequate.

---

*Director General, International Waterlogging and Salinity Research Institute, IWASRI, WAPDA. P O Thoker Niazbeg, Lahore, Pakistan

The introduction of irrigation has resulted in an impressive production capacity, but also in widespread waterlogging and salinity. The groundwater levels have been steadily rising since the introduction of irrigation and are now in the root-zone at many places. Millions of hectares of agricultural land in Pakistan suffer from waterlogging, salinity, or both, thereby severely restricting agriculture. Because the economy and society depend on agriculture for 50% or more, waterlogging and salinity are not 'just' agricultural problems, but impact the environment and the 'social fabric' of the country as well. Irrigation and drainage are strongly inter-linked through several aspects, including: (i) irrigation as cause of waterlogging, and (ii) relationship between irrigation management and drainage effluent. To combat the irrigation-induced waterlogging and salinity, tubewell drainage was started in the 1950s, and pipe drainage was introduced two decades later. Drainage has proved to effectively control water tables, but the effluent of deep tubewells has made some lands less productive due to mobilization of salts from deeper layers of the aquifer. Re-use is sometimes possible to reduce the quantity of drainage effluent, augmenting water shortages at the same time. The experience with evaporation ponds is not entirely positive in Pakistan.

2. OBJECTIVES OF WATER RESOURCES DEVELOPMENT

Water resources are developed with the following main objectives:

(i) Increase food security through increasing agricultural production;
(ii) Poverty alleviation;
(iii) Social uplift of people; and
(iv) Environment protection.

Water resources projects are categorized into the following:

(i) Irrigation and drainage;
(ii) Power generation;
(iii) Domestic water supply and sanitation;
(iv) Industry;
(v) Navigation; and
(vi) environment services.

3. WATER RESOURCES AND ENVIRONMENT ISSUES

The main environmental issues related to water resources are categorized as:

(i) Overall;
(ii) Watershed and reservoirs;
(iii) Domestic water supply and sanitation;
(iv) Power generation;
(v) Rainfed agriculture; and
(vi) Irrigation and drainage.

3.1 Overall Issues

The overall issues include the following:

- Lack of environmental awareness;
- Competition for water;
- Growing demands;
- Construction and operation-related safeguards;
- Lack of environmental knowledge base and decision support systems;
- Adequacy of policies, institutions, instruments, incentives & coordination in management of the resource base and service delivery;
- Cultural property management,
- Appropriate indigenous knowledge use.

3.2 Watershed and reservoirs

The environmental issues related to watershed and reservoirs are:

- Erosion,
- Siltation,
- Dam safety, and
- Downstream releases

3.3 Domestic water supply and sanitation

The environmental issues related to water supply and sanitation are as following:

- Access to clean water,
- Pollution of local water bodies,
- Drinking water quality & testing,
- Health benefits from access to clean water and sanitation,
- Domestic and storm water run off treatment/management,
- Sludge and solid waste management

4. IRRIGATION AND DRAINAGE

As this paper mainly deals with environmental issues related to irrigation and drainage those are being discussed in this section.

4.1 Assess to Water (Reliability and Equity)

Due to changed physical conditions and poor management the discharges at head of distributary canals are not reliable. Figure 1 show variation in head discharge of Jalalpur Distributary and Wagi Distributary of LCC East Canal Punjab. The variations are as high as 250 percent.

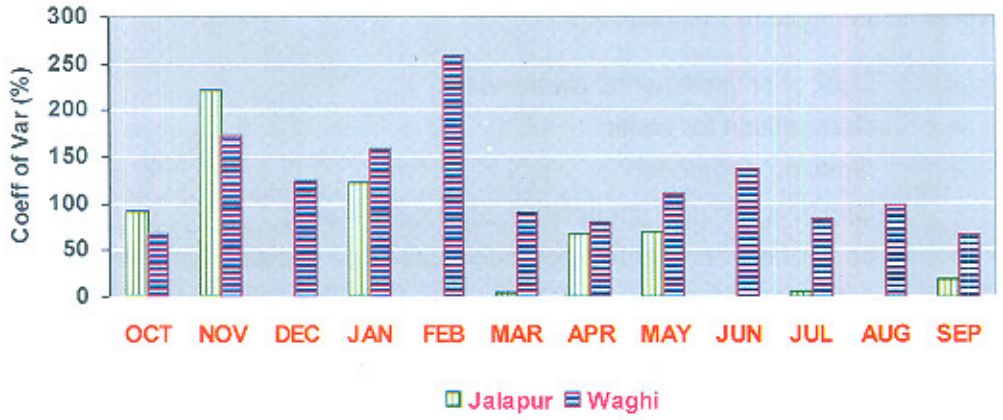


Figure 1. Variability of Water Supply at Head of Disty. Canal

Equity of water distribution among secondary canals are also not maintained as per design. Figure 2 shows monthly average discharge value of discharge for distributaries. It is obvious from the figure that most of the dots arte away from central equity line.

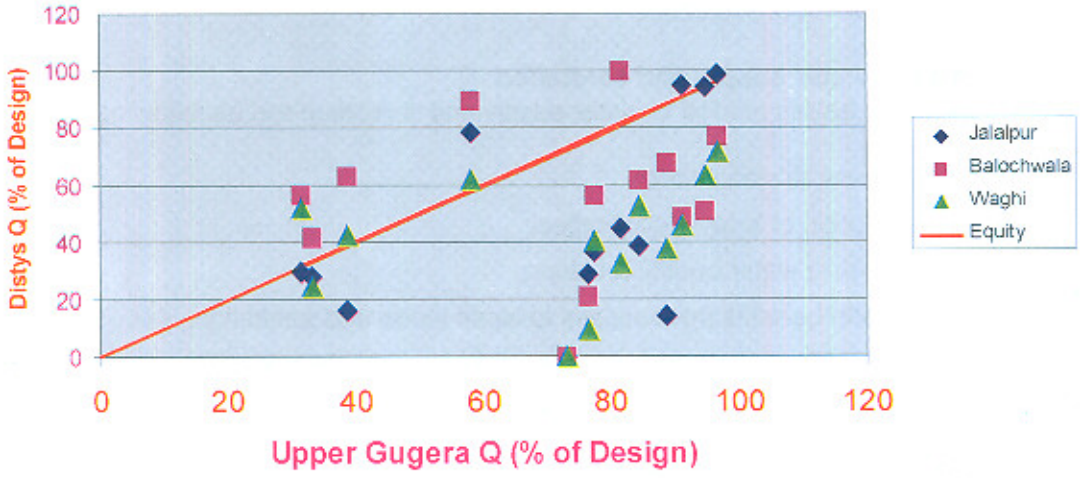


Figure 2. Equity of Water Distribution Along Disty. Canal

4.2 Water Logging

Pakistan has about 5 Mac water logged. Annual loss to the country is estimated as Rs. 80 Billion. There is huge loss to infrastructure i.e. roads, railway and buildings etc. Figure 3 shows that water logging has been decreased in Punjab but has been increased in Sindh and Balochistan.

