1st International Conference on Safe Drinking Water Governance (SDWG)

Conference Proceeding Report

January 15-16, 2019, Lahore

Organized by

School of Governance and Society (SGS)

University of Management and Technology (UMT)

Knowledge Partners

Planning and Development Department

Freshwater Action Network South Asia

Public Health Engineering Department (PHED), Punjab

Preface

The idea behind organizing international conference on Safe Drinking Water Governance was to deepen our understanding of the collective action problem faced by citizens. We therefore, planned to engage and brought together policy makers and implementers, experts, academia, and water user communities to deliberate contributory causes to unsafe drinking water, governance challenges and possible remedies to safe supply of drinking water.

lmost seventy percent of the earth surface is water. Water exists in atmosphere, earth soil, aquifers, glaciers, rivers and lakes. Yet it is becoming scarce and unfit for human consumption. The pressure of the ever-increasing human population, especially in South Asian countries, is coupled with unregulated, unbridled anthropogenic activity, which is ignorantly aiming human progress. Pakistan faces the challenge of scarcity of water in general and of potable water in specific, owing to a variety of reasons. Aquifers, the main source for municipal water are contaminated due to lack of understanding of social behavior, inadequate policies, absence of rules, unaligned operational structures, deficient enforcement mechanism, and over population. Water sources, which once were in abundance and potable, have gradually turned into poison due to aforementioned causes. Of much concern are the unregulated municipal waste water disposal, poor sewerage infrastructure, unregulated pesticide and fertilizer use, human and animal defecation which their find way in rivers and ponds in rural areas. The absence of rules and enforcement regimes add to the challenge.

This conference was a humble effort to bring all stakeholders together to deliberate multi-dimensional nature of common pool resource (water) problem, and develop common understanding for policy input. The different conference sessions focused on these diverse causes. The interactive sessions with community-based organizations introduce possible technologies for safe drinking water at domestic level. We have included in this volume all the proceedings of the conference for the benefit and dissemination of accumulated knowledge to wider audience.

I am grateful to Dr Aslam, Rector UMT, Ibrahim Murad, President UMT, RahatUl Ain, Director School of Governance and Society, all the University Offices for the tremendous support and facilitation provided to make the Conference a fruitful activity.

I am thankful to the Planning and Development Department, Government of Punjab, UNICEF and all our knowledge partners for extending support and facilitation.

Last, and not at all the least, Jawad Ahmed (Late) was the mover and doer of small and big tasks of the conference shall always be remembered. His immaculate organization, great team spirit and ever smiling face shall remain in our memories. We lost Jawad in an accident two months after the conference. May his soul eternally rest in peace (Ameen).

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Introduction

South Asia region inhabits 1.7 billion people, almost 1/4 of the world population. Pakistan, one of the main countries of the region, has a population of more than 200 million people, and a population density of 260 persons per square kilo meter. This places demand on municipal services, especially on water for food production as well as human consumption. Increase in demand with declining per capita water availability has placed serious pressure on water resources.

Water coverage in urban areas in Pakistan is estimated to be 96 percent, of which 58 percent is through individual service connections and 38 percent through other means, such as standpipes and hand pumps. The Sustainable Development Goals (SDG) baselines prepared by the WHO-UNICEF Joint Monitoring Programme (JMP) states that in 2015, 2.1 billion people lacked water services reaching the new standards, including 159 million who still drank untreated water directly from surface water sources such as streams or lakes. The SDG no. 6, 6.1, 6.5, and 6.6 (a) aim to ensure availability and sustainable management of water and sanitation for all,achieve universal and equitable access to safe drinking water for all, implement integrated water resource management at all levels including trans-boundary cooperation as appropriate, and support and strengthen the participation of local communities in improving water and sanitation respectively.

The two day 1st International Conference on Safe Drinking Water Governance organized by the School of Governance and Society (SGS) on 15-16 January 2019 was attended by international and national practioners, scholars, policy practitioners, policy makers, communities, NGOs etc. together to develop common understanding on issues related to safe drinking water availability to all and explore means for effective governance in the area. Over 100 students of the SGS engaged in the conference activities. Moreover, students from Kinnaird College University and Lahore College University also participated.

The two-day Conference on Safe Drinking Water Governance (15-16 January 2019) was an opportunity to deepen our understanding of the subject under the SDGs and facilitate collaborative deliberation and action around sustainable management. One of the objectives of the Conference is to bring academic andpolicy researchers,

The objectives of the conference were to:

1. Developing, widening and deepening understanding about safe drinking water policy framework and the SDGs.

2. Grasp the challenges, implications and causes underlying inadequacies in existing policy and implementation measures

3. Exploration of possible ways and methodologies to ensure effectiveness of safe drinking water governance and infrastructure for equitable availability across rural and urban dwellings.

4. Contemplating and proposing measures, processes and mechanisms for healthy community participation in improving water and sanitation conditions.

5 Provide a critical forum for future discourse, dialogue and debate as well as the opportunity for networking among range of stakeholdersfor continued deliberations to address the issue.

Conference Themes

1. Existing Safe drinking water legislation and policy and the SDGs achievement

2. Challenges to safe drinking water availability and improving water resources governance

3. Political, social, economic and governance challenges to overuse of water and depleting water table

4. Communities' contribution and participation ineffective water resources management

Conference speakers

Speakers	Topic
Ananda Jayaweera	Water Governance to Achieve SDG 6 Targets
KitkaGoyol	Safe Water & Sanitation Governance in the SDG Era: Surveillance, and Water Quality Regulation
NiazUllah Khan	Accountability and Regulation- A Case Study of Punjab Pakistan
Muhammad Ajmal Sandhu	Appraisal of the Implementation of Water Related Policy Instruments in Pakistan
Saad Khan	Understating and Reversing Drinking Water Crisis in Pakistan
Sohail Ali Naqvi	The Groundwater Challenges in Pakistan and Strategy to Replenish it
Zamir Ahmed Soomro	Drinking Water Quality Assessment of District Bhakkar
SaeedaBatool	Willingness to Pay for Safe Drinking Water and Incidences of Diseases: A Case Study of Pakistan
Dr. Daanish Mustafa	Social Power and the Politics of Water Access in Karachi
Rummana Khan Sherwani	Water Quality Assessment of GulbergII Lahore and its Impacts on Nearby Community
Mushtaq Gill Khalid Gill	Improving Water Resources Governance of Safe Drinking WaterChallenges and Opportunities
IftikharTalpur	Water Governance Policy Gaps in Sindh and Marginalized Groups: Participation of Women
Hassan Abbas	Drinking Water Supply for the Tail-end Communities of Canal Command Areas and Indus Delta
Mohamed Rasheed	Overcoming Barriers to Water Utility Service Provision for Small Island Communities in the Maldives with an Emphasis on Social Enterprise Business Model
Atif Hassan	Community Participation
Rano Khan	Improving Access to Safe Water and Organic Food by Use of Solar Energy in Thar Desert (a model of participatory management of water supply with innovation of water metering Thar Desert)
Dr. Tahira Mughal	Monitoring of Groundwater Quality of Different Towns of Lahore
GhulamHassanZakir	Groundwater as a Source of Drinking Water and Associated Concerns
Ali Akbar	Mobile Reverse Osmosis (RO) Plant for Thar Desert (An Innovative Initiative)
RazaNaeem	'Water, Women Everywhere, but Not a Drop to Drink?' Reading Saraswati and Paroshni as Allegories for Water Governance, Ecofeminism and Environmental Activism

Dr. SammiaSaif	Introduction on Water and Environment Crisis
Dr. Shafique	A Potential Water Vision to Manage Water Crisis in Pakistan
Dr. Saqib Nawaz	Waste Water Treatment & Reuse in Pakistan
Dr. Iftikhar Ahmad	Feasibility of Dams in the context of water/energy crises
Dr. AsimMahmood	Water Sustainability and Concluding Remarks
HumairaKanwal	Analysisof Drinking Water Quality Parameters: A Review

According to the programme (Appendix 1) on 15 January after the inaugural session, four presentations and eight full length papers and on 16 January seven presentations and three full length papers were presented The papers were presented by Ananda Jaya Weera (Sri lanka), NiazUllah, Muhammad Ajmal Sandhu, Sohail Ali Naqvi, Zamir Ahmed Soomro, Saeeda Batool, Rumana Khan Sherwani, Iftikhar Talpur, Muhamed Rasheed, Rano Khan, Dr Tahira Mughal, and Ghulam Zakir Hussain Their edited full length papers and the abstracts of the presentations are include. Moreover the conference also arranged poster competition among students/ faculty of participating institutions awarding cash prize to first (Rs 9000), second (Rs 7000) and third (Rs 4000) winning persons.

Full length papers

Water Governance to Achieve SDG 6 Targets

Ananda Jaya Weera (Sri lanka),

ABSTRACT

The overall objective of water resources governance is to ensure the use of water resources in an efficient and equitable manner, consistent with the social, economic and environmental needs of the present and future generations. Main objectives could be summarized as follows; to establish a formal water allocation and entitlement system at national level, which will provide directions to operating agencies through policy and regulations, to ensure equitable allocation of the limited resource to various sectors, in the provision of all water services.

Essential Change that would be required to introduce a robust water governance system is to provide adequate financing for performance of water governance functions. The challenge is to reform traditional institutions which are focus on maximizing water utilization for a particular sector.

Strengthening water governance has become an important aspect in recent times after realization that the potential for further development of water resources is diminishing and the cost of development is unaffordable due to social and environmental issues associated with large scale water resources development. Efficient use of already developed water resources will be more cost effective than embarking on major water development projects. Good water governance will play an important role in sustainable utilization of existing water resources.

Internalizing a process of reforms in the water sector is important to change the traditional institutions and create a robust system of water governance to face the current and emerging

challenges in the wake of impact of climate change and population pressure on natural resources base.

Progressive realization of SDG 6 Target 6.1 depends on transformation of current and future drinking water supplies to safely managed status. This would be possible through recognizing that drinking water as a national priority andthrough improve water governance across all water use sectors to accept this priority.

1 What is Sustainability in Water Governance

1.1 Matters of Concern

Water is a diminishing resource in the wake of climate change and increasing demand due to population expansion. Increasing competition among major water use sectors such as irrigation, agriculture and industry affectsaffordability and availability for the drinking water sector. Many countries all over the world have responded to their obligation to respect UN declaration on access to water and sanitation as human rights. The expectation is to amending constitutions to reflect HR to water and sanitation. Water is the first casualty due to the impact of climate change and first to suffer is the drinking water availability. Commitment to achieve SDG 6 provides a great opportunity to focus on water sector reforms and establish collaborative partnerships to implement water governance. Importance of water governance is now well established across the globe with the realization of the fact that water is a diminishing resource. The key equation for achieving SDG 6 is based on the following;

Securing SDG 6 + Legal Compliance = Sustainable Water Governance and Management

Fig 1.

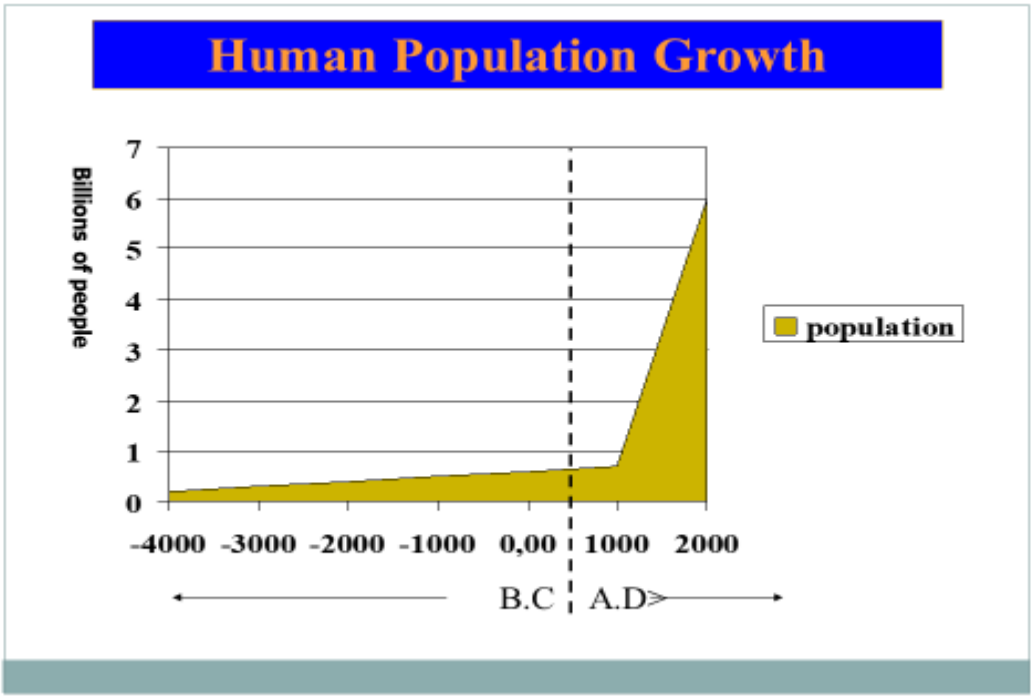


Fig 2

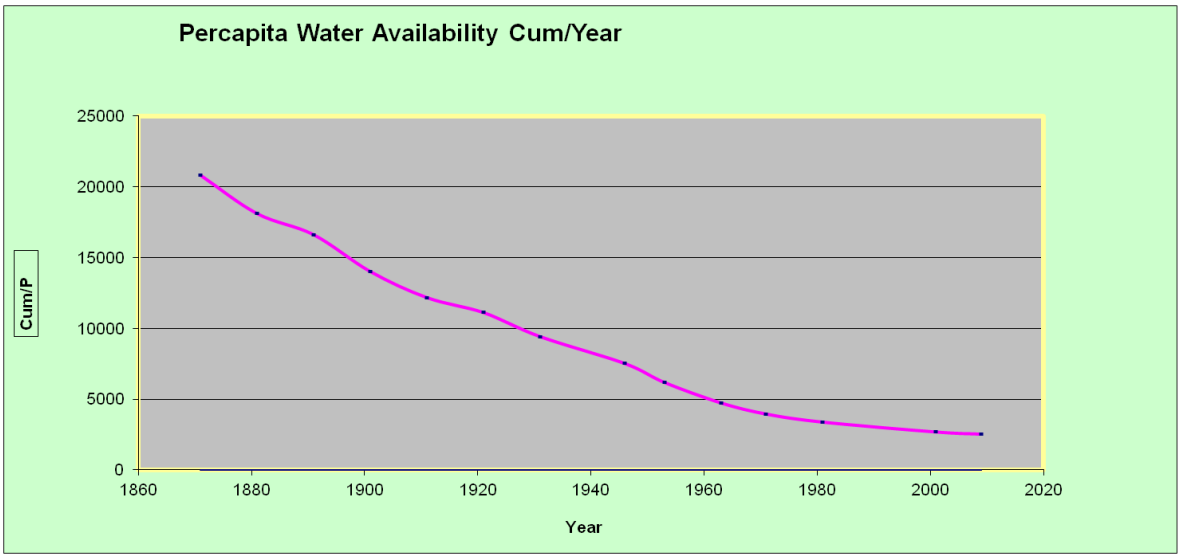


Fig 1. Steep rise in the world population growth in the past 1000 years is an alarming sign in terms of stress on natural resources and proportionately diminishing water resources as shown in the Fig 2.