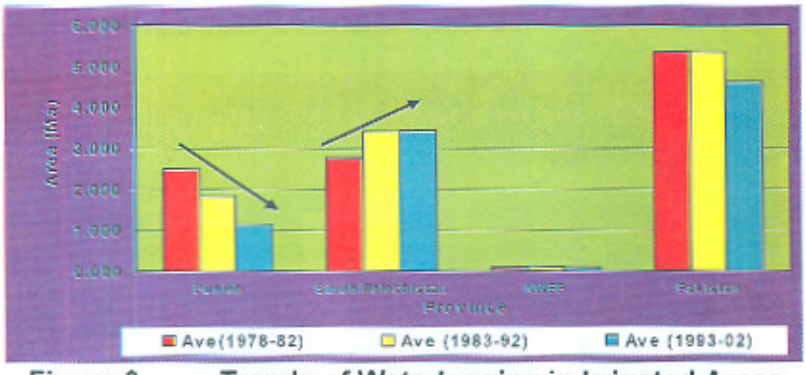


Figure 3. Trends of Waterlogging in Irrigated Areas

4.3 Deterioration of Water Quality

Groundwater quality has been monitored during 1952-62 and 2002-03. Figure 4 indicate changes in groundwater quality in different doabs of Indus Plain. It is clear that more areas has gone under deteriorated water quality than improvement in water quality.

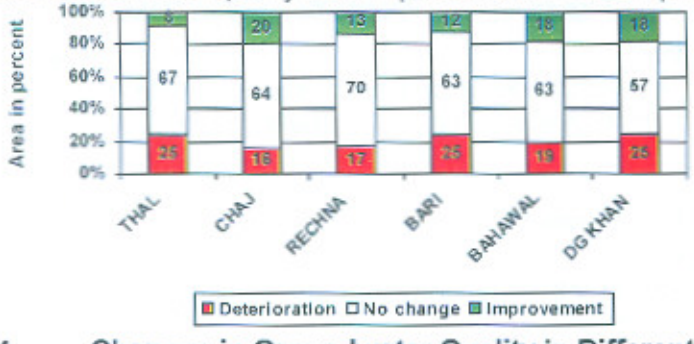


Figure 4. Changes in Groundwater Quality in Different Doabs

4.4 Salinization

Pakistan has about 11 Mac partially and fully affected by salinity. Figure 5 shows changes in surface salinity of irrigated areas of Indus Basin. An improvement has been shown in the surface salinity due to bringing more area under irrigation.

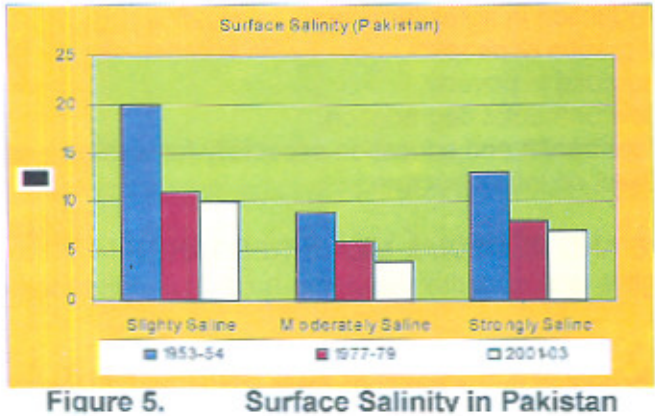


Figure 5. Surface Salinity in Pakistan

Figure 6 shows status of profile salinity in the Indus Plain. There is no improvement in the profile salinity and salts moved from surface have accumulated in the profile.

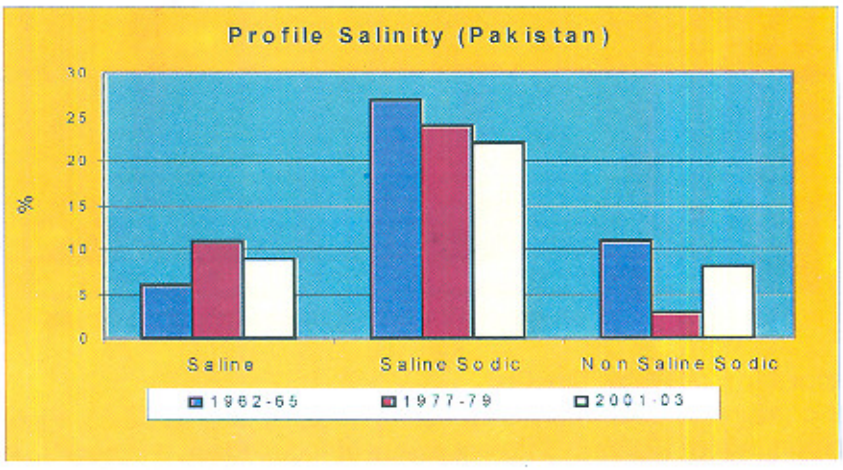


Figure 6. Profile Salinity in Pakistan

4.5 Groundwater

Due to increase in population and limited surface water supplies dependence on groundwater has been increased. The environmental Issues related to groundwater are as following:

- Salt mobilization.
- Mining.
- Salt water intrusion (Horizontal and vertical).
- Sectoral competition.
- Small farmers (5% in Punjab and 15% in Balochistan) deprived from GW.
- Pollution.

5. ECONOMIC, SOCIAL AND ENVIRONMENTAL IMPACTS

The environmental issues related to irrigation and drainage has following impacts:

(i) Reduction in agricultural production, 25%.
(ii) Migration of people.
(iii) Increase in poverty.
(iv) Environmental degradation.
(v) Poor health and education especially for women and children.
(vi) Effect on infra-structure.

6. PREVENTIVE AND REMEDIAL MEASURES TAKEN

The following preventive and remedial measures have been taken to overcome the above problems.

(i) Salinity control in the rootzone by leaching and drainage.

(ii) Improved irrigation management.
(iii) Reclamation of salinized lands (measures include agronomic, soil management and/or biological measures, use of gypsum and other amendments).
(iv) Groundwater management by installation of tubewells.
(v) Management of storm water by providing surface drains.

7. OUTSTANDING ISSUES

Although huge investment has been made to overcome the environmental issues related to irrigation and drainage but still there are many outstanding environmental issues as following:

(i) Secondary Salinization;
(ii) Groundwater mining;
(iii) Pollution;
(iv) Drainage effluent disposal; and
(v) Waterlogging in lower Indus etc.

8. INTEGRATED WATER RESOURCE MANGEMENT (IWRM)

In IWRM, drainage is land and water management through the process of removing excess surface water and managing shallow water tables – by retaining and removing water – to achieve optimal mix of economic and social benefits while safeguarding the ecological functions. It includes:

(i) Acknowledgement of multiple objectives of management of excess water (agricultural production-economic, drinking water-social, waste water disposal-conflicting, stormwater drainage-positive & negative);
(ii) Understanding and managing diversity;
(iii) Inclusive forms of governance and decision making
(iv) Improving the scientific knowledge base on sustainability, multi-functionality and stake holder representation.

8.1 IWRM Objectives

The specific objectives of IWRM are:

- Control of Water logging & Salinity (WL&S) for sustainable irrigated agriculture;
- Protection of irrigation water quality;
- Reduction of saline drainage effluent;
- Regulation and management of groundwater;
- Reduction of Government liability for O&M; and
- Improve knowledge through training, research and monitoring.

8.2 IWRM Planning

IWRM planning includes following:

- Define area of intervention;
- Describe natural resources: land and water;
- Identify stakeholders: more than farmers;
- Ask stake holders what the issues are;
- Find solutions in a participatory manner; and
- Take transparent decisions and provide information.

8.3 Interactive Approach

Steps for interactive approach of IWRM are:

(i) Understanding the natural resources system in the area (bio-physical characteristics of the drainage basin).
(ii) Identifying problems and opportunities (water logging, salinity, flooding, disposal of untreated municipal and industrial effluent).
(iii) Describe proposed interventions (infrastructure, management practices or both).
(iv) Determine the geographical and time range of changes.
(v) Identify affected landscapes (on-site and off-site effects and impacts).
(vi) Identify affected functions and their stakeholders, and assess impacts on economic, social, and ecological values.
(vii) Discussions of impacts and negotiation between stakeholders about tradeoffs (consultation).
(viii) Stakeholders decide on interventions and mitigation measures or alternatives .
(ix) Implementation.

8.4 Pre-requisites of Realizing Integration

Pre-requisite for realizing integration are:

(i) Enabling policy environment.
(ii) Institutional arrangements which ensures multi-sectoral coordination, participation of stakeholders and reliable service to users.
(iii) Financial arrangement based on public-private partnership and cost sharing.
(iv) Enforced laws and standards.
(v) Capacity to implement and manage an integrated system.
(vi) Knowledge base (research and extension).
(vii) Awareness and shared information.

8.5 Scale of Analysis

Scale of analysis for IWRM are:

(i) River basin.

(ii) Hydro-ecological region.
(iii) Landscape (e.g. drainage basin, canal command).
(iv) Project.

8.6 First Step

The first Piloting the integrated approach for detailed Drainage Development and Water Management Plan at a BASIN Level is required.

9. WAY FORWARD

The way forward for IWRM is the following:

(i) Involve stakeholders in planning, design, construction, operation.
(ii) Manage the problem within the basin as much as possible.
(iii) Detail study of each basin.
(iv) Updating of data and analysis.
(v) Improve water management to reduce drainage requirement.
(vi) Salinity management (not only salt disposal).

REFERENCES

Beg, A. and M.I. Lone. 1992. Trend of Changes in Groundwater Quality of SCARP I. In: Proceedings 5th International Drainage Workshop, Vol. II: 3.66-3.72. IWASRI, Lahore Pakistan.

Bhutta, M.N., W. Wolters, and W.Z. Siddiqui. 1996a. Performance of Pipe Drainage in Pakistan. Proceedings of the 6th Drainage Workshop on Drainage and the Environment: 79-88. ICID. Ljubljana, Slovenia.

Bhutta, M.N., M.A. Khan, and W. Wolters. 1996b. Reuse of Drainage Water for Irrigated Agriculture in Pakistan. Proceedings of the 6th Drainage Workshop on Drainage and the Environment: 428-436. ICID. Ljubljana, Slovenia.

IIMI, 1995. Proceedings of the Workshop on 'Salinity and Sodicity in Pakistan'. IIMI.

IWASRI, 1994. Newsletter Vol. 1: Nº 2. IWASRI, WAPDA, Lahore, Pakistan.

Kishwar, I. 1996. Socioeconomic survey of the Joint Satiana Pilot Project. (Draft) Publication of IWASRI, WAPDA, Lahore, Pakistan.

Latif, M. and T. Hussain. 1992. Comparative Study of Vertical and Horizontal Drainage Projects. In: Proceedings 5th International Drainage Workshop, Vol. III: 6.96-6.105. IWASRI, Lahore Pakistan.

Mathur, R.S. and R.K. Garg. 1991. Reclaiming Use Lands. Workshop on 'Sodic Lands Reclamation in UP, Management & Prospects'. UP Land Development Corporation Ltd. Lucknow, Uttar Pradesh, India.

NESPAK/MMI. 1993. Pakistan Drainage Sector Environmental Assessment - National Drainage Program. Executive Summary (p 9 & p 14). pp. 37.

Summers, J.B. and S.S. Anderson (Eds.). 1989. Toxic substances in agricultural water supply and drainage. US Committee on Irrigation and Drainage, Denver, 424 pp.