1.2 Goals in Sustainability

Overall goal of the commitment is to ensure water security and safety of the nations through promoting conservation, protection and restoration of fresh water ecosystem.

The challenge of water governance and management are to ensure the use of water resources in an efficient and equitable manner, consistent with the social, economic and environmental needs of the present and future generations. It is imperative to establish a formal water sharing mechanism to securing adequate water for expansion of drinking water at national level, which will provide directions to operating agencies through policy and regulations to ensure equitable allocation of the limited resource to various sectors to maintain sustainable service delivery. Many countries have invested heavily in water resources development to maximize the resource for irrigation, agriculture and hydropower and all cost effective water resources have been utilized and prudent management is essential to safeguard the investments and maximize the benefit of already developed water resources.

Key Issues is, in the absence of a formal water allocation mechanism the water agencies have been facing difficulties in ensuring water rights of the existing users and flexibility to meet needs of new users.

The key message is to strengthen institutions for sustainable utilization of available water resources to avert the impending water crisis.

Safe drinking water is critical to all Nations across the globe as vital resource connected in all aspects of human life, economic development, food security and economic vitality. Water, combined with land, provides plant and forests, which in turn, are indispensable to sustain human and animal life. Whole world is now facing the challenge of sustainable development. The main reason for this is that human civilization in the past 200 year was based on unsustainable

development. The so called development that took place during the industrial revolution through conversion of resources to non-degradable substances have caused irreversible negative impacts on water, land and atmosphere.

Although the mobilization of resources and conversions were done to improve quality of life, degradation of most important aspects for quality of life are now evident. Literally quality of life depends on the following universal facts;

I) Quality of air
II) Quality of water
III) Quality of food
IV) Quality of environment

In the past water resources development considered only few aspects such as utilization of water to meet certain demands. There are number of such examples all over the world. The illusion that engineer could produce water where and when it was needed led to egregious waste and disruption of freshwater ecosystems. Everybody is learning that there are limits to mankind's ability to move water from one place to another without seriously disrupting the natural balance. New consensus are emerging to apply rigorous project selection criteria, long term and short term, side effects are defined as effects beyond the objectives of the project. In order to eliminate negative side effects, which are having direct impact on sustainability of any development, a rigorous analysis of the following is included for sustainability.

Table 1. Sustainability Analysis

	Sustainability Challenges	**Functional Areas for Management**
1	**Technical Sustainability**	**Balance demand and supply no exploitation**
2	**Financial sustainability**	**Stability of population, stability of demand and willingness to pay**
3	**Social sustainability**	**Cost recovery or cost sharing application of user pay and polluter pay principles**
4	**Economic sustainability**	**Sustaining economic development, water as an input to growth**
5	**Institutional sustainability**	**Capacity to plan implement maintain and operate systems**
6	**Environmental sustainability**	**No long term negative or irreversible effects**

Planning, appraisal, implementation and sustainable service delivery of drinking water are to be subjected to above analysis to ensure water security and safety.

IWRM Definition

"Management of surface and subsurface water in qualitative, quantitative and ecological sense, from a multidisciplinary perspective and focused on the needs and requirements of society at large regarding water*"*

The opportunity created by the commitment made by countries all over the world achieve global goals and in particular the SDG 6 Target 6.5

"By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate*"*

Water sharing corporation agreements and establish common framework for equity and inclusion when allocating water for all communities.

Global progress towards target 6.5 is monitored through two indicators:

- 6.5.1 Degree of integrated water resources management implementation (0-100)
- 6.5.2 Proportion of transboundary basin area with an operational arrangement for water cooperation
- Basis for improving water governance is in the IWRM process.

2. Global Goals and Country Process to Achieve SDG 6 Target 6.1

2.1 Transition from MDGs to SDGs

With the expiry of MDGs at the end of 2015 countries all over the world commenced understanding the service levels required for achieving SDG 6 and established baseline for SDG 6 by 2016 which is the base year for SDG 6. The sector coverage status achieved during the MDG period was based on improved water sources, the improved water services are based on accessibility and availability.

SDG 6 is designed to ensure sustainable service delivery for achieving universal access to safely managed drinking water. The targets are based on ensuring commitment of the water sector as a whole. Since water is a limited resources and rather diminishing resource due to expansion population and water increasing demand, drinking affordable only if other major water use sectors improve water use efficiency by implementing target 6.4 and transfer the savings for expansion of pipe water. This requires agreement at the highest level and implement IWRM Target 6.5 and revise policies, strategies and plans to reflect the national commitments to SDG 6 as a whole.

The service levels defined in the WASH Ladder by the JMP of the WHO/UNICEF are as follows

Target 6.1 “By 2030, achieve universal and equitable access to safe and affordable drinking water for all”
Means of verification -Percentage of population using safely managed drinking water services

DRINKING WATER-Safely managed

- **Accessibility** on premises,
- **Availability** available when needed, and
- **Quality** - free from contamination.

Realization of Human Rights to Water & Sanitation is an important aspect during the transition period and the respective governments who recognized this declaration are supposed to amend their constitution and include in the human right action plans.

The human right to water and sanitation was explicitly recognized only in 2010 by the United Nations General Assembly and the Human Rights Council.

The implications for water service delivery are that provision of **Free Basic Water to be commensurable with affordable solutions.**

2.2 Progressive Realization of Drinking Water Service Levels /UN WASH Ladder

Target 6.1 Achieve universal access to safe and affordable drinking water

WASH Ladder Service	Indicator	Accessibility	
Safely managed drinking water services	Drinking water from an improved source which is located on premises, available when needed and free of faecal and priority contamination	• Pipe Water supplied to door steps (Operated by Boards and Community Based Organizations subjected WSP) • Tube Wells (HH WSP) • Protected Dug wells subjected to household water safety plans (WSP)	PROGRESSIVE REALISATOON
Basic service	Drinking water from an improved source provided collection time is not more than 30 minutes for a roundtrip including queuing	• Protected Well outside premises • Individual Pipe supply • Stand pipe • Common well • Rainwater Harvesting	
Limited service	Drinking water from improved sources which require over 30 minutes for a roundtrip including queuing	Source outside premises safety depending handling	
Unimproved	Drinking water from unprotected dug wells or unprotected springs	Vulnerable to contamination and depletion	
Surface water	Drinking water from a river, dam, lake, pond, stream, canal or irrigation channel	Risk of contamination and potential for	

Based on the emerging WASH ladder (above) of SDG 6 it is important to agree nationally what categories of water availability and accessibility qualify as safely managed drinking water.

From the above Accessibility to safely managed drinking water categories are identified under the top rung of the WASH ladder.

Target 6.2 By2030, achieve access to adequate and equitable sanitation and hygiene for all, and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations

	WASH Ladder Service Level	Indicator Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water	Categories
	Safely managed sanitation services	Private improved facility with excreta safely disposed on site or transported and treated off site	Water Sealed Connected to well-designed septic tan Water Sealed Connected to pipe sewerage Subjected to Septage Management service Off site
	Basic Service	Private Improved facility with proper excreta disposal	Water sealed connected to pit not shared with others
	Limited Service	Improved facility shared with other household	Water sealed sahred with others
	Unimproved	Does not separate excreta from human contact	Direct pit with no proper disposal of excreta
	No Service	Open Defecation	No toilet

Progressive realization of sanitation services to safely managed status is imperative in order to protect the environment, surface and ground water. Depletion of water due to diffused pollution is a thread to maintain sustainable drinking water services.

Challenges are;

1. Limited and unimproved services to safely managed status by providing properly designed septic tanks or off site treatment and disposal through septage treatment facilities (STP). Overflowing pit latrines an provision of septage treatment facilities for urban areas
2. Provide new facilities for the people practicing open defecation with safely manage services

Target 6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally"

	Global Indicators for Target 6.3	Progressive Realization
6.3.1	Proportion of waste water safely treated	In collaboration with the partners identified under in chapter 4 establish baseline for waste water generated and treated in all sectors including domestics waste water discharged to the environment. National inventory of all waste water generated and discharged by agreed milestone. Develop national strategy Identifying respective

		responsibilities in the progressive reduction of waste water discharged with national monitoring system established. A strong public awareness campaign is essential in realizing these targets
6.3.2	Proportion of bodies with good ambient water quality	Amend environment laws to include ambient water quality standards. Designate all water bodies and expected water quality. Bring all water bodies to a national network c coupled to a SCADA system with appropriate technology to monitor water quality.

National action plan to achieve **Target 6.3** will go a long way in ensuring drinking water security and safety see Annex II for the conceptual diagram for identifying pollutants and polluted systems

2.2 Mainstreaming SDG 6 in the Water Sector

The SDG 6 actually has 8 targets unlike in the MDGs these targets are not related only to water and sanitation sector therefore strong institutional collaborationist with robust multi-stakeholder engagement is needed to achieve SDG 6. The action points identified for successful national framework towards targeting SDG 6 are as follows;

1. Identify the lead agency for WASH responsible for policy, coordination, monitoring and reporting to GLAAS and JMP
2. Identify focus agencies for Target 6.3 , 6.4 , 6.5, and 6.6
3. Identify lead agency /government focal point for each target
4. Work with national statistical system to formulate indicators for each targets based on global monitoring initiatives (GEMI) GLAAS an JMP
5. Agree on national level monitoring through census (proxy indicators)
6. Establish Collaborative partnerships with key water and environmental agencies and agree on a national accountability mechanism
7. Prepare national baseline for each target starting from 6.1 & 6.2
8. Agree with partner agencies for collecting baseline data for Target 6.3 -6.6
9. Formulate national targets and milestones for SDG 6 towards achieving global goas by 2030
10. Develop national indicator framework and mechanism for periodical reporting on the progress of SDG 6
11. Develop cost tools for financing SDG 6
12. Provide leadership for coordination and engage with dialogue through a multi-stakeholder platform with the aim of maximizing synergies
13. Agree on national bench mark for water and sanitation service expansions

The lead agency for Goal 6 is required to analyses the key points above and create a knowledge platform in orientation of sector agencies.

With the expiry of MDGs in 2015 it has been accepted globally that the base year for SDG is 2016. National governments prepared baseline reports for almost all target of Gola 6. Difficulties have been reported in establishing baseline for 6.3 to 6.6 due to the absence of specific data gathering system. Establishing collaborative partnerships with key water agencies to implement the national

framework towards targeting SDG 6 as explained above will be able to resolve many issues is carrying out surveys in order to find out the baseline status and agree on the progressive steps and milestones for each target.

2.3 Main Roles and Responsibilities of Lead Agency

- To function as the lead agency to undertake sustainable development responses and interventions including the facilitation of the formulation of necessary policies, strategies, programmes, mechanisms and tools.
- To liaise with sectoral agencies at national and sub-national levels for identifying priorities and developing mechanisms to implement national policies on SDG 6.
- To facilitate Sustainable Development related research and distribution of research results to trigger policy reforms and actions.
- To facilitate and coordinate national and international commitments to the 2030 Agenda for Sustainable Development and the SDGs including monitoring, evaluation and reporting.
- Assist national level reporting for global platform on the periodical reporting of progress towards SDG 6 Targets
- Establish national baseline, indicators and bench marks for WASH services
- Facilitate periodical joint sector review and agree on mutual accountability towards sector goals

2.3 National Multi-stakeholder Framework

An important step towards a comprehensive approach is to mobilize support of the key stakeholders through revision of national policies on drinking water (urban & rural) and national plans. Work with national statistical systems to include WASH indicators for the next national survey and national census is important in developing a MIS for the sector. Facilitate joint sector review with key stakeholders through inclusive approach by mobilizing support of government, donors, private sector and civil society who contribute for WASH service delivery.

Government's Accountability; is demonstrated in many ways through the commitment and response to global monitoring, active involvement with international partners such as SWA, regional partners of SACOSAN and leadership provided to the national platform where an all-inclusive approach to be followed in engaging sector partners including CSOs and private sector.

National coordination platform is a responsibility of the lead agency and to be held more frequently and at least 6 meetings per year in order to identify priorities, policies, investment opportunities and more over maximise synergies. Coordination is an all-inclusive approach and could be considered as the apex body. The mutual accountability of all stakeholders will be based on the following;

The right to water and sanitation cannot be dissociated from human dignity

- Everyone has the right to participate in decision- making processes that affect their right to water and sanitation
- Communities have the right to determine the nature of their water and sanitation services
- Everyone should be given full, transparent and equal access to information

The lead WASH of the Government being accountable for respecting, protecting and fulfilling its obligations, is "in the driving seat" of the National Water and Sanitation Coordination forum and continue to chair and provide for policy directions, effective resource mobilization, sharing of responsibilities with partners and identifying priorities.

Coordination is vital, in order to avoid overlaps, duplications and to fill gaps, and to ensure a coherent response to emergencies, when there is a large number of entities focus on one objective engaged in number of tasks.

Example of Strong Coordination Platform- National WATSAN Coordination

Sri Lanka's national water sanitation coordination form has been recognized as best practice by regional and international WASH agencies.

The Ministry of City Planning and Water Supply the lead agency for SDG 6 considers the forum, National Coordination Meting as an accountability plat form for sector decision making on policy review, technological options and create opportunities for the experts from INGO/NGOs to engage in use of the knowhow at national level.

The Forum adopted a Terms of Reference during Tsunami recovery phase and it was reviewed as the standard operating procedures at NCM where number of nationally importance subjects are being discussed.

The proposed interagency committee to be established under the Ministry of City Planning and Water Supply representing CSOs as well will be responsible for reporting the progress of establishing baselines for SDG 6, respond to global monitoring coordination with UN agencies, knowledge management on SDG 6 for sector partners CSOs and at various level of the government and prepare indicators for national survey and census.

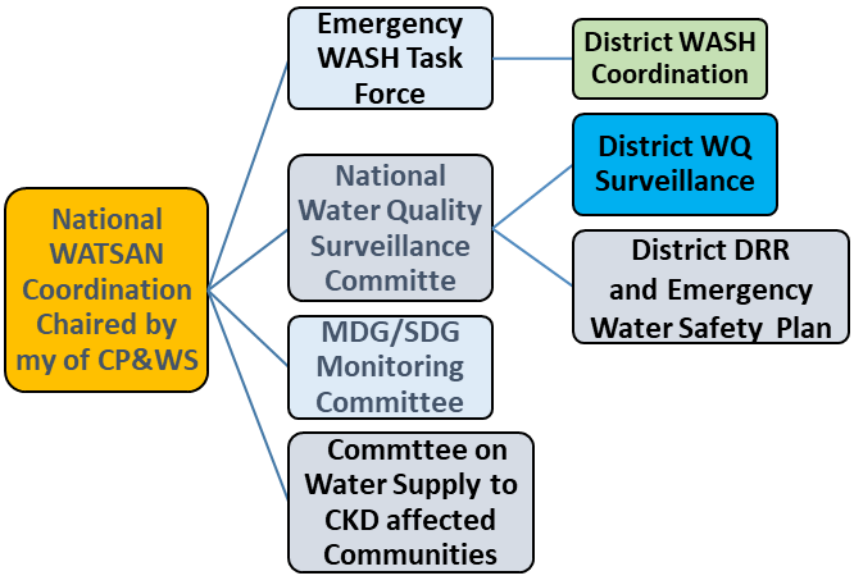


Fig 2.3 Institutional Framework of the National Coordination in Sri Lanka

Thematic concerns such as chronic kidney disease prevailing in NCP, salinity intrusion in rivers affecting water supply, School WASH and strategic follow up

Responses to the South Asian Conference on Sanitation SACOSAN held periodically among the countries in the SAARC region is an important agenda item for which national international agencies and CSOs/NGOs have shared responsibilities in fulfilling commitment to the SACOSAN process. Emergency WASH including preparedness and capacity building has a special focus and linkage to district WASH coordination.