Wolters, W., M. Ittfaq, and M.N. Bhutta. 1996. Drainage Discharge and Quality for Drainage Options in Pakistan. Workshop on Managing Environmental Changes due to Irrigation and Drainage: pp 45-55. 16th Congress on Irrigation and Drainage, ICID, Cairo.

E-WASTE: AN IMPENDING CHALLENGE

By

Muhammad Daniel Saeed Pirzada* and Farkhanda Nahid Pirzada**

Abstract

Driven by the rapidly changing technologies and increasing quantities of end-of-life electronic equipment, electronic waste is emerging as a transnational problem. Industrial nations are shipping millions of obsolete computers yearly to developing countries. The large material flow can be toxic as well as beneficial. This article analyses the flow of obsolete computers to Pakistan and discusses the potential ecological and health impacts of inadequate e-waste management practices. Legislation, regulatory action and public awareness can help avoid the health and environment risks across Pakistan. Adoption of modern recycling technology, on the other hand, can help transform the problem into a multi-million opportunity. However, this requires government support in the form of necessary legislation and strict regulatory actions. Global cooperation – necessary funding and technology transfer – should also be sought.

Abbreviations used in this text:

BFR: Brominated Flame Retardants	CFC: Chlorofluorocarbon
PBB: Polybrominated biphenyls	PBDE: Polybrominated diphenyl ethers
PCB: Polychlorinated biphenyl	PCDD: Polychlorinated dibenzo-p-dioxins
PCDF: Polychlorinated dibenzofurans	PVC: Polyvinyl chloride

Introduction

Electronic waste, e-waste, or e-scrap, may be defined as electronic devices destined for recycling or disposal. Rapid technological developments in electronics industry are resulting in large numbers of electronic items being scrapped and becoming electronic waste (e-waste). E-waste includes a broad range of devices; these include televisions, VCRs, stereo equipment, mobile phones, other handheld devices, and computer components. The United States Environmental Protection Agency (EPA) refers to obsolete computers as "hazardous household waste"[1].

In the U.S. alone, 1.5 billion pounds e-waste was generated during 2006. The total annual global volume of e-waste is about 40 million metric tons. The rate of growth of e-waste is three times that of other municipal waste. Although e-waste makes a small fraction of municipal waste (only 1-4% percent), it may be responsible for as much as 70 percent of the heavy metals in landfills, including 40 percent of all lead.

Management of electronic waste is of great concern largely due to the toxicity and carcinogenicity of some of the substances. Toxic substances in electronic waste may

*, **Pakistan Institute of Nuclear Science & Technology P.O. Nilore, Islamabad, Pakistan.

include lead, mercury and cadmium. Carcinogenic substances in electronic waste may include PCBs. Electronic waste may have up to 38 separate chemical elements. Many of the plastics used in electronic equipment contain flame retardants making their recycling more difficult and more hazardous.

Table 1: Typical E-Waste Composition

Substance	Occurrence in e-waste
Halogenated compounds:	
PCB	Condensers, transformers.
TBBA*	Fire retardants for plastics (thermoplastic components, cable insulation)
PBB	
PBDE	TBBA is presently the most widely used flame retardant.
CFC	Cooling unit, insulation foam.
PVC	Cable insulation.
Heavy (and other) metals:	
Arsenic	Small quantities as gallium arsenide in light emitting diodes.
Barium	.CRTGetters in
Beryllium	Power supplies containing silicon controlled rectifiers and x-ray lenses.
Cadmium	NiCd-batteries, CRT screens, printer inks and toners, printer drums.
Chromium VI	Data tapes, floppy-disks.
Lead	CRT screens, batteries, printed wiring boards.
Lithium	Li-batteries.
Mercury	Fluorescent lamps that provide backlighting in LCDs, in some alkaline batteries and mercury wetted switches.
Nickel	Rechargeable Ni-Cd batteries or Ni-MH batteries, electron gun in CRT.
Rare Earth elements (Yttrium, Europium)	Fluorescent layer (CRT-screen).
Selenium	Older photocopying-machines (photo drums).
Zinc sulphide	Interior of CRT screens, mixed with rare earth metals.
Others:	
Toner dust	Toner cartridges for laser printers / copiers.
Radio-active substances:	
Americium	Medical equipment, fire detectors, active sensing element in smoke detectors.

Nature of the Threat

Electronic appliances are composed of a host of materials that can be toxic as well as valuable. Typically 80 % of the waste (by weight) is made up of various alloys of iron, aluminum, plastics and glass. Many metals that appear in small quantities are quite expensive. This makes recycling of e-waste an attractive business opportunity. On the other hand, if waste streams are mishandled, the presence of some of the hazardous

substances such as lead and arsenic poses serious risks to environment and to the health of recycling workers at various stages of processing. Table 1 shows the typical material composition of e-waste and the origin of its various components.

Many materials present in the e-waste (mostly printed circuit boards) in small quantities are very valuable. These include gold, silver, platinum and palladium as well as rare metals like indium and gallium. Substances found in large quantities (constituting more than 80% of the weight) include: epoxy resins, fiberglass, PCBs, PVC, thermosetting plastics, lead, tin, copper, silicon, beryllium, carbon, iron and aluminum. Cadmium, mercury, and thallium occur in relatively small quantities. The substances found in only trace amounts include americium, antimony, arsenic, barium, bismuth, boron, cobalt, europium, gallium, germanium, gold, indium, lithium, manganese, nickel, niobium, palladium, platinum, rhodium, ruthenium, selenium, silver, tantalum, terbium, thorium, titanium, vanadium, and yttrium. Table-2 provides the composition of a desktop computer (including a CRT screen).

Table-2 Composition of a Desktop Computer with a CRT screen[2]

Range of Amount Present	Materials
4-7 Kg	Aluminum, iron, plastics, silica (glass)
1.5-2 Kg	Lead, copper
0.25-0.5 Kg	Nickel, tin, zinc
< 0.1Kg	**(~550 g)** Antinomy, beryllium, barium, cobalt, cadmium, manganese, tantalum, titanium, silver. **(~125g))** Yttrium, bismuth, chromium, arsenic, mercury. **(~50 g)** Indium, gallium, germanium, gold, ruthenium, selenium. **(~ 5-6 g)** Europium, niobium, vanadium , palladium

Hazards Involved

The presence of toxic substances makes the e-waste a hazardous material. Table 3 provides a list of toxic materials present in the e-waste and their effects on human health[3]. The impact of e-waste disposal on the environment and health depends on the nature of e-waste management practices followed. Uncontrolled burning, processing, and disposal can trigger serious health problems especially among those directly exposed. Thousands of workers are currently employed in extracting the metals, toners, and plastics from computers and other electronic waste.

The waste management practices can be classified into conventional (primitive) techniques and (cleaner) modern technologies. The conventional practices include some unsafe and wateful methods. The practices continue in developing countries where strict health and environment standards are lacking. The cleaner recycling technologies comply with higher environmental and occupational safety standards.

The conventional technologies of waste management include landfills, open-air-burning and incineration. Many of the materials found in e-waste generate hazardous toxic substances on burning that are dispersed in the atmosphere. This is particularly true for open-air burning, which releases several toxins including various carcinogens and neurotoxins, e.g. dioxins and furans into the air.

The copper in the e-waste can catalyze the production of dioxins, PBDDs, and PBDFs. The release of resultant pollutants can trigger a host of illnesses in humans. It can also result in loss of property. In landfills such leachate can contaminate ground water resources. The vaporization of volatile compounds is yet another environmental concern. It was on account of these concerns that some European countries banned the disposal of electronic waste in landfills in the 1990s.

The modern e-waste disposal processes work on the principle of increased cost-effective processing of bulk electronic waste. This involves sorting, concentrating and refining.

Sorting avoids dilution and/or contamination with toxic substances during the downstream processes. As a first step, materials are classified as metals, plastics and glass. This is followed by physical/ mechanical processing of classified waste to obtain concentrates of recyclable materials in a dedicated fraction. In the final step, the e-waste is refined to extract the raw materials with minimal environmental impact.

A recent report from a scrap computer recycling plant located in Taiwan shows that employing the available recycling technology can recover 94.75 % of useful materials (by weight) from the main machines (CPU, IC boards, DVD/ CD drive, hard disk, etc.) and 45.99.% (by weight) from scrapped monitors[4].

Table 3: Toxic substances in E-waste

Material	Toxicity
Arsenic	Skin diseases, lung cancer, decreased nerve conduction velocity
Barium	Brain swelling, muscle weakness, damage to heart, liver and spleen.
Beryllium	Lung cancer (beryllicosis), skin disease
BFRs	Severe hormonal disorders
Cadmium	Lung cancer, kidney damage, pulmonary emphysema and bone diseases.
CFCs	Skin cancer, deleterious to ozone layer
Chromium(VI)	Irritating to eyes, skin and mucous membranes, DNA damage
Dioxins* (PCDD, PCDF)	Impairment of the immune system
Lead	Vomiting, diarrhea, convulsions, coma, even death.
Mercury	Brain and liver damage if ingested or inhaled.
PCB	Cause cancer, damage to immune system, reproductive system, nervous system, endocrine system etc.
PVC*	(on combustion) respiratory problems.
Selenium	Hair loss, nail brittleness, and neurological abnormalities

** From combustion of wastes*

Environmental Colonialism

Because electronic and electrical products are laden with chemicals harmful to human health and the environment, their disposal is often governed by strict regulations in developed countries. Increased regulation of electronic waste management has raised disposal costs. This provides an incentive to export unscreened electronic waste to Afro-Asian countries, avoiding the processing expenses. Around 80% of the e-waste in U.S. is exported to Asia and Africa. But U.S. is not the only country dumping e-waste in Asia. Many consignments from European Union, Japan and South Korea, as well as the US that sought to sneak through customs and illegally dump e-waste have been intercepted. Guiyo in China, and Delhi and Bangalore in India, are main e-waste processing centers. Other dumping grounds include Pakistan, Philipines, Nigerea and Ghana. In Pakistan, Lahore and Karachi are the main activity centers in terms of e-waste dumpig.

There have been attempts to restrict the flow of hazardous e-waste to developing countries. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal commonly known as The Basel Convention is an international treaty designed to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed to less developed countries. The Basel Convention was adopted in 1989 and entered into force in 1992. Another significant effort in this direction was The Basel Ban Amendment, of 1995. United States is currently the only OECD country that has not ratified the original Basel Convention, or the Basel Ban Amendment.

In spite of these efforts illegal e-waste dumping in developing countries continues. Lack of legislation, inadequate strategies and poor implementation of law in developing countries are some of the many reasons for the unlawful flow of hazardous e-waste.

The consequence and impact of unsafe practices of e-waste recycling can be comprehended by the following case study.

A Case study: Guiyu

Guiyu is located in the west of the coastal city of Shantou, in Eastern Guangdong province of People's Republic of China. The Lianjiang River runs through the region. E-waste recycling at Guiyu began around 1995. Today Guiyu is regarded as the global electronic-waste capital. Nearly 150,000 Guiyu workers are associated with e-waste processing. While an average e-waste processing worker, earns merely US$0.30 an hour, the town reports revenues of $75 million from processing 1.5 million tonnes of e-waste every year.

Recycling practices at Guiyu remain primitive. These include "cooking" of circuit boards to remove chips and solders, burning of wires and other plastics to collect metals such as copper, use of highly corrosive acid baths to extract gold from the microchips, and dusting of printer toner out of cartridges. Workers are exposed to the dioxin-containing ash. The soil has been badly contaminated with heavy metals. The water is undrinkable. Visitors to the city experience headaches and a metallic taste in the mouth. The concentration of dioxin at Guiyu has been reported to be the highest ever recorded.

Early this year, a Chinese government report revealed that 80% of Guiyu's children suffered from lead poisoning. A study conducted by Hong Kong Baptist University since 2003 concluded early this year that the level of PBDE flame retardants at an e-waste combustion site in Guiyu was more than 16,000 times higher than at a control site. The research has established that PBDEs can be persistent, bio-accumulative, and toxic and can cause liver and neuro-developmental toxicity and affect thyroid hormone levels. Today Guiyu is world's second most polluted spot, next only to Lake Karachay[5, 6].

Working conditions in Pakistan are certainly not better than China. Unfortunately no study has been conducted to evaluate the impact of e-waste processing on workers' health and on the environment.