It could be called a good cross section of WASH partners who are actively engaged in the sector at present and provide expert advice on the national issues discussed at the NWSCG meeting. Water supply and sanitation to resettled population is high in the agenda of the forum. NWSCG meeting provide an excellent platform for finding solutions for many national issues and the general development.

The main subjects matters taken up with shared responsibilities

1. MDG /SDG Monitoring Committee – this is now focusing on the SDGs and the main tasks assigned are to establish baseline for SDG 6, agree on national indicators, develop consensus for national targets and milestones and establish benchmarks.
2. Chronic Kidney Decease of unknown Origin CKDu affected areas
   Water supply to the region affected by CKDu is supported by many agencies including CSOs, Private sector and donors the coordination help to mobilizing resources to provide water for drinking and cooking for the affected people in the North Central Province of Sri Lanka

3. Emergency Water and Sanitation – Coordination of efforts of all sector partners in bringing relief to the people affected by floods, landslides and droughts – floods and droughts have become an annual emergency in Sri Lanka
4. Policy Working Group – Contribute in formulating of policies related to urban and rural drinking water supply
5. Water Quality Surveillance Steering Committee – Chaired by Ministry of Health as the regulator for water quality (All service providers implement water safety plans(WSP)

The current National Water Sanitation Coordination forum has been established on the basis of the emergency WASH coordination functioned during Tsunami recovery phase. Transformation of emergency coordination into regular development coordination was smooth with the recognition of the roles of CSO in the WASH sector. The forum is of great help for the government sector when dealing with emergency WASH support.

Key positive aspects are;

- Emergency response and resource mobilization and maximize synergies
- Establish collaborative partnerships for regional and international responses in participation in high-level dialogue
- Effective interventions in rural sector avoiding duplication and identification of priorities.

What needs to be improved?

- Need to strengthen governments capacity in facilitating the forum

- Improve on regular frequency of conducting meetings
- Local /provincial level WATSAN coordination forums to be strengthen

Major Gaps:

- High Staff turnover in the government and loss of institutional memory continuity of tasks in both government and CSO sector
- Continuous knowledge management on the sector activities to be institutionalized with CSOs
- Changing leadership and direction in the government sector

4. Important Task is Mapping of National Responsibilities for SDG 6

Mapping of Ministries/Divisions and Key Stakeholders by Targets under SDG 6			
Targets SDG 6	**Lead**	**Collaboration with**	**Institutional Arrangement**
Drinking water 6.1	Lead for SDG 6 Ministry in charge of WASH	NWSDB DCWS LG & others v	Ministry of Health, Local Government Community Based Organization(CBO)
Sanitation 6.2	Lead for SDG 6	Min of health Local government	DCWS, Local Authorities, NWSDB and CBO
Waste water discharge control 6.3	Ministry of Environment Ministry of Industries	Central Authority for Environment, Water Board, Industrial Development Board and	Form a steering committee for baseline , formulate policies , inventory and Monitoring of waste water CSOs as watchdog for non-compliance
Water Use Efficiency 6.4	Ministry of Irrigation and Water Resources Management	Ministry of Agriculture , Tourism and Industries	National Steering Committee for water footprint
IWRM 6.5	Ministry in Charge of WASH	Major Sector Agencies CSOs for River Basin Committees and catchment protection	Propose to establish water resources council for policy law and advocacy and monitoring
Restore Eco-	Ministry of	Ministry in Charge of WASH, Local	Environmental Council

systems 6.6	Environment	Government and Urban Development	
international relationships 6.a	Ministry in charge of WASH	External Resources Department Water Board	Ministries and Service Delivery agencies Regional Sanitation Centre for SACOSAN
Strengthen Participation of Local Communities 6.b	Ministry in charge of water and sanitation DCWS and CSOs	NWSDB, Provincial Councils and Local Bodies. Ministry of Health	Ministry of Health for Water Quality Surveillance. Local Bodies for Sanitation regulatory process DCWS for capacity Building Technical agency for technical backstopping CSOs for sustainable service delivery

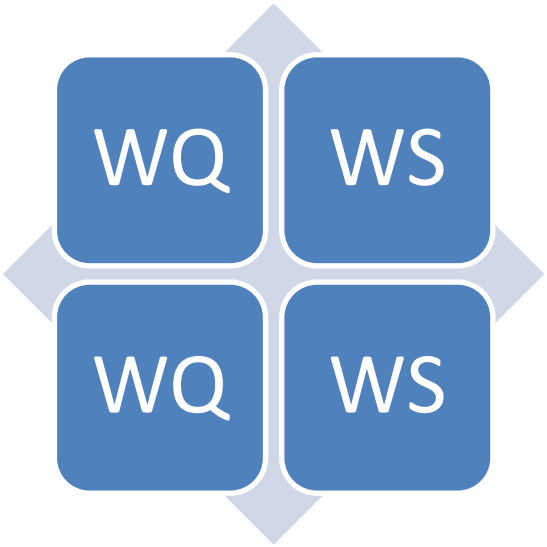
Above is a possible framework for national collaboration among the water health and environmental sectors for strategic approach to complement the water governance system and compliment achieving SDG 6.

5. Model for Water Governance to Support March towards SDG 6 and ensure water availability for Drinking Water Sector

5.1 Transforming Conceptualized Vision to National Actions

Achieving SDG 6 has implications for water resources management. If water resources management is not given its priority place compared to water service delivery, water safety and security will be at risk. Implementation of overarching Target 6.5 is there to ensure sustainability of the resource by adopting IWRM as the basis for water governance.

The Big Picture



Integration of qualitative and quantitative aspects in the management of water resources is the key to ensure drinking water

Water Quality – Water Safety

Water Quantity – Water Security

In order to achieve SDG 6 Target 6.1

Most important Changes are

1. **Policy, legal framework and institutional arrangement-enabling environment for strengthening water governance**
2. **Prioritize drinking water over all other uses**
3. **Implement IWRM targets**
4. **Maintain Integrity of the Hydrological Cycle**
5. **Adaptation to climate impacts through water resources planning**
6. **Training a new generation of water professionals**
7. **Introduce Water Safety Plans and Water Quality Surveillance**

5.2 **What is Water Governance? Who gets What, When and How (3WH)**

Strengthening water governance has become an important focus in recent times after realization that the potential for further development of water resources is diminishing and the cost of development is unaffordable due to social and environmental issues associated with large scale water resources development. Efficient use of already developed water resources will be more cost effective than embarking on major water development projects. Good water governance will play an important role in sustainable utilization of existing water resources.

Water governance refers to the political, social, economic and administrative systems in place that influence water's use and management. Essentially, **who gets what water, when and how**, and

who has the right to water and related services, and their benefits. It determines the equity and efficiency in water resource and services allocation and distribution, and balances water use between socio-economic activities and ecosystems.

One of the important aspect of water governance is to establish an institution for high-level decision making and build institutional capacity according to water service delivery and water resources management. When there is a clear institutional responsibility for water service delivery and resource management decision on financing water governance will be made easy.

The system development need to focus on generation of adequate funds from water service delivery to finance water governance functions.

The overall objective of water resources governance is to ensure the use of water resources in an efficient and equitable manner, consistent with the social, economic and environmental needs of the present and future generations. Main objectives could be summarized as follows; to establish a formal water allocation and entitlement system at national level, which will provide directions to operating agencies through policy and regulations, to ensure equitable allocation of the limited resource to various sectors, in the provision of all water services.

Essential Change that would be required to introduce a robust water governance system is to provide adequate financing for performance of water governance functions. The challenge is to reform traditional institutions which are focus on maximizing water utilization for a particular sector. The irrigation sector uses the bulk of the developed water resources where as domestic water supply utilizes about 5% of the water used in the irrigation and agriculture sectors. . Securing water for the drinking water has to face competition among other water users and also to cope with the increasing cost of water abstraction.

The opportunity created due to the commitment made to achieve SDG 6 will be the plat form for improving water efficiency in bulk water use sectors and savings would be re allocated to drinking water sector. The SDG 6.4 by 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity, and substantially reduce the number of people suffering from water scarcity.

To achieve the targets it is proposed that to establish water sector institutional collaboration for increasing water use efficiency in irrigation an agriculture and transfer excess to drinking water sector. Reduce water stress due to drought and over pumping of ground water

Key aspects are water foot print of agricultural produce – SDG 12 Responsible Consumption and production

In the case of Sri Lanka

5% improvement of water use efficiency in irrigation and agriculturesectors is a saving that could be used in the drinking water supply sector to double the population coverage in 2017 with pipe water

Under normal circumstance domestic water supply need to meet 120 lpcd

Under emergency situation where there is drought or displacement 40 lpcd

Virtual water- water foot print of one Kg of rice equivalent to water requirement of 50 persons/day

Key instruments for water governance

a) **Policy – on water governance**
b) **Law- water rights , permits , transferable water rights, demand management pollution control and water quality management**
c) **Apex body – with powers over all other users and uses**

Table 5.2 Instruments for Good Governance

Policy	For transparent decision making	Reverse unfavorable trends Mobilize commitment promote IWRM
Legislation	To protect the Decision	Protect resources, Individual Rights
Regulation	To provide modalities & details of implementation of the decision enforce	Promote commitment For conservation and protection public awareness
Manual	To operate the decision management	To be effective at grassroots level

5.3 Revenue from Service Delivery to Finance Water Governance.

Water governance would not be financed by external support as it is a recurrent expenditure on operational planning of water resources. It is important to recognise the difference between the resources management and delivery of services related to water. Current institutions are mandated to perform a mixture of these functions, as explained below, this has caused many important resource management functions, left unattended by the agencies as their core businesses are providing water for services such as irrigation water supply, industrial, tourism and agricultural use.

Management of the Resources

"Water is a Renewable resource"

- policy & water laws
- water allocation
- regulations
- planning at basin and national level
- entitlements and water rights
- water quality management
- assessment

Delivery of Service

"Water is a Commodity"

irrigation
water supply
industrial water supply
hydro power generation
navigation
fisheries
reclamation

- conservation & demand management
- data and information management
- protection of river system

fire protection
recreation
pollution control

Since water is a commodity, in the service delivery sector, adequate revenue is required to be generated to support water resources management functions which are not related to commercial outputs.

Current and future water governance need to focus on how well already developed resources are allocated equitable to the water use sector. Decide on priorities when there is an emergency such as drought and floods.

Water governance has to be based on hydrological boundary therefore the management unit would be river basin, logical argument here is that the water in a river basin has to be shared by the people within the basin. It is also possible to establish water balance within the river basin which is an important tool for management.

Why water Governance and water integrity are underfunded?

Many countries including Sri Lanka were complacent with regards to water availability due to its high rainfall. Only in recent times challenges emerged. The past investments were mainly to develop water resources and not for its governance through IWRM, therefore traditionally water governance is underfunded. Shift from implementation of non-cost effective water resources development projects to generate required revenue through water service delivery to promote integrity of the hydrological cycle.

'Above is an essential change in the water administration to ensure sustainable service delivery in all water use sectors'

5.4 integrity of the Hydrological Cycle through IWRM

Atmosphere, Ocean and Land are the 3 key elements of the hydrological cycle. Integrity of the cycle terms of harnessing water resources depends on how well we managed river basins. River Basins are the instruments by which we derive water for human consumption. Therefore man's influence on, the riverbasin, whichis the hydrological boundary for water resources, to be based on conservation, protection and restoration.

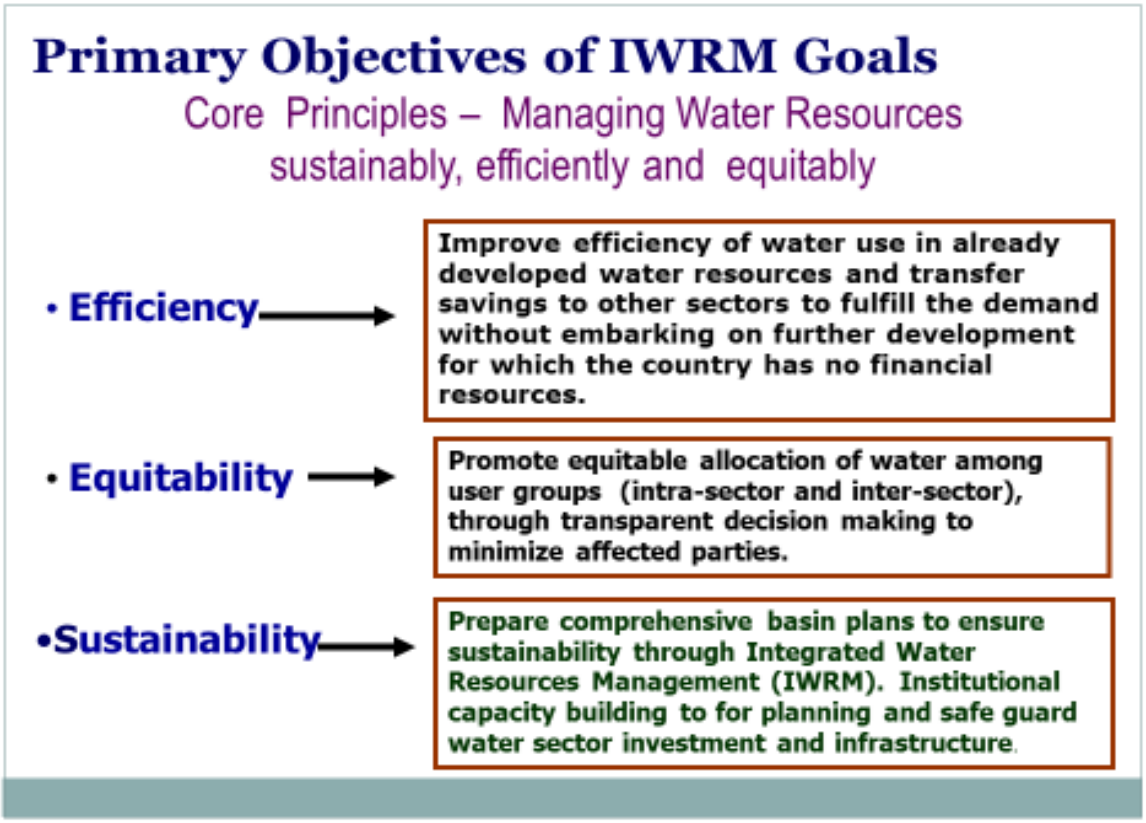
Fig 3. Integrity of the hydrological Cycle

Created by Author

River basin planning to be based on the above conceptual diagram which consider all aspect of water in terms of the following;