Strategies Adopted in the Developing Countries

In developed countries many efforts have been made to face the impending challenge of e-waste. The EU directives on Waste Electrical and Electronic Equipment (WEEE) and Reduction of Hazardous Substances (RoHS) are aimed at preventing the generation of hazardous waste, and require the substitution of several heavy metals (e.g. lead, mercury, cadmium, and chromium-VI) and brominated flame retardants (e.g. PBB or PBDE) in new electrical and electronic equipment marketed since July 1, 2006.

Extended Producer Responsibility (EPR) is yet another effort to further the same objectives. Its purpose is to make manufactures responsible for their products, especially when they become obsolete. Corporations have started offering low-cost to no-cost recycling. Since 2001, China has banned the import of e-waste.

Despite the fact that dumping old computers in developing countries has been declared as violation of international law, Pakistan was being used as dumping ground for over 50,000 tons of E-Waste that hurts local industry and also creates environmental and health hazards.

Despite being a signatory to the Basel Convention that restricted importing used / old computers, more than 500,000 used computers are finding ways into Pakistani computer market each year.

The government seems to be ignoring the issue. Fortunately, Pakistan is still not a major E-Waste dumping ground. However, the situation is likely to change in the near future. It is feared that with the ever escalating generation of e-waste and strict legislation making recycling financially less attractive in the developing countries and a ban on E-Waste exports to China, the E-Waste brokers will try to find new markets. Consequently, E-Waste flow to Pakistan can swell exponentially. This necessitates expeditious measures and a rational strategy to avoid transforming Karachi and Lahore into new Guiyus.

Pakistan is a signatory to the Basel Convention. The computers and other obsolete electronic goods are however imported under the pretext of "second-hand". Barely a small percentage of the items imported are useable. In practice, after removing the working machines and usable parts the bulk of the consignment is sent to the recycling

industry. The Basal Convention in essence is flouted. The unregulated and unsafe waste management practices let hazardous materials in the waste to disseminate into the environmental resources. The bulk solid waste is dumped in the landfill and the effluents arisen from the recycling processes are dumped into the Lyari River and ultimately into the Arabian Sea contaminating the marine ecosystem.

This issue has received little attention from government and non-governmental environmental bodies in the country. No scientific study has been made to assess the impact of e-waste processing to our environment. There is no reliable data available on the volume of used electronic components imported and the fraction of it recycled or dumped as solid waste. There is a dire need to determine the detrimental impact of e-waste processing on environmental health.

Conclusions

1. Rapid technology change and low initial cost have resulted in a fast-growing electronic waste problem.
2. The technological innovations and tidal wave of new consumers is bound to increase the pace of e-waste generation.
3. Legislation, regulatory action and public awareness can help avoid a likely health and environment catastrophe.
4. Adoption of modern recycling technologies can help transform the problem into a multi-million opportunity.
5. To the best estimates of the authors, Pakistan is not equipped yet to face this challenge; a lot of homework is needed in several areas. The private sector lacks the necessary skills and resources to meet a challenge of this complexity and magnitude. The only way to cope with the situation is a well-coordinated public-private joint effort. Government support as well as technical/financial help from developed countries will be essential for environment friendly recycling of e-waste in Pakistan.

References

1. Morgan, Russell (2006-08-21). "Tips and Tricks for Recycling Old Computers". Smart Biz. *Available at*: http://www.smartbiz.com/article/articleprint/1525/-1/58.

2. Source: Microelectronics and Computer Technology Corporation (MCC). 1996. Electronics Industry Environmental Roadmap. Austin, TX: MCC.

3. More information on toxicity of metals and compounds mentioned in Table 3 can be found from following internet sources: Cadmium : CFC: Chromium: http://www.intox.org/databank/documents/chemical/cadmium/ehc135.htm http://www.c-f-c.com/supportdocs/cfcs.htm http://www.intox.org/databank/documents/chemical/chromium/ehc61.htm http://www.atsdr.cdc.gov/tfacts68.html http://www.deh.gov.au/industry/chemicals/dioxins/pubs/incinfinal.pdf http://www.hc-sc.gc.ca/english/iyh/environment/lead.html and http://www.intox.org/databank/documents/chemical/lead/ukpid25.htm.

http://www.intox.org/databank/documents/chemical/mercury/cie322.htm
http://www.atsdr.cdc.gov/toxfaq.html

4. Ching-Hwa Lee, Chang-Tang Chang, Kuo-Shuh Fan, Tien-Chin Chang, "An overview of recycling and treatment of scrap computers", Journal of Hazardous Materials B114 (2004) 93–100.

5. International News, Green Left Weekly issue #715 27 June 2007.

6. *Johnson, Tim (April 9, 2006).* "E-waste dump of the world". *The Seattle Times.* http://seattletimes.nwsource.com/html/nationworld/2002920133_ewaste09.html. Retrieved on 2007-03-09.

UNSAFE DRINKING WATER AND HEALTH HAZARDS

By

Sabir Ali Bhatti* and Zia Mustafa**

1. Backdrop / Introduction

Pakistan Potable drinking water and sanitation facilities have emerged as one of the most critical issues adversely affecting human health and increase in poverty, particularly in rural areas of major parts of Pakistan. Most pressing issue is the water security for meeting basic provision of water supply and sanitation.

Availability of safe drinking water and proper hygienic facilities are a pre-requisite for health and success in the fight against poverty, hunger and child mortality. It is also the human right and personal dignity of every women, man and child on earth to have safe drinking water and improved sanitation facilities. Inspite of this, 2.6 billion people, nearly half of the population of developing world does not have proper sanitation facilities while more than one billion people have no choice but to use potentially harmful water for drinking. More than 6,000 children under five die every day from diseases associated with lack of access to safe drinking water. According to World Health Organization (WHO), more than 80% of illnesses are reported due to poor water quality in developing countries. The consequence of our collective failure to tackle this problem dimmed prospects for billions of people locked up in a cycle of poverty and disease. In much of the world, polluted water and poor water management cause serious public health problems. Water related diseases such as diarrhea, hepatitis, cholera, typhoid kill over 5 million people per year and about 2.5 billion illness. In Pakistan, 25% of the adults and 40 percent of children attending hospitals are ill from water related diseases.

Moreover, the leading cause of deaths in infants and children upto 10 years of age, is because of contaminated water. The mortality rate of 136 per 1,000 live births due to diarrhea is reported, while every fifth citizen suffers from illness caused by unsafe water.