1. Natural system
2. Water resource systems
3. Water use systems
4. Water allocation and recycle systems

Fig 4



5.5 **Water Resources Management Targets in a River Basin**

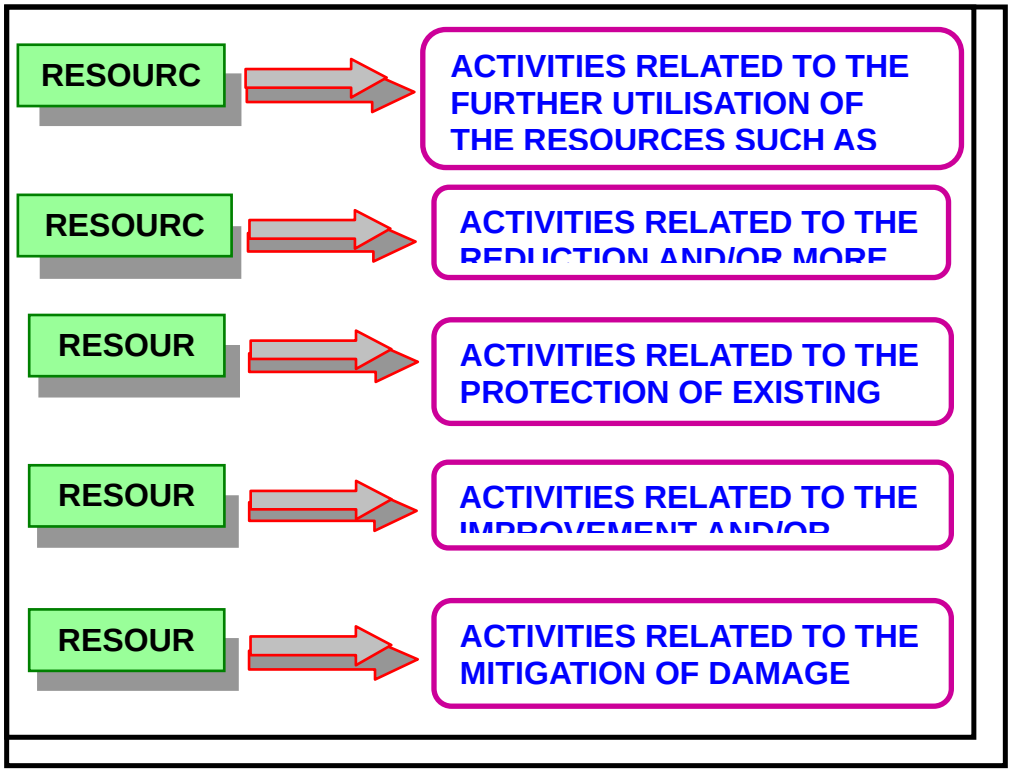
Most of the national objectives in the past five decade or so were to maximize resources through large scale water resources development projects for multipurpose use. Engineers were the key professional in decision-making and neglecting negative side effects of water resources development.

How we treated our rivers

- No mandate to protect river environment due to fragmented responsibilities
- Improper land use reservations are being seriously encroached
- Private owner ship of river banks extend up to water lines
- Reservations are not legally enforceable
- Disposal of waste & residues
- Industrial discharges use river water for dilution

- River flow obstructions floods and drought
- Environmental and ecological issues
- Sand and clay mining devastation to river environment and river health
- Water quality deterioration

Fig 5. River Basin Plan based on IWRM Targets



Comprehensive river basin plan will address all of the above and the plan implementation process to be agreed with the river basin committee

The plan is developed through **Jointly Diagnose, Jointly Plan and Jointly Implement**

5.6 Training New Generation of Water Professionals

5.6.1 Old approach and Understanding Side Effects of Water Resources Management

The art of engineer is to establish systems and build relevant structures, which may change the face of the earth with inadequate data and information. This applies to especially to the engineer who has to do with the complexity and diversity of the large natural surface and subsurface water resources water resources on earth. Failures and negative side effects are therefore the unavoidable and permanent companions of the management of water resources.

Side effects are defined as effects beyond the objectives of the project. Negative side effects have introduced new dimensions to project planning and implementation recognizing the importance of affected parties, environment and mitigation and prevention of negative side effects through a multidisciplinary approach.

Possible Negative Side Effects of Water Resources Project

I. Resettlement of displaced population

II. Sedimentation of reservoirs and river scouring
III. Destruction of flora and fauna by submergence
IV. Effects of ground water regime
V. Induced seismicity
VI. Effects on microclimate
VII. Effects on health
VIII. Shortage of allocation of water for environment
IX. Irrigation drainage
X. Water quality due to eutrophication and
XI. Salinity intrusion
XII. Soil acidity and salinity

Table 5.6 Training a New Generation of Water Professionals

TARGET AREA	ACTIVITIES	CAPACITY BUILDING AREAS
RESOURCE DEVELOPMENT	**Activities related to further utilization of the resource, such as Irrigation, Water supply schemes a Multipurpose projects.**	• Strategic planning and Management for Integrated planning at national and basin level. • Institutional Collaboration in functional areas for improved coordination and to avoid duplication. • Use of modern planning tools for optimization of resources • Image processing in Remote sensing and data processing • Integrated models to meet utilization for all purposes. • Mitigation of side effects of development • Geophysical investigation • Techniques for Establishing water balanc in hydrologic units • Training on EIA and minimize affected parties.
RESOURCE CONSERVATION	Activities related to the reduction and/or more efficient utilization of the resource through demand management	• Knowledge of Demand management tool • Design of Water Saving Technologies • Design, Construction and of • Operation of water efficient field structur • Negotiation skills and techniques for wat saving agreements

RESOURCE PROTECTION	Activities related to protection of existing surface and ground water sources, (quality &Quantity) for future use	• Total catchments protection strategies • Water and soil conservation structural methods • Surface and Ground water monitoring for quantity • Design and develop water quality management systems • Training on sampling testing, data gathering and transmission using modern techniques.
RESOURCE RESTORATION	Activities related to the improvement and /or restoration to the Existing quality of the resources	• Techniques of maintenance of Ambient water quality • Capacity building on enforcements and developing manuals for field operations • Promotion of user participation for restoration
WATER ALLOCATION AND PERMITTING	Activities related for equitable water allocation to all the us sectors and stakeholders Agreements for prioritization during shortages	• Water resources administration and enfor regulations • Water auditing and accountability • Conflict resolution • Water resources modeling • Consultation of water user associations
RESOURCE CONTROL	Activities related to the mitigation of damage due to the resources (flooding, drainage, saline intrusion) develop climate resilient infrastructure	• Floods and droughts forecasting • Data and information processing • Assessment of drainage and contaminatio • Salinity investigation and reservoir operation modeling • Prepare communities for adaptation and Disaster risk Reduction

6. OUTLINE STRATEGIES

It is a common phenomenon among many nations that past policies in management of water resources focused on developing water resources to maximize utilization in the irrigated agriculture and hydropower. Agencies were created with mandate to develop water resources and main focus was on project planning and implementation. Lack of focus on sustainability is now evident during operations of these projects. In order to ensure sustainability of installed facilities and continue to reap the benefits institutions reforms/ restructuring and capacity building for Integrated Water resources management is essential to meet the future challenges.

- Establish a regime for Integrated Water resources Management through reforms of policy, legal and institutional framework. Understanding of water resources management functions and water service delivery functions and assigning them to respective agencies is a fundamental principle in the emerging institutional arrangement.
- Policies and plans for national, regional and basin level water resources management will be developed in an open and consultative manner considering views of all stakeholder and

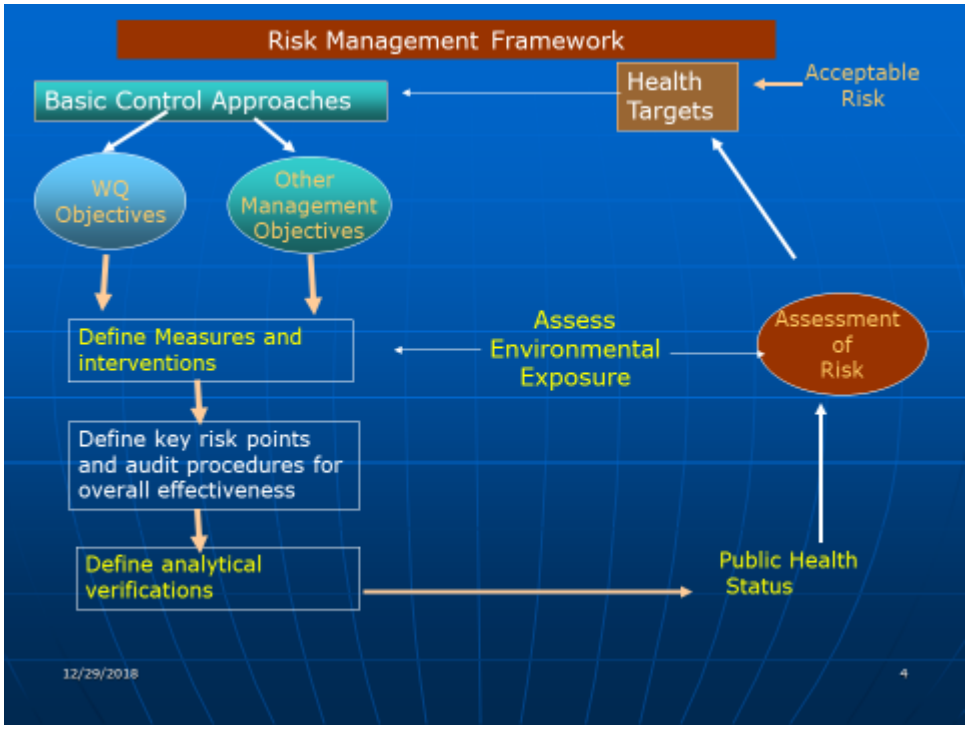
will be updated from time to time. Urgent priority actions will be identified through consultation and implemented in order to establish National Water Resources Authority

- Water resources policy will be coordinated with other national policies and will be directed toward the achievement of broad social objectives. Water resources policy will also be reflected, as appropriate, in the policies and strategies of water-related sectors. Institutionalize a system of post evaluation and feedback system for decision making and periodic review of policies.
- Management of surface and groundwater as recommended by comprehensive basin plans. Institutional development at basin and regional level to implement and monitor compliance of the plan. Identify *urgent priority actions* to address pressing issues at national and basin level. A
- National and multi-basin water resources plans will be prepared to address strategic water resource issues such as national objectives (food security, industrial location, etc), coordinated management of water resources for hydropower generation, inter-basin water diversions and identification of priority river basins for more detailed planning."
- Water resources planning and management will be carried out by a set of national and regional agencies, which are independent from those water service sector agencies. Water resources planning have to achieve IWRM goals.

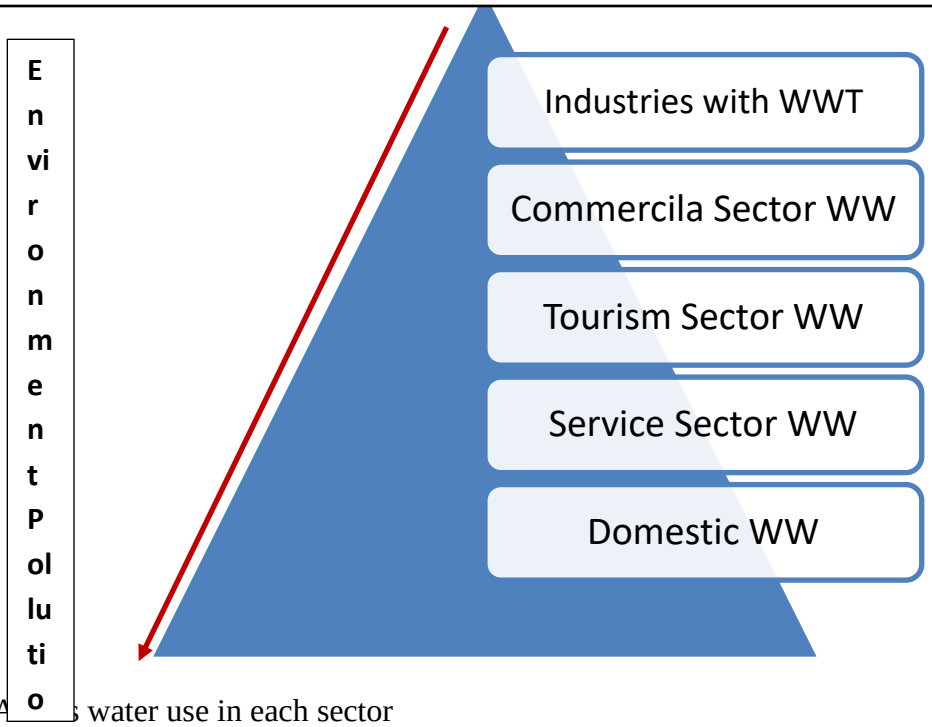
- Adopt a consultation strategy to minimize affected parties in the management of water resources. Institutional arrangements will be made at the provincial and local levels as well, so that stakeholders at all levels can participate effectively in water resource planning and implementation.
- Other national water-related agencies are expected to continue to carry out their present functions, while bringing their activities into collaborative partnerships to implement delegated functions in line with IWRM goals as defined in the river basin plans.
- Many water resource management functions will be organized on the basis of river basins and groundwater aquifers. Basins and aquifers are natural units for information collection, planning, water allocation and other functions. Institutional arrangements will reflect this river basin orientation. Pilot testing of recommendations under the reforms in selected basins and adoption of incremental implementation strategy are key factors for success.
- All water service delivery agencies required to use the WSP as an instrument to ensure that the water supplied to consumers are subjected to water quality assurance by the service delivery agencies.
- Ministry in charge of health to as the regulator for water quality formulate a national water quality surveillance system for independent surveillance and to certify safety of all water services
- Adaptation of technologies and climate resilience and disaster risk reduction to minimize affected parties.

Annexes

Annexes I – Water Safety Pan for Safely Managed Drinking Water



Annex II Target 6.3 Applied to water Polluting Sectors



Assess water use in each sector

Assess liquid based waste treated percentage by 2020

Assess liquid based waste untreated – water quality

Water Resources Systems affected due to Quality Issues

R

I

V

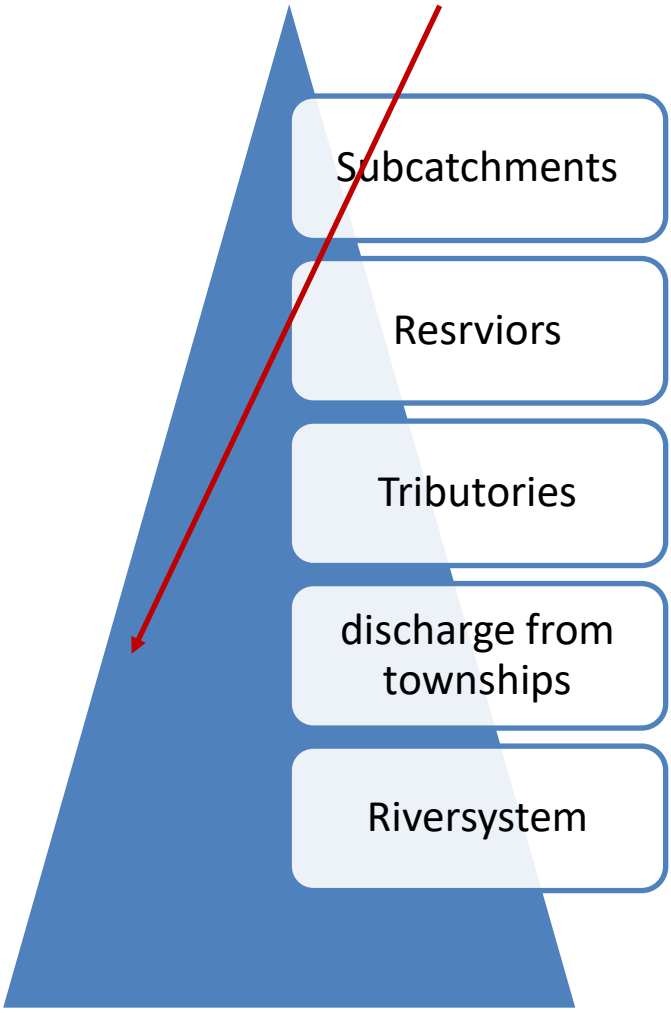
E

R

P

O

L



Annex III

Some Ambiguities/Clarified of SDG Goal 6 Target 6.1 and 6.2

Terminology	Definition/Clarification	Objectives	Remarks
Coverage	% of population with access to safely managed services as per WASH Ladder defined by JMP at a given time	To establish targets for periodical review and achievement of milestones	Services based on the development of facilities and safely managed individual sources such as protected wells
Target	Set to achieve universal coverage by 2030 and agree on milestone on the way towards the targets	Qualify service levels to safely managed WASH and periodical review	Mechanism to be developed on monitoring of performance and raising the standards
Baseline Data	Population coverage in the base year which is end of 2016	The objective is the establish current status in terms of Safely Managed services	Project from the National census in 2012 by adding the population access

	service levels are defined in terms of WASH ladder		through new development and deduct equal amount of unimproved service
Bench Mark	Nationally agreed service levels in par with WASH ladder	Water safety through WSP and Water Quality Surveillance. On site well designed septic tanks, off site STP and pipe sewerage	Consensus to be built on service levels to qualify as national standards
Indicator	Nationally surveyed Service Levels	Develop indicators to reflect on the SDG targets	Agree on the nationally accepted indicators

Accountability and Regulation- A Case Study of Punjab Pakistan

Niaz Ullah Khan, Salman Yusuf, Sabahat Ambreen and Dr Saima Shafique

Introduction

The features of the regulatory state at the end of the 20th century had made re-arrangements of governmental architecture, control mechanisms and relationships between actors. Apart from changing ownership structures in various service delivery domains, thus shift had been associated with the creation of quasi-independent agencies, the supposed formalization of relationship between actors as well as the increasing number of actors involved in the regulatory space (Loughlin & Scott, 1997). The 'regulatory state' is said to have led to a more complex 'regulatory space'(Scott, 2001) of over- and under-lapping relationship across regulatory regimes, involving to a varying extent government departments, politicians, regulatory bodies, 'target population', firms, shareholders and the wider public. Decision-making in areas involving politically sensitive trades-offs, for example between value of economic efficiency, social and environmental objectives as well as security of supply concerns, are seen to have been moved from majoritarian to non-majoritarian institutions(Baldwin & Cave, 1999). Furthermore, accountability may not only be required legally, but also represent responses to demand on reputation and legitimacy. Similarly, regulatory and other standard-setting regimes have become increasingly internationalized in a number of policy domains. Thus, accountability and transparency involve a multiplicity of relationship, based on different types of power relationships (accountability and transparency requirements can be established coercively or through voluntary consent, and may receive different degrees of 'acceptance' by those held accountable). Therefore, question of 'who is accountable to whom and for what' are said to have become increasingly pertinent(Scott, 2000).

The importance of drinking water sanitation has been recognized in the Vision 2025 document of Ministry of Planning, Development and Reforms, Government of Pakistan. The document lays emphasis on provision of safe drinking water and improved sanitation through an integrated development strategy. Further, the document highlights water contamination and water quality issues and the pressing need for eliminating open defecation. There is specific indicator of "Increase of proportion of population with access to improved sanitation from 48% to 90%" to assess the progress of Vision 2025 Pakistan. Sustainable development goal 6 has articulated more refined targets for safe drinking water and, equitable, affordable sanitation for all. Furthermore, Pakistan is not only a signatory country of Sustainable Development Goals but also officially recognized it as Pakistan Development Goals.Pakistan's HDI value is 0.550 out of 1 as against South Asia's average HDI value of 0.621 and World's average HDI value of 0.717.The under-five mortality rate is 90 per 1000 live births in 2011, and infant mortality rate is 72 per 1000 live births (National Institute of Population Studies; ICF International, 2013.). The major causes of these high rates of mortality include diarrhea (22.5 percent), acute respiratory illness, and other communicable and vaccine-preventable diseases. Further, malnutrition is very high as is evident from prevalence of Stunting (44 percent) and Underweight (31.5 percent) (Bhutta, Z; Soofi, S; Zaidi, S; Habib, A; Hussain, M, 2011).

Punjab is the most populous province of Pakistan with approximately 55.6% of the country's total population. The population of Punjab increased from 20 million in 1951, to 73 million in 1998,

95 million in 2011 and was 110 million in 2017[1]. At the present growth rate of the population, Punjab is expected to double after 36 years. Rapid urbanization and a growing population will continue to increase demands for sector and sub-sector services, as the current share of urban population is 31.3%. The Government of Pakistan enacted its 18th Constitutional Amendment in April 2010, with revised National Finance Commission 2009, which resulted in shift of legislative and administrative authority from the Federation to the Provinces. In 2011, the policy and administrative functions of water and sanitation also shifted to the provinces though these were already part of the provincial government under 1973 constitution.

Administratively, the sector is overseen by a number of departments. Planning & Development department has role of financing and approval of development projects. The Housing, Urban Development and Public Health Engineering Department (HUD&PHED) and Local Government and Community Development Department (LGCCD) are key service providers along policy formulation and service delivery. For five major urban areas, Health department along with its curative role have major contribution in creating awareness regarding water borne diseases and hygiene behaviors. Education department is responsible for WASH in school and as well as awareness raising role among school children. Punjab Environment Protection Directorate is regulatory body for controlling environmental pollution and enforcement of Punjab Environmental Protection Act 2012 adapted from Pakistan Environmental Protection Act 1997 and compliance to the national environmental quality standards (NEQS).

Methodology

The methodology for the paper mainly revolve around intensiveliterature review that includes Constitution of Pakistan, decision of supreme court for CP-38/2016, Economic Survey of Pakistan 2016, Punjab Multiple Indicators Cluster Survey 2011 and 2014 Pakistan Demographic Health Survey 2012-13, National Nutrition Survey 2011, Census Results 2017, National and Provincial Policies, Local Government Acts 2013, National Environment Protection Act 1997, available operational researches and literature for theory of accountability and regulations. Furthermore, the individual learning and experience has also reflected in the paper with quoting real implementation issues.

Results

The Article 9 of constitution of Pakistan, “No person shall be deprived of life or liberty, save in accordance with the law”, guarantees the right to life implicitly ensures the right of uninterrupted access to basic amenities, including water and sanitation. This has been further endorsed by Supreme Court of Pakistan in its decision on constitutional petition 38/2016 where water and sanitation have been recognized as fundamental rights of the citizen of Pakistan. The court decision also underpins the local government to ensure effective service delivery for safely managed WASH with particular focus on water quality and wastewater treatments. Further two articles of

[1] Provisional National Population Census Results 2017- PBS, Government of Pakistan

constitution of Pakistan are linked to water and sanitation. Article 24 is about protection of property rights and Article 155 that is about complaints as to interface with water supplies.

The government of Pakistan enacted its 18th Constitutional Amendment in April 2010, with revised national finance commission 2009, which resulted in shift of legislative and administrative authority from the Federation to the Provinces. Resultantly, 17 federal Ministries including all social services like education, health, environment, women development, etc. have been devolved to the provinces. Under the Constitution of Pakistan, the areas of local government, drinking water supply, sanitation, solid waste, rural and urban development are provincial subjects with responsibility of planning, funding, regulating, monitoring and service delivery. The sector is overseen by a number of departments, including Local Government, Rural Development, Works and Services, Health, Education for WASH in schools and Public Health Engineering Departments (PHED). The Local Government through elected councils works with PHED for seeking technical support in infrastructure development especially in relation to complex schemes (WSP, 2012). Since the 2001 Local Government Ordinance, municipal services including water supply and sanitation services were the responsibility of the Tehsil Municipal Administrations (TMAs) across the districts. Presently, the main legislation that governs drinking water and sanitation is the Local Government Act 2013, adopted by provincial governments, envisaging the restoration of mayoral system for the metropolitan cities, and chairman led district councils. The rural-urban divide has once again been instituted. In rural areas, the union councils and zila (district) councils are responsible for services; while in urban areas and the metropolis, metropolitan, municipal corporation, municipal and town committees have been restored.

Pakistan Environmental Protection Act 1997 that has been revised in 2014 by the Punjab province is key law that is related to environmental policies and ensure their implementation. Department of Environment is responsible for Prepare and publishes an annual National Environment Report on the state of the environment; ensure enforcement of the National Environmental Quality Standards (including Punjab standards for municipal effluents 2016 and drinking water 2016), establishing standards for the quality of the ambient air, water and land, by notification in the official Gazette. The Government of Punjab has drafted a Municipal Water Act with the purpose to address the need for everyone with a focus on assuring a reasonable quality of life, the need for equitable access to municipal water services and the operational efficiency/economic viability of municipal water services.

Discussion

The provincial Rules of Business delegate the responsibility of provision of drinking water, drainage & sanitation facilities and legislation / policy matters related to PHED and Local Government Departments at the provincial levels, while LGA 2013 extends these responsibilities to elected local councils under the Local Government Department. As per new provincial Local Government (Conduct of Businesses) Rules, the local councils have been empowered to lead on overall management functions that include operation and maintenance under municipal infrastructure and services. The budgetary analysis for 2016-2017 revealed that multiple departments are involved in the provision of services. This clearly defines the needs for a

comprehensive review to bring synchronization and overcome any dichotomies to draw clear roles and responsibilities at different tiers.

WASH Sector lacks structured approach for capacity development especially in-service trainings for the development of the human resources like it occurs in education and health sector where continuous professional development trainings are considered integral component of service delivery and had been delegated up to district and sub district level with certain authorities and accountabilities. Due to lack of reliable data and evidence, it is difficult to ascertain the effectiveness and efficiency of services pertaining to expected levels versus the actual level of work being managed by the human resources engaged in WASH related activities. Different capacity building manuals have been developed for field workforce followed by trainings organized at local government academies and other institutes in the province, but these have not been fully integrated into the systems. The aspect of technical and management capacities is mainly ad-hoc and opportunistic without any defined capability framework. As the capacity development mainly drives from the provincial departments, so little inputs or steering from the district and sub district is extended.

Currently, elected political representatives at provincial levels play a key role in identification of WASH related priorities of their areas but this is not fully supported with comprehensive need assessments and projects placed by local councils. Often, this approach negates inclusive and equitable distribution of resources evident from coverage, access and financial data. Generally, areas with strong political voices are more advantaged compared to other areas with less active political representation. An inequity study and budgetary analysis conducted by Government of Punjab in 2015-2016 also showed wider disparities in the allocation of resources (HUD & PHED, 2016), and areas with low socio-economic profile have low investments compared the areas with better socio-economic profiles and political voices. These reports provide the basis for dialogues and reforms among policy makers and implementing agencies to prioritize areas with poor coverage and resource distribution.

Different provincial departments responsible for WASH are in need of developing an integrated approach to envision and design common implementation plans that are owned by multiple departments and reinforced by all major supporting organizations. Currently, issue specific coordination arrangements via formulating different committees exist in the provinces where stakeholders share their perspectives and initiatives, but there is no specific focal point that may hold various sub-sector together through developing strong coordination among these stakeholders. The Government of Punjab upgraded WATSAN cell at PHED as Program Management Unit in 2017. This unit shall not only steer the implementation and reporting on WASH initiatives plan but will also provide a platform for coordination, joint planning and periodic sector review to overcome the duplication of efforts and resources. The provincial Joint Sector Reviews (JSRs) have suggested for adopting the same type of arrangements in other provinces. However, it is also important that mechanisms of JSRs should be delegated and organized at the district and sub district level for more informed decision making and effective accountability

Recommendations

1. Conduct a comprehensive legislative review of water and sanitation to identify necessary sectoral reforms with a specific focus on regulatory frameworks.
2. Devise and implement need-based criterion for distribution of sanitation related resources in the districts under Provincial Finance Commission (PFC) award while envisaging separate budget line for sanitation under Annual Development Plan (ADP). This criterion should preferably include weightage of poverty, WASH access, vulnerability of all types, and geographical size of the districts
3. Generate evidences for inequities based on areas, group and income levels to strengthen the voices and accountability
4. Revisit the existing sanitation related service delivery standards, approaches and guidelines and make necessary adjustments for designing, implementing, operation and maintenance of sanitation services
5. Undertake regular review of the current rules of business for fixing clear roles and responsibilities of different service providers
6. Conduct a structured capacity assessment followed by a roadmap for human resource development for government staff, elected representatives and other stakeholders in the provinces.
7. Establish and strengthen the program management units at the provincial levels with staffing up to district levels for ensuring reporting and compliances to decentralization as envisaged under the laws.

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The groundwater challenges in Pakistan and strategies to replenish it

Sohail Ali Naqvi

Abstract

Groundwater contributes around 45-55 MAF to Pakistan's freshwater resources. Unfortunately, it is on the verge of becoming scarce as the usage exceeds its rate of replenishment. It is being exploited by multiple stakeholders without any accountability. As, groundwater is not fed properly through recharge due to mismanagement and other environmental factors, there is dire need to conserve it and establish recharge possibilities. Lahore is a living example where excessive infrastructure development has resulted in most of the rainwater being fed into the River Ravi through the drains carrying domestic and industrial effluents. Pakistan is also facing severe water quality challenges that render multiple health hazards to the population consuming it.

This review paper will be highlighting the importance of groundwater in Pakistan, major water quality and quantity issues, governance issues and some suggestions to utilize it in a fair way. The parley concludes with a few suggestions to replenish this scarce resource by different techniques e.g. reducing the footprints of products, timely and volumetric management and a strategy to raise collective voice and generate massive awareness for the better management of water resources. These efforts can contribute to Integrated Water Resource Management (IWRM) approach as propagated by Pakistan's National Water Policy (2018) and may improve livelihoods.

Introduction

Pakistan, which was once a water rich country, is unfortunately water stressed now and approaching fast to fall in the list of water scarce countries (IMF, 2015). Pakistan depends on surface water, ground water and rainfall for it's freshwater. Ground water is defined as the water present below ground surface encompassing the saturated zone. It is almost always free of bacterial contamination and is the first choice for water supply. However, in Pakistan, excessive pumping and over utilization of groundwater has put a strain on this precious resource while its quality is also deteriorating.