2. Global Perspective

In September 2000, 189 member countries of the United Nation adopted Millennium Development Goals (MDGs) setting time bound targets for making progress on the most pressing development issues we face. Achieving targets will directly affect the lives and future prospects of billion of people around the globe. One of the MDG is to reduce by half the proportion of people without access to safe drinking water and improved sanitation facilities by 2015. Target 10 of MDG 7 deals with sustainable access to safe drinking water and basic sanitation which is gives as under:

---

*Team Leader (PSDS), EPHE Division, NESPAK
**Senior Engineer, EPHE Division, NESPAK

Millennium Development Goal 7: *Ensure Environmental Sustainability*

Target 10:

By 2015, halve the proportion of people without sustainable access to safe drinking water and basic sanitations

Joint Monitoring Programme (JPM) by WHO/UNICEF 2008 indicates that global pressure on safe water supply and sanitation has been generally encouraging in major parts of the world except in sub-sarharan region of Africa. The percentage of people using safe drinking water has risen by 13% to 87% in South Asia between 1990 and 2006. Globally, 87% of global population now uses an improved source of drinking water, compared to 77% in 1990. An additional 784 million people worldwide will need to get access to an improved drinking water source to meet the MDG target. Getting on track to meet the target in drinking water will mean better health, longer lives and greater dignity for billions of world's poorest people.

3. Pakistan Perspective

It may be worth mentioning that improvement in domestic water supply has not received the consideration it merits. It remains neglected in terms of allocation of resources as well as adequate attention at policy and decision making levels. It may be attributable to the fact that addressing water supply issues require financial commitment upfront. However, an important change is already underway in form of Tehsil Municipal Administration (TMA).

Presently, more than 65% of the total population in the country has access to safe drinking water including 85% persons living in more than 500 urban areas including the cities and towns. In rural areas, 55% of population living in about 30,000 large villages are served with planned water supply, while in remaining 20,000 rural settlements, the water supply schemes are yet to be developed. Most of the water in urban areas is supplied from groundwater except for the cities of Karachi, Hyderabad and part of the supply to Islamabad, which mainly uses surface water. Rural water supply is mostly from groundwater except in saline ground water areas, where irrigation canals are the main source of domestic water.

The main source of drinking water in Pakistan is hand pumps. Hand pumps and motor pumps together provide 57% of households with drinking water, whereas tap water provide drinking water to 36% of households. Table 1 shows main sources of drinking water by each province and region.

Table 1: Main Sources of Drinking Water by Each Province

Province and Water Source	2004-05 PSLM			2005-06 PSLM			2006-07 PSLM		
	Urban	Rural	Over-All	Urban	Rural	Over-All	Urban	Rural	Over-All
Punjab									
Tap Water	52	17	28	50	16	27	53	17	29
Hand Pump	13	50	39	11	47	35	10	48	35
Motor Pump	32	27	29	37	31	33	34	30	31
Dug well	1	2	2	1	3	3	1	2	2
Other	2	4	3	1	2	1	3	2	3
Total	100	100	100	100	100	100	100	100	100
Sindh									
Tap Water	71	19	44	71	11	43	74	19	47
Hand Pump	13	60	37	14	63	37	8	55	32
Motor Pump	10	3	6	9	9	9	11	4	8
Dug well	2	8	5	1	9	5	0	8	4
Other	5	11	8	5	9	7	6	13	10
Total	100	100	100	100	100	100	100	100	100
N.W.F.P									
Tap Water	62	40	44	56	45	47	63	40	44
Hand Pump	8	12	11	11	13	13	11	11	11
Motor Pump	17	4	6	24	10	12	15	8	9
Dug well	11	18	17	9	17	16	9	15	14
Other	2	27	23	1	15	13	2	26	22
Total	100	100	100	100	100	100	100	100	100
Balochistan									
Tap Water	84	22	33	77	25	36	81	24	37
Hand Pump	3	5	4	3	6	6	2	7	6
Motor Pump	5	4	4	8	9	9	7	2	3
Dug well	4	28	23	9	15	14	3	20	16
Other	5	42	36	4	45	36	7	47	38
Total	100	100	100	100	100	100	100	100	100
Pakistan									
Tap Water	60	21	34	59	21	34	62	22	36
Hand Pump	13	44	33	12	42	32	9	41	30
Motor Pump	23	18	19	25	23	24	24	20	21
Dug well	2	7	5	2	7	5	1	6	4
Other	3	11	8	3	8	6	4	10	8
Total	100	100	100	100	100	100	100	100	100

Source: Pakistan Social and Living Standard Survey (PSLM), 2006-07

Notes:

1. Household obtaining water from the source indicated expressed as a percentage of the total number of households.

2. Categories: `Tap Water' consists of both tap water inside and outside house; `Hand Pump' includes hand-pumps both inside and outside. Motor pump includes motor pump and tube well outside the house; `Dug Well' includes well open and well closed both inside and out side the house; and `Other' includes public standpipe (supplied by tanker), water seller, canal, river, spring, stream, pond and other.
3. Totals may not add to 100 because of rounding.

4. Drinking Water Quality

The poor quality of drinking water all over the country is the major problem which is required to be addressed in a holistic manner under all future water supply strategies. The majority of the population in the country is exposed to hazards of unsafe and polluted water. Based on the National Water Quality Monitoring Programme carried out by Pakistan Council of Research in Water Resources (PSRWR), four major quality tribulations in drinking water source of Pakistan include bacteriological (68%), arsenic (24%), nitrate (13%) and fluoride (5%). On an overall basis, out of a total of 357 sources studied, only 45 water source (13%) were found safe, the remaining 312 (87%) were unsafe for drinking purpose. The bacterial contamination ranged from 40-74% for Islamabad, 37-63% for Lahore, 38-79% for Faisalabad, 52-76% for Bahawalpur, 29-71% for Gujranwala, 31-87% for Multan, 53-87% for Rawalpindi, 75-92% for Sargodha, 48-68% for Quetta, 100% for Ziarat, 40-70% for Mangora, 31-77% for Peshawar, 73-100% for Hyderabad, 61-100% for Karachi and 67-83% for Sukkur during 2002-06.