The availability of water has fallen from 5,650 cubic meter per capita of freshwater in 1947 to 1000 cubic meter per capita in 2016 according to the Pakistan National Water Policy, 2018. The per-capita water storage in Pakistan is 150 m3 which is second only to Ethopia (State Bank of Pakistan, 2016-2017). Regrettably, Pakistan has no proper groundwater monitoring network as well.

Groundwater is majorly used for agriculture in Pakistan. However, other important uses also include domestic and industrial usages. This leads to excessive pumping of groundwater. Research findings point out that Punjab's water table is falling 2-3 m every year. Moreover, over abstraction and pollution is also jeopardizing the ground water quality which has negative health impacts for people. Groundwater that is supposed to be safe to drink, now has compromised quality in most areas (Raza et al., 2017).

Groundwater Quantity Issues in Pakistan

Access to groundwater resources let people utilize them in agriculture, industries and households. Particularly in Pakistan, access to water decides the poverty or welfare level. In Pakistan approx. 45-55 MAF water is abstracted from the groundwater aquifers and majority of it is utilized in agriculture. However, the unchecked exploitation of groundwater resources in Pakistan has put a strain on it. The water table is declining swiftly, and salt levels are increasing thus posing a threat to sustenance and working of irrigated agriculture. (Qureshi et al., 2008). According to an estimate, in Pakistan, 50% and more land is being irrigated by groundwater (Chaudhary et al., 2002), while the private sector accounts for 80% overuse of groundwater and there is no check or balance mechanism present. Particularly in Punjab and Baluchistan, the fresh groundwater level is falling which gives rise to expensive pumping of groundwater and the subsequent decline in the water quality (PPSGDP, 2000). Furthermore, farmers are using high-electric powered tube wells as compared to diesel run tube wells to pump water from greater depths. This increases the construction and operation cost. Although, the increase in electricity tariffs to control groundwater extraction have seen a rise in diesel run tube wells, this policy of increasing electricity tariffs to control groundwater extraction bore little to no fruit as it was more focused on generating revenue rather than preserving groundwater. Similarly, over pumping also introduces the saline water layer into the freshwater. This has resulted in almost 200 tube wells present in Punjab and Sindh, being shut down due to excessive salinity. With an estimate, there are more than 1 million tube-wells in Punjab and majority of these tube-wells were installed without considering the down curves of the aquifer during installation and operation of those tube-wells.

WWF-Pakistan conducted named “Situational analysis of water resources of Lahore” in 2014. This study revealed that the water balance of Lahore is disturbed due to over-abstraction of groundwater as well as reduction in the recharge through river Ravi. This study also showed the results that every year 1.5-2 ft groundwater of Lahore is depleting (Qureshi, A.S., 2014).

Groundwater Quality Issues in Pakistan

In 2015, Pakistan Council of Research in Water Resources (PCRWR) launched a water monitoring program in which it sampled groundwater from 23 different cities of Pakistan and found that 89% of the groundwater quality in the country falls below safe limits for drinking.

In Pakistan, pathogenic and heavy metal contamination such as Arsenic, Cadmium, Nickle and Lead, and anions such as nitrates and fluoride are the imminent risks to the groundwater quality. The sources of contamination of groundwater are natural and anthropogenic. For example, studies showed that earthquakes of 2005 and 2013 severely deteriorated the water quality in KPK, AJK and Baluchistan province in terms of bacteriological contamination. Anthropogenic sources include domestic effluents and industrial effluents producing toxic heavy metals and contaminants. Data on health effects due to contaminants is very limited. Cases have been reported in Sindh of As and F-exposition, where skin lesions, black spots on skin, skeletal fluorosis have been observed. Similarly, in Punjab, high concentration of Fluoride has resulted in skeletal deformation, joint pains and spinal problems (Raza et al.,2017)

Recently World bank conducted a study in Pakistan on Water and Sanitation and children’s stunting and they came up with the findings that at district level, there is a strong correlation between poverty and the quality of water and infrastructure (WB, 2018)

In early 2018, Shahid et al. discussed the extent, possible sources, and the subsequent health hazards of Arsenic in the groundwater of Pakistan through a comprehensive review of research papers, news articles and reports etc. The WHO guidelines for arsenic are 10 µg/L while in

Pakistan the NEQS state the permissible limit to be 50 µg/L. It was found that out of the 43 studies done, 73% of the water samples had arsenic greater than WHO limit while, 41% were higher than the NEQS. Based on the data available, it was estimated that almost 47 million population is living in areas which have approximately 50% groundwater contaminated with arsenic greater than WHO limit. With the decrease in water table, groundwater wells are going deeper and deeper. In 2013, Ahmad et al., reported that with the increase in well depth, As contamination also increased from 9.19 to 24.9 µg/L. In Muzaffargarh, Nickson (2005) observed that shallow wells having depth less than 30 m had less arsenic (5 µg/L) as compared to deeper wells (125 µg/L) having depth greater than 30 m. Fatmi et al., surveyed people in a Khairpur district of Pakistan, greater or equal to 15 years of age for arsenic related health impacts in 2009. They found that the presence of a definitive case i.e. hyperkeratosis of both palm and soles was 3.4 in 1000 and the suspected case was 13 in 1000. It was also reported that most cases of arsenic contaminated wells and arsenic related diseases were found in areas close to Indus River. More epidemiological studies are needed to establish a strong link between arsenic contaminations in groundwater close to Indus River.

The need to characterize the groundwater for drinking purposes is crucial. A study under the title of "Drinking Water Quality Challenges in Pakistan" was published in 2011 which analyzed the water samples from 21 cities of Pakistan, in addition to six main river, five dams, two reservoirs, three natural lakes and two major drains. Testing for different parameters, such as fluoride, magnesium, calcium, sodium, TDS, turbidity, Nitrate, Iron, Arsenic and microbiological analysis was done. The results showed that most of the samples collected were not found to be fit for drinking in all four provinces. The major reason is the microbiological contamination found in the water samples of all the cities. Punjab showed the highest concentration of Arsenic in water while water from Mardan and Peshawar showed very high concentrations of Iron. Samples collected from Sukkur & Hyderabad indicated very high turbidity. It was suggested that major responsibility lied on the shoulders of the water supplying agencies to ensure that the water supplied was free of contamination (Soomro, 2011).

Challenges in Management and Recommendations

In Pakistan, various strategies to manage and control the excessive pumping of groundwater and its declining state have been tried. Initially, the government tried to issue licenses to install a tube well, however it could not work as there were approximately 0.8 million users to oversee. In the past, there have been different acts (Canal and Drainage act 1873, Punjab Irrigation and drainage act 1997 etc.) implemented in the country but these laws and acts couldn't address the comprehensive situation of the current scenarios. After the 18th amendment, the provincial governments started work on the groundwater issues. The Irrigation Department, Govt. of Punjab, drafted Groundwater Act in 2017 which needs approval from the assembly. This act states that no one can waste the water and this act also tells about the constitution of a groundwater commission. Although there are some shortcomings in the act but it's a healthy exercise for the constitution of commission with the involvement of stakeholders.

Moreover, at the institutional level, even if different acts have been developed, there remains a lack of implementation because of non-existence interest of the political entities. Another reason is that the governments are usually more focused on alleviating poverty in rural areas by allowing groundwater extraction rather than investing in large scale surface water programmes. Farmers are often ignorant of the water demands of a crop. Smart irrigation practices are required to conserve water. Methods like drip irrigation systems, furrow-bed method, sprinkler irrigation system and precision land levelling etc need to be researched and implemented. Research has shown that if furrow-bed method is employed, it may save up to 40% of water (Qureshi et al., 2003). Moreover, focus should also be made on wastewater treatment and its potential to recharge groundwater and rainwater harvesting.

Shah argued in 2007, that the model for efficient management of groundwater in South Asia cannot follow the paradigms of Australia and USA where the number of users is relatively small.

Hence there is a need to develop a model centered particularly around South Asian users and their needs. As discussed before, in Pakistan, the government mainly focuses on groundwater development projects as if the country still has abundant water resources to spare. The groundwater situation can be managed if the government can build a tight-knit water resource management programme that focuses not only on the supply side but on the demand side as well. In China, it is required to obtain a permit for a deep pumping tube well however, otherwise it is free, and villages as a whole have the permit to use groundwater without any restrictions. China has also put a price on Canal irrigators. India has long since had a draft for groundwater billing but has reservations regarding its implementation as the users are quite large in numbers. Moreover, there are some indirect strategies for managing demands. For instance, it is advised to stop or limit the rice exports in India to limit water usage. Also, alternate wet and dry irrigation is recommended for certain crops. However, proper research should be done to find its applicability based on water availability of the areas. In short, instead of groundwater-centric approach, the government should have a broader view of groundwater governance.

Fig. 1. Water used by the community for drinking purposes (In Manchar Lake)

Fig. 2. Water table going down and quality affected (In Manchar Lake)

Fig. 3. Manchar lake shrinking due to water shortage

Fig. 4. River Ravi carrying the effluents and sand mining issues

A report was published by UNEP on water and sanitation and integrated water resources management status in the world (2018). This report showed that Pakistan stands among medium-low tier countries for IWRM implementation (UNEP, 2018).

Furthermore, there are a number of ways to cater groundwater over-extraction. For instance, if artificial recharging was employed to recharge the groundwater, it was found that artificial groundwater recharge contributed the groundwater extraction to a degree of 30% in Western Germany, 25% in Switzerland, 22% in the USA and 12% in England. Check dams in Baluchistan have also proven to be useful. Moreover, harvesting the rainwater for public tube wells can also be employed, but there is need to research about the efficiency of rainwater harvesting systems installed in Pakistan at large scales, particularly regarding the costs involved and the land slopes available. (Venot & Molle, 2008). Qureshi (2015) suggests that management of groundwater particularly of the Indus Basin aquifer, can be divided into three regions. In Punjab, groundwater has a thin freshwater layer while the rest is saline. Therefore, it should be managed accordingly so that saline and freshwater don't mix. While in Central parts of Punjab, groundwater is quite shallow and fresh, therefore over extraction is a major issue and can be catered by careful consideration of cropping schedule and monitoring. In the lower Indus basin, the groundwater is very shallow and brackish in nature which causes salinity of ground. The disposal and drainage should be planned to cater ground salinity. Moreover, due to seepage losses in the canals, the farmers at the downstream of canals get 20% less water (Latif & Ahmed, 2009). Therefore, they rely 90% on groundwater for irrigation. Further insights are needed for the mixing ratio of canal and groundwater for upstream and downstream areas to alleviate salinity and recharging of aquifers. It was also suggested that we need to revise the standards for water allocation. For instance, upstream farmers need to use more groundwater and less canal water while downstream farmers need to use more canal water and less groundwater. We need to devise a policy which decides the permissible amount of groundwater abstraction in each area to avoid salinity and water table fall. The upstream farmers can be incentivized by subsidizing them the pumping of groundwater to relinquish a part of their share of canal water to the downstream users.

In Pakistan water usage efficiency and crop yields are very low, due to a number of reasons like soil salinization, lack of awareness regarding good irrigation practices etc. (Bhutta & Smedema, 2007). They can be improved by using new methods of irrigation, such as direct seeding of the rice crop which reduces water consumption by 15-20% (Qureshi et al., 2006). There is also a need to focus on crops which make more money but consume less water like sunflower, pulses, orchards and vegetables etc. As discussed before, the government has not been very effective or strong in implementing the laws and regulations devised for groundwater abstraction. Also, there has been no single body under whose domain lies the groundwater usage and abstraction rather there are multiple governing bodies with overlapping responsibilities. A similar example is Europe, where groundwater abstraction monitoring has proven to be very difficult and cost-intensive (Zoumides & Zachariadis, 2009).

A much-neglected aspect of water management strategy has been water demand management in Pakistan. Brooks, (2005) suggests a new definition of water demand which includes lessening the quality as well as quantity of water needed for a particular operation, make changes in the nature of a task so that it requires less water, reduce the water-losses along the way and make water system capable of serving populations at water deficit time.

Conclusion

Freshwater is undoubtedly the lifeline for all improper management, overuse and pollution are jeopardizing Pakistan's freshwater resources and a severe water crisis is a writing on the well unless urgent measures are taken at the policy and administration levels. Water conservation practices and attitudes pertaining to water stewardship need to be adopted in order to ensure access to safe drinking water to all while providing enough water for economic sustenance and progress.

There is a need to manage industrial and domestic waste effluents properly so that they do not pollute groundwater supplies. Creating awareness amongst the populace regarding the impeding water crisis and how to manage it and make smart, informed choices is crucial.

The paper concludes following recommendation for the better governance of groundwater in the country

i. The groundwater should be given under one authority (potentially irrigation department may take lead as they are the custodians of surface water, so integration in one department will be beneficial)
ii. The water pricing in all sectors should be revisited and implemented as after consultation with relevant stakeholders
iii. The basin approach and water stewardship approach should be adopted in the region for maintaining the aquifers' health
iv. The water replenishment measures should be taken on urgent basis
v. The importance of groundwater awareness is needed at the massive scale among the communities and other stakeholders
vi. We need to promote recycle, reduce and reuse concept in water usage
vii. There is a need to promote High Efficient Irrigation System (HEIS) for irrigation purposes in the agricultural field

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Willingness to Pay for Safe Drinking Water and Incidences of Diseases: A CASE STUDY of Pakistan

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Abstract

Developmental goals target improved health and sustainable environment. These goals are of complementary nature as better environment can help reduce incidence of disease and thus improving health in general. The environmental goods like safe drinking water, solid waste management, and sanitation facilities are of paramount importance when general public health is concerned. Pakistan being a developing country has higher incidence of diseases like malaria, typhoid and cholera along with poor water and sanitation situation. This paper is aimed at providing the evidence that limited access to safe water is affecting health status in Pakistan. Furthermore, the aim is also to see whether the improvement in these facilities have any significant impact on incidence of diseases in case of Pakistan from 2002-03 to 2012-13. Country wide data from PSLM is used which is a survey from sample covering Pakistan as a whole. Method of cross tabulation is used which gives fisher's effect to statistically validate our findings. Health status in Pakistan is influenced by the provision of drinking water and its improvement over a decade has helped reducing incidence of diseases.

1. INTRODUCTION

Public health is considered as one of the indicators of wellbeing. Many development programs have health in their targets. MDG (millennium development goal) six was to combat HIV/AIDS, malaria and other diseases, while MDG seven was to ensure environmental sustainability. Access to clean water and sanitation, and good health and wellbeing, are two of 17 global Goals (Goal 3 and 6) for Sustainable Development agenda 2030.

The goals of improved health and environment seem complimentary because in order to reduce diseases we need to ensure environmental sustainability. The main objective of this study is to show empirically that unhygienic water and sanitation conditions result in high incidence of diseases like diarrhea and malaria. Therefore in order to achieve SDGs, policy makers need to consider the interdependence of goals thus approaching them collectively for success.

The goal of improving health status means controlling and preventing the diseases that have high mortality rate. Rueedi & Pedley (2004) observes that diarrhea (one of the water borne disease) is the sixth largest cause of mortality worldwide. It is observed that a lot of children suffer or die due to such water borne diseases in Pakistan as well.