This indicates that in most of the cities of Pakistan, municipal water is unsafe to drink and does not meet WHO guidelines. Further, poor maintenance and intermittent shutting down of piped supply leaving water lines empty, thereby allowing sewage to seep in and make the water quality hazardous. The microbial quality of drinking water supplies is extremely poor in the rural areas as well. In rural areas, there is simply no system in place to assess the quality of drinking water. The availability of drinking water where groundwater in saline is also a serious problem. The Government of Pakistan, while recognizing that access to safe drinking water is the basic human right of every citizen and that it is the responsibility of state to ensure its provision to all citizens, is committed to provision of adequate quantity of safe drinking water to the entire population at affordable cost and in an equitable, efficient and sustainable manner.

5. Contaminated Water and Health Impacts

Communicable diseases associated with contaminated waters include viral, bacterial, protozoal and worm infections. Viral diseases associated with water include hepatitis and poliomyelitis. The bacterial diseases include Cholera, Gastroenteritis, Leptospirosis, Paratyphoid Fever, Typhoid fever, Shigellosis and Salmonellosis. Protozoans such as Giardia and Cryptosporidium can produce gastroenteritis and are very resistant to disinfectants. Schistosomiasis, Dracunculiasis and Ascariasis are caused by worms. Table 2 shows diseases associated with contaminated water.

Table 2: Diseases Associated with Contaminated Water

Diseases	Effects
Viruses	
Hepatitis	Fever, nausea, loss of appetite, fatigue, jaundice
Poliomyelitis	Headaches, nausea, vomiting, stiff neck, nasal voice, runny nose, difficulty in swallowing
Bacteria	
Cholera	Extremely heavy diarrhea, rice-water stool, vomiting, thirst, pain, dehydration, high death rate
Gastroenteritis	Vague term for abdominal discomfort, characterized by mild to severe diarrhea, nausea, indigestion, vomiting, cramps, and possibly fever
Leptospirosis (Weil's disease)	Fever, rigors, headaches, nausea, muscular pains, vomiting, prostration, jaundice
Paratyphoid fever	Continued fever, diarrhea, occasional rose spots on body
Salmonellosis	Abdominal pain, diarrhea, vomiting and nausea, chills, fever
Shigellosis	Diarrhea, fever, mucus and blood in stool
Typhoid Fever	Continued fever, usually rose spots on body, abdominal discomfort
Protozoa	
Amebiasis	Prolonged diarrhea, abdominal discomfort, blood and mucus in stool, abscesses of liver and small intestine
Giardiasis	Mild to severe diarrhea, nausea, indigestion, flatulence
Cryptosporidiosis	Diarrhea, abdominal cramps, fever, nausea, and vomiting
Worms	
Ascariasis	Worm in stool, abdominal pain, skin rash, protuberant abdomen, nausea, large appetite
Dracunculiasis	Abnormal redness of skin, itching, giddiness, difficulty in breathing, vomiting, and diarrhea. Symptoms gradually manifest themselves over the entire incubation period and become pronounced a few hours before the appearance of the worm beneath the skin
Schistosomiasis	Worm enters blood stream. Itching of skin, dermatitis rash, body pain, dysentery, anemia, vigors. Snail is intermediate host. The disease is prevalent in tropics and Nile Deltas

6. Action Plan – Way Forward

Realizing the importance and role of safe drinking water in the improvement of environment as well as the commitment to achieving the MDG, following paragraph would amply summarize the national vision, which forms the foundation for National Water Supply Programme.

> *"By 2025, every Pakistani should have adequate water supply facilities. The water supply should be of potable quality, adequate in quantity, equitably distributed to meet all basic needs of drinking, bathing and washing. Water supply facilities*

should be with due consideration of quality of life, economic value of resource, ability to pay and participation of all stakeholders".

In order to meet the vision, Pakistan would require additional water resources to the tune of 4 MAF/year by the year 2025, in addition to existing uses of 4.5 MAF. The major constraints to meet the vision targets for water supply are:

6.1 Major Constraints / Issues

i) Lopsided / unsymmetrical exploitation of groundwater. Water tables are falling in many areas. This requires in depth analysis of groundwater.

ii) A very important parameter for water supply is the quality of available water. It plays vital role for the health of people. It is reported that 40% of all diseases in Pakistan are attributable to poor quality of water, while for children below 5, it is 60 percent.

iii) Lack of operational sewage treatment facilities and industrial effluent is resulting in pollution and hazardous conditions in many streams and rivers.

iv) Groundwater pollution due to vertical and lateral movement of saline water is adversely affecting water quality of groundwater reservoirs which is limiting the availability of potable water.

v) Lack of proper funding for the water supply sector.

6.2 Strategies / Recommendations

- Resource Availability:

The two major sources of water for water supply and sanitation are groundwater through open wells, tubewells, hand pumps springs etc. and surface water through canals. Through the introduction of Devolution Plan, the responsibility for water supply has been transferred to Tehsil Municipal Administrations (TMAs). TMAs are responsible for planning, implementation and administration of water supply sector. In order to plan and implement the schemes, it is essential that water resource availability and quality on sustainable basis be determined at each Tehsil level. Existing water uses with quality be determined and future requirements be estimated for planning horizons of each 5 years upto 2025 and onward.

- Capacity building in TMA would have to be developed to meet the technical requirements.

- Periodic evaluation of some important parameters like bacterial load especially indicating faecal pollution, (coliforms, e.coli etc.) free residual chlorine, turbidity, pH and TDS should be carried out both at source and consumer's end. To ensure safe water supplies for drinking, there is a need to formulate an effective management strategy based on multi barriers of protection from source to the point of use.

- Chlorine, in a variety of chemical forms, has been the disinfectant most commonly used in the world. If only chlorination is practiced, it would eradicate large percentage of water borne diseases. Chlorination equipment must be installed at every tubewell and its efficient operation should be ensured because it is the only choice to provide persistent residual in water supply network to kill pathogens.

- Public awareness campaigns should be launched to educate people about the importance of safe drinking water supplies. The hazards of unsafe drinking water should be publicized. Media and non-government organizations can play a pivotal role in this aspects.

- Water borne diseases data from hospitals should be collected on seasonal basis to propose precautionary measures against water borne diseases in most critical seasons. It would help in devising special monitoring and disinfection programmes during critical period of the year.