Incidence of diseases and health status of households is also linked with the quality of drinking water and sanitation. The lack of such facilities to a large population results in deteriorating health conditions and high incidence of diseases (Montgomery & Elimelech, 2007) which ultimately leads to poverty. According to an estimate around 135 million deaths will occur by 2020 due to lack of water and sanitation facilities; and by providing these facilities many lives can be saved (Gleick, 2002). A very important aspect of public health status is disposal of the solid waste. If solid waste management is poor it results in environmental pollution and serves as a breeding ground for pathogenic organisms that causes infection (Boadi & Kuitunen, 2005). People get infected either from direct contact with the infectious micro-organism living on such waste or through contamination of food chain whereby animals or other vectors get infected (Cointreau, 2006).

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The main purpose and objectives of this study are to analyze the relationship between the provision of environmental goods (Drinking water, Solid waste management and Sanitation) and the incidence of diseases. We basically want to empirically test whether the notion that "SDGs are complimentary" is in fact true. The existence of safe drinking water facility, sanitation facility or proper, management of waste material are all indicators of Goal three (SDG) which targets environmental sustainability. The information regarding the role these indicators play in reducing the incidence of disease will be crucial to the policy makers. The relationship would mean that government should focus more on environmental sustainability instead of immunization or other band aid measures to reduce incidence of diseases. Improving the quality of drinking water, sanitation and better solid waste management would be a long term solution to reduce the incidence of diseases as this will have two effects in terms of achieving SDG targets; improved health as well as better environmental conditions. Previous attempts at studying the impact of environmental goods on incidence of diseases are for particular city or town (Sankoh, Yan and Tran (2013), a case study of Granville brook dumpsite, Freetown, Sierra Leone)

With that said, our paramount motivation for this research was not because no study on Pakistan has been done but also because demand side information is usually neglected when certain policy or welfare decisions are being considered regarding provision and quality of environmental goods and their relationship with incidence of diseases. A dynamic approach for Pakistan (comparison over a decade) would give us a clearer view as to what has changed and which trends have been adopted during these ten years. Moreover, it can help relate different policy or welfare decisions to these results and future oriented policy implications can be based on this empirical analysis.

2. Methodology

Researchers have mostly based their work on primary data as area specific studies have mostly been done. We are using the Pakistan Social & Living Standards Measurement (PSLM) cross-sectional data of 2001-2002 (8319 Observations) and 2011-2012 (7404 Observations). The PSLM data is published by Pakistan Bureau of Statistics (PBS) after survey conducted through sample selected from across Pakistan.The data on the incidence of diseases (Diarrhea and Malaria) is used to measure the health status of households in 2001-02 and 2011-12. Three environmental goods are considered namely, drinking water, sanitation and solid waste management. Crosstabs are made with the aim to understand how the provision of environmental goods affects the health status of various households.

3. Results

The cross-tab results for environmental goods (drinking water, sanitation and solid waste management) and incidence of Diarrhea are reported in table: 1. 79.55% of the households with no solid waste management (SVM) facility were suffering from diarrhea in 2001-02; while in 2011-2012 76.62% of the households with no SVM facility were suffering from diarrhea. However, the p-value of Fisher Exact tests i.e. 0.481 and 0.204 shows that variables SVM and diarrhea are independent. There is no relationship between them.

For Sanitation, the data of 2001-2002 shows that 90% of the households with no sanitation facility were suffering from diarrhea and 86.71% of the households in 2011-2012 with no sanitation facility were suffering from diarrhea. The p-value of fisher exact test i.e. 0.01 for the year 2001-2002 shows dependency between sanitation and diarrhea. This means that lack of proper sanitation facility might be causing diarrhea while the p-value of fisher exact test for the year 2011-2012 shows that these variables are independent.

There were 53.22% of the households in 2001-2002 with no safe drinking water who were suffering from diarrhea. The p-value for fisher exact test (0) shows that safe drinking water and diarrhea are dependent and poor water quality might be causing diarrhea. For the year 2011-2012 43.05 % of the households with no safe drinking water were suffering from diarrhea while the p-value of fisher exact test shows that the variables are independent.

Table: 1: Environmental Goods & Diarrhea

Year		2001-2002			2011-2012		
Diarrhea		Health Status					
		Good	Poor	Fisher Exact	Good	Poor	Fisher Exact
Solid Waste management	No	80.3	79.55	0.481	74.71	76.62	0.204
	Yes	19.7	20.45		25.29	23.38	
Sanitation	No	87.78	90	0.01	85.45	86.71	0.326
	Yes	12.22	10		14.55	13.29	
Safe Drinking Water	No	48.18	53.22	0	43.45	43.05	0.835
	Yes	51.82	46.78		56.55	56.95	

Table: 2: Environmental Goods & Malaria

Year		2011-2012		
Malaria		Health Status		
		Good	Poor	Fisher Exact
Solid Waste management	No	74.64	83.21	0.001
	Yes	25.36	16.79	
Sanitation	No	85.16	97.45	0
	Yes	14.84	2.55	
Safe Drinking Water	No	43.67	36.13	0.015
	Yes	56.33	63.87	

Table: 2 reports the relationship between environmental goods and incidence of Malaria. For Malaria,dataisunavailablefortheyear2001-2002.Thedatafor2011-2012showsthat83.21%of the households with lack of SVM facility were suffering from Malaria, the p-value of fisherexact test i.e. 0.001 shows that SVM and malaria are dependent. Absence of SVM facility may cause malaria.

97.45% of the households with no sanitation facility were suffering from malaria and the p-value of fisher exact test i.e. 0 shows dependency between these variables. The data further shows that 36.13%ofthehouseholdswithnosafedrinkingwaterfacilityweresufferingfrommalariaandthe p-valuefisherexacttestresultsconfirmsthedependencybetweenmalariaandsafedrinkingwater suggesting that lack of safe drinking water facility might be causing malaria in thesehouseholds.

Table 3: Immunization as a Moderator

Year		2011-2012					
Malaria		Health Status (Immunized)			Health Status (Not Immunized)		
		Good	Poor	Fisher Exact	Good	Poor	Fisher Exact
Solid Waste management	No	74.25	83.52	0	86.88	71.43	0.243
	Yes	25.75	16.48		13.12	28.57	
Sanitation	No	84.96	97.38	0	91.4	100	1
	Yes	15.04	2.62		8.6	0	
Safe Drinking Water	No	43.38	35.21	0.008	52.94	71.43	0.454
	Yes	56.62	64.79		47.06	28.57	

Herewewanttoseewhetherimmunizationhelpsinreducingtheimpactofdiseasesintheabsence of environmental goods so we are using immunization as a moderator. The results from the table shows that 83.52 % of the households who were immunized but lack SVM facility weresuffering from malaria. This shows that immunization will not help in eradication of malaria if SVM facilities were not available. The p-value of fisher exact test i.e. 0 confirms the dependent relationshipbetweenSVMandmalaria.71.43%households,whowerenotimmunizedandhadno SVMfacilityweresufferingfrommalaria.However,thep-valueoffisherexacttestof0.243shows that the variables areindependent.

97.38% of the households with lack of sanitation facility but immunized, were suffering frommalaria.Thep-valueofthefishertestshowsthatthevariablesaredependentandifsanitation facility is unavailable, the immunization will not help in prevention of malaria. 100% of the not immunizedhouseholdswithnosanitationfacilityweresufferingfrommalaria,however,thep-

value of fisher exact results shows independent relationship between malaria and sanitation facilities.35.21%ofthehouseholdswhowereimmunizedbutlacksafedrinkingwaterfacilitywere suffering from malaria. The p-value of fisher exact test shows dependency between the variables. 71.43% of the households who were not immunized and lack safe drinking water facility were sufferingfrommalaria.However,thep-valueoffisherexacttestshowsthatabsencesafedrinking water and malaria have norelationship.

Conclusion

Access to improved drinking water and sanitation is one of the goals of SDGs. Another goal of SDGistoimprovehealthstatusandreduceincidenceofdiseases.Thesegoalsarecomplementary innatureasitisobservedthatsocietieslackinginsafeaccesstodrinkingwaterandsanitationalso have high incidence of diseases like diarrhea and malaria (Montgomery & Elimelech, 2007).This means in order to achieve health goals especially in long term, the need is to target the goals for waterandsanitation.Thiswillnotonlyimproveenvironmentalconditionsbutalsohelptoimprove health status. This study is an attempt to provide some evidence that by providing access to safe drinking water, sanitation and proper waste management, Pakistan has seen reduction in the incidenceofdiseases.Thisfurtherprovesthenarrativethatalthoughdiseasescanbecontrolledby immunization but if complemented by targeting the goal of improved water and sanitation, the prevention can be of permanent nature.

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Water Quality Assessment of Gulberg-II Lahore and Its Impacts on Nearby Community

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ABSTRACT

Water is very much important for human survival. Contamination of any kind in the water, air or environment is dangerous for human health directly or indirectly. The research focus was to investigate the water contamination in the vicinity of Gulberg II, Lahore. The area is of multi Sectoral nature as it is the mix of land uses including industrial, Residential and commercial. The monitoring of water both for drinking and waste water for the whole N block was done in the month of November and December. Drinking water samples were collected and analyzed for, the 14 parameters of concerns including Total dissolved solids (Total Dissolved Solids), Turbidity, pH, temperature, Odour, Carbonates, Bicarbonates, Calcium, Magnesium, Chloride, Sodium, COD, BOD, DO, Oil &Grease, Iron, Copper, Nickel, Chromium, Silver, cadmium and Zinc. The results show not much variations. The examination shows that the value of pH, TSS, TDS, COD, BOD, DO, Oil and Grease, Copper, Nickel, Chromium, Silver, Cadmium and Zinc were exceeding the NEQS in only some samples. It is cleared from the health sample survey that the Inhabitants of the area have a poor quality of water and suffering from the water-borne diseases like diarrhea, arsenicosis and typhoid.

INTRODUCTION

The environment consists of air and water along with its major constituents and the major contamination in its constituents' results into the health hazards. Any professional Urban & Regional Planner, need to determine the major reasons causing contaminations and possible solutions.

This Study focuses the evaluation of the environmental status of N block Gulberg II, Lahore. (The importance of Air Quality 2013). Due to mix land use like industry, commercial and residential, there are health issues of the residents. Water supports every community organism and support human health. The residents of Study Area have health issues due to drinking water having harmful pollutants. Due to the operational status of various industries in this residential neighborhood, almost in the center of Lahore, the air and water quality of the area can well be imagined (Heritage 2012).

DETERIORATING WATER QUALITY

Water quality deals with both drinking and wastewater. Globally from 1990 to 2010 more than 2 billion people have access to improved water sources. Sustainable Millennium Development Goals for the availability of safe drinking water have been achieved but still 11% of the global population is exposed to improper source of water (Organization 2012).Low water pressures in supply systems and old leaky

pipelines are prominent reasons of water contamination and infiltration. The sewage leakage into the drinking water pipes leads to the existence of various water-born diseases (Managing Karachi's water supply and sanitation services 2004), (Bridges 2007). Higher quantities of Arsenic, Nitrates and Fluorides were detected in drinking water of Lahore according to a water quality study.

OBJECTIVES OF THE STUDY

- Highlighting the health impacts due to the mixed land-use of the Study Area
- Carry out the water quality monitoring
- Assessing the water contamination due to the industrial waste water in the study area
- To propose a sustainable solution and mitigation measures against the health and environmental hazards identified in the study area

LITERATURE REVIEW

Upgradation in living standards and increase in urbanization due to industrialization has put the man's life at risk. The unsustainable means of industrialization have unanimously big reasons for the destruction of world's natural ecosystem and natural resources which are irreversible and brought the humans at the verge of irreversible global crises (Sunit.G 2000).

The ongoing anthropogenic activities are clearly causing environmental pollution and damaging the earth's life support system categorized as Air, Water, land and noise pollution. The pollutants have changed the chemical, physical, radioactive and environmental proportions in the environment having life threatening potentials on the mother earth (Eldon.D.E 2006)(Ejaz.N 2009).

Water is a prime constituent of life's existence in this world. The human consumption of water per day is 2 liter per day making a total of 70%. Water as a basic constituent of existence of life have different forms and is used for different purposes as industrial, drinking, agriculture and domestic activities. According to an estimate out of 80% of total available water 33400 cubic meter is available for all the above purposes in the world and its demand on the earth is increasing day by day due to increasing urbanization and industrialization trends. It is necessary to maintain the quantity and quality of existing water which is being depleted by different activities and resulting in water quality depletion and causing waterborne diseases, a present dilemma of both developing and underdeveloped world (Ejaz.N 2009).

Commonly it is practiced that ground water is a major source of water supply in municipal hubs. The waste disposal from various urban sources has gathered the subsurface is the one of the major receptor of pollution. This alarming situation is confirmed in the major cities of Asia and Latin America. It is therefore required an educated and systematic water resource management system to be developed by the policy makers of urbanized world (Foster 2001).

It is identified that the disturbance in ground water quality is due to the urban development. The groundwater sample collection in the Amalner town of District Jalgaon, Maharashtra, India from its various locations, high TDS values and electric conductivity are showing the poor water quality of ground water(V.T 2011). The industrial effluent in the drain of study area are the major source of groundwater depletion. These industries which are present in the hub of Lahore city are a serious threat to the environment in the surrounding localities. China is a leading example of industrial boom in the overall economic development throughout the world in Asian region is leading towards the serious environmental quality crises at present. If we talk about the water quality in major cities of china as a whole having industries in their central hub are the major concerns of the study. It is estimated that more than three quarters of urban population in China is facing the problem of water quality deterioration and depleting the surface and under- ground water as well and not only not meeting the National environmental quality standards of China but also categorized as high level of both primary and secondary water contamination. As it is clear from the economic policy of China that they have to quadruple the economic growth by the year 2020 which further will leads it to further deterioration in water and environmental quality levels(Shao M. 2006).

MATERIALS AND METHODS

Lahore, One of the largest cities of Pakistan, is considered as the major contributors of the increasing environmental pollution.

Lahore, as the cultural hub since centuries, is one of the most thickly populated cities in Pakistan.

It is not only the provincial capital of the Punjab Province, acting as a social, political and educational hub, but also a major environmental pollution source in the country, due to its urbanized character.

Primarily Lahore is being served as a contemporary Fashion & Culture Industry and a business center. Lahore city is divided into nine major zones or administrative towns (Government 2009).

The focus of this research is on N-Block of Gulberg II, an important area of Gulberg Town, having mixed land use classification i:e commercial, residential and industrial etc. The Allama Iqbal International Airport is situated at the East,Model Town to the South, the Aitchison College Campus to the North and the Shadman to the West. Gulberg is an exclusive residential area in Lahore. The figure clearly shows the boundaries of the Gulberg Town.

It consists of 14 blocks starting from A block to N block, along with various commercial hubs like Hafeez center, Liberty market, health care facilities including a number of hospitals, various educational institutes and universities along with spacious residential areas.

The concern area is the N block Gulberg II having all types of mixed land uses. It is at an elevation of 714 ft Above Sea Level (ASL), between the GPS coordinates74d 21m 27.50s E and 31d 31m 24.27s N.

It comprises of 55 residential plots containing an area of 115 Kanals in residential excluding 30 % allocated to open spaces and roads. Mostly the 4 kanals plots converted into industrial land use due to

bigger plot size an approximately 200 residents are living there in industrial accommodation. area can be clearly divided into three distinct zones residential, commercial and residential.

Walk through Survey, Literature review, Review of maps and identification of sampling sites, Sampling plan and development of a profile of the study area, Water Quality Monitoring, Parameters Analyzed for drinking water samples, Parameter Analyzed for waste water Samples, Results, Sustainable recommendations, Pictorial Representation are the steps involved for study methods.

WATER QUALITY MONITORING

Determinant of the monitoring and analysis is based on two basic factors:

The area under investigation should be representative sample. The affordability and practicality aspect should be prior for sampling, monitoring and analysis. The water quality assessment of Gulberg II is divided into Drinking water and wastewater.The samples of drinking water were collected from the industrial inflow, commercial taps, residential taps and tube-well of the study area.

Table-1

Existing Industries

Sr. No.	SECTORS	IDENTIFIED INDUSTRIES			
1	Newspaper Printing Press	Express news	Daily NaiBaat	DAWN NEWS	ROYAL NEWS
2	Beverages	Pepsi cola	RC COLA		
3	Desserts	Hico Ice Cream			
4	Flour Mill	Sunny Flour Mill			
5	Rubber Goods	Elastomer Engineering			
6	Textiles	Watex Pakistan (pvt.)	SEFAM PVT. LIMITE		

		Limited	D		
7	Molded Rubber	Longman Mills			
8	Thermophore	Thermophore Mills			

RESULTS AND DISCUSSIONS

The analytical results are compared with WHO standards and national Environmental quality standards (NAAQS) in appropriate tables and graphs.

There is a deterioration of mother Earth with the development in human intervention. It is the vicious cycle of the Globe whichever is done by the man kind positively or in negative context come back to its turn. As overpopulation demanding overconsumption of resources which in turn generating pollution deteriorating both the environment and the population in returns. It is our duty to critically pinpoint the actual problems at source and determine possible mitigation measures.

The study focus was on the identification of the water quality assessment of an area which exist almost in the middle of the Lahore city, which consist sof almost mixed land uses. The area is being neglected by all the concern authorities in making it an alarming factor. The study area contains eight identified industrial sectors having almost two to three concerned industries each. It also contains a number of commercial shops and banquet halls as well as the residences in the vicinity of almost all income groups. The people comprising of lower income groups are mostly effect ted by the polluted water and the environment due to lack of resources for opting mitigation measures. Whereas the elite has already installed a filtration plant for safe and healthy water due to available resources and awareness.

The assessment of the water quality and its results showed that the coliforms, lead and arsenic are present in higher ratio as determined by the National Environmental quality standards in the water used for drinking whereas the others values are within the specified limits. The samples collected for two months does not show much variations in the concentration. The detailed results are given in table 4.2 and 4.3 respectively. The higher concentration of the parameters may be the presence of mixing of sewage water in the drinking water pipelines due to the poor maintenance and non-upgradation of the old infrastructure for the past 30 years almost.

The presence of fluoride concentration is natural and the rock formation in the underground earth formation(WHO, In adequate or excess flouride: A Major Public Health Concern 2010).

1.01mg/L in November and 1.12 mg/L in December, which should be ≤1.5 mg/L. The fluoride concentration is exceeding the standards from the samples of drinking water in the industries like Express New Printing Press, Hico Ice cream, Pepsi Cola, WATEX Pvt. Ltd, Elastomer Engineering and Longman Mills. Theother reason of excessive fluoride transportation through water is usually the presence of complexed mix with Aluminum, and may also results from the adhesive industrial usage of aluminum, Sulfuryl fluoride, Copper and Steel. (WHO, WHO Drinking Water Guidelines 2011)Which duly justifies the presence of high fluoride concentration than the standard limits because of industrial production process with intentional or natural injection in the public water supply system.

Lead is rarely present in drinking water as its toxic nature. The presence of Lead in drinking water is due to the presence of obsolete plumbing system and leaching of polyvinyl chloride (PVC)(D.Z. 1990). The increased Lead concentration in drinking water is causing high blood pressure and kidney failures(WHO, Pure Water Gazzete Water treatment Issues 2008). It is found to be0.06mg/L and 0.07 mg/L in November and December. The lead concentration in tubewell and industrial water samples are high. The rest of the samples are within the limits.

Arsenic is a semi metal and also a potent poison in traces also. It is found in pentavalent and trivalent harmful forms in ground water(Environmental Health 2008). There are chances of water contamination with Arsenic due to wind-blown dust, run off from soil, leaching, sediments and rocks. The Arsenic contamination is at greater risk due to ground water bores than rain and surface water. The drinking water sample are exceeding the limits in all collected samples which is 0.04mg/L. the health effect ts due to the Arsenic presence are cancer of liver, bladder, lungs, skin,kidneys, nasal passage, liver and prostate, numbness in feet and hands, stomach pain, nausea, vomiting, partial paralysis and diarrhea.(Hopenhayn 2006)

The coliforms are the presence of bacteria in water, soil and vegetables. The analysis confirms the presence of coliforms which confirms the mixing of sewer in drinking water. The sampling results 184CFU/100mL which are much greater than specified limits. The samples collected near the drains shows high bacterial concentration as from the farther sample collections.

The ground water is contaminated by the waste water. So, it is necessary to check the impacts of waste water, either it is disturbing the groundwater or not. The waste water samples were collected against twentythree parameters of concerns.

A total of 12 samples were received, four from the representative parts parallel of drains and eight from the industries of N block. The analyzed results are compared with the National Environment Safety Standards for Wastewater 2010. The values of zinc, Cadmium, Silver, Chromium, Nickel, Copper, Grease, Oil, BOD, COD,TDS, TSS and pH are higher than the NEQ standards at some points rest of the parameters are within specified limits.

It is obvious that pH determines the water acidity and alkaline nature. It is analyzed in wastewater sample the average value of the collected samples is 7.7 which is within the standard range 6-9 except WatexPvt Limited and Express News Printing Press where ink and dyes are being used along with different chemicals which increases the PH value in the analyzed sample.(WorldBank 2007).

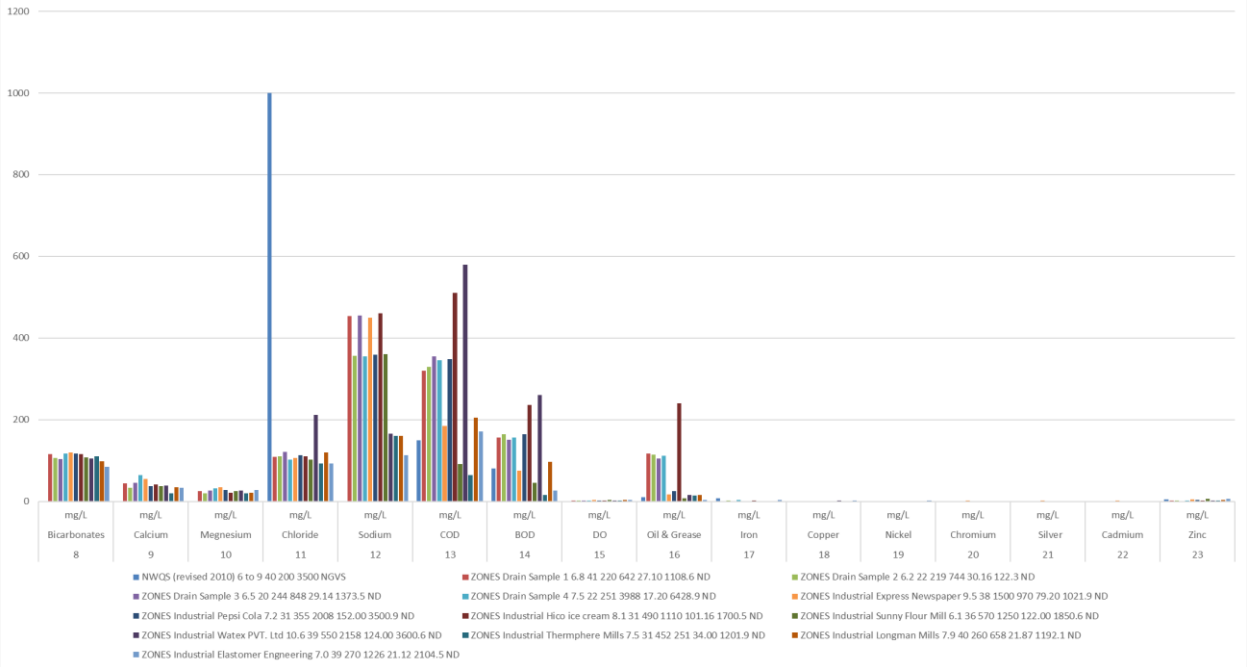
TSS are the total suspended solids which are organic or inorganic, higher amount of TSS in the wastewater blocks the sunlight penetration upto the base of the drains and restrict the chemical reactions necessary for the decomposition(Environment 2006).

The values are higher 457 mg/L from the collected samples from all the points as industries are discharging their effluent without any primary, secondary or tertiary screening and treatment(SFWF 2002).

Total dissolved substances (TDS) having inorganic components like salts, Calcium, Magnesium, Sulphates and Chlorides etc and some portion of organic elements in wastewater(Dana.A 2012). The concentration of TDS is within the specified range which is 3500mg/L. The average of 1336 mg/L is present in the average collected samples which is due to the presence of food processing industries in the study area(Dul.F.L. 2012)

Chemical Oxygen Demand(COD) is to denote the presence of organic pollutants in the water which is an average of 298.6mg/L which is far more than the specified standards 150mg/L due to the presence of woven dyed fabrics in woven cotton mill WATEX Pvt. limited Express News printing press and Hico ice cream factory heavy untreated water discharge from these factories, from then chiller flush outs and back wash and tank wash(C.L. 2011).

Biological Oxygen Demands (BOD) denotes the amount of oxygen consumed in a chemical process reaction of an organic material in wastewater.(Characteristics of residential Wastewater 2012)



The most common industries releasing wastewater with high values of BOD contents including rubber manufacturing Longman Mills, WATEX Pvt. Limited, Pepsi cola Pvt limited and Hico Ice-cream factory, major constituent of BOD is WATEX mills Express News printing press and Sunny flour mills are the minor pollutant BOD constituents in waste water. The average value analyzed is 130 mg/ L which is higher than the standard values 80mg/ L.

The presence of oil and grease in the effluent discharge samples taken from different locations is due to the oily materials in households, factories and food industries and cuisine discharge which are present around the vicinity,floating grease and oil causing reduction in oxygen and sunlight penetration in the wastewater, smell creation and attracting mosquitoes and other pests in the vicinity. It is also a major cause of surface pollution of soil which is unhealthy for the agriculture and crops.

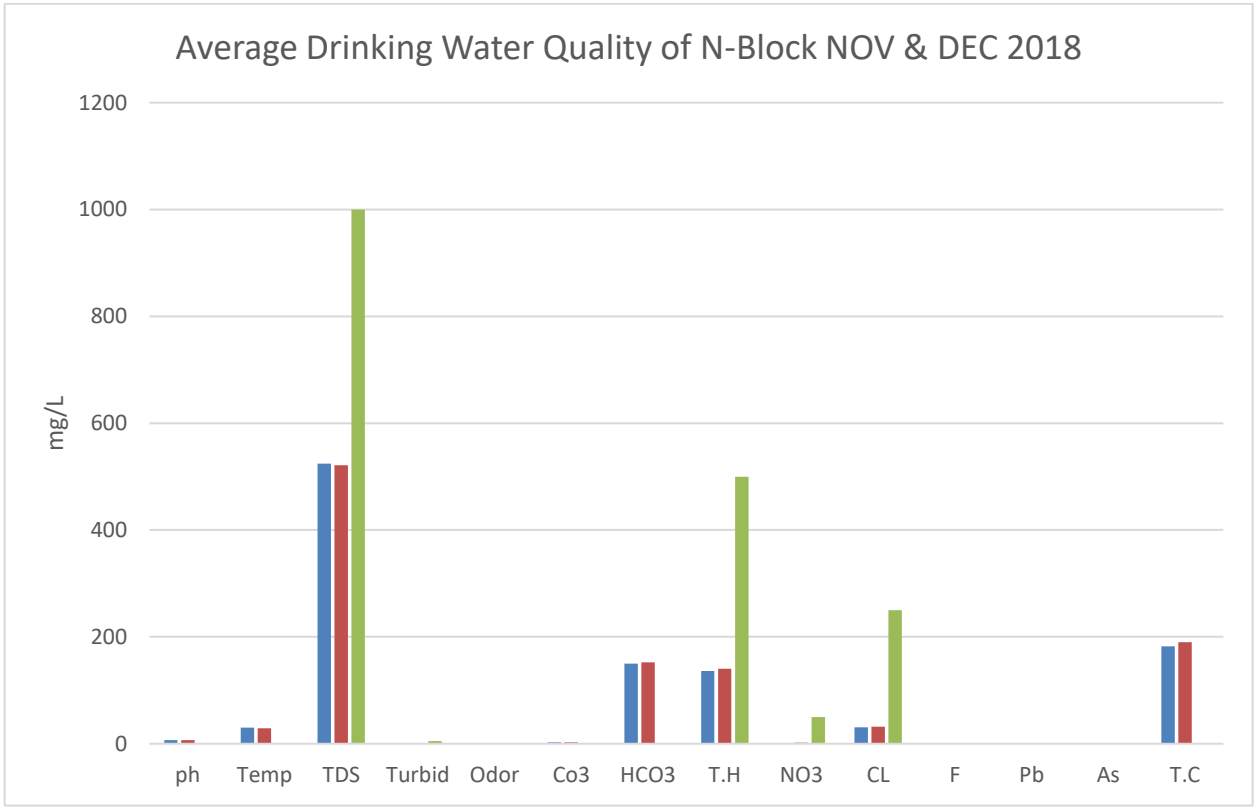
The presence of nickel is 0.1 mg/L in the vicinity's wastewater as standard but the average value is more than 2.6 mg/L which is due to the Elastomer engineering as amajor contributor of nickel in the study area. It is an essential micronutrient for plants and vegetables its deficiency reduce germination process(Thornton I. 2001) and its greater quantity is toxic to all living organisms especially in vegetables and plants(Khalwn A. M. 2006). Nickel is present in large quantity of industrial waste where industrial effluent and domestic wastewater mix with each other in drains.

Copper is an essential for human body as nutrient but its high concentration may cause health issues like stomach pain, (Dul.F.L. 2012)(Khalwn A. M. 2006)Nausea cramps, diarrhea, nose and eye itching.

It is up to the limits in residential areas where as it is highly concentrated with metal coating and dying industries, Elastomer engineering is the major Cu contributor in the study area.

Chromium is an essential constituent of human diet but in traces its high concentration may cause cardiovascular diseases and intolerance to sugar absorption, decreasing in glycogen reserves in human body. Metallurgical industries and phosphoric fertilizers release cr which ultimately cause atmospheric deposition. It is also released by the tanning industries, Ink industries, textile industry using dyes and ceramics industries the presence of chromium is within the range in the wastewater sample of the drains. The desired standards are 1.0 mg/L and the present concentration is 0.45 mg/L.

The concentration of silver and Cadmium is 0.4mg/L which is below the specified NEQs which is 1.0mg/L in the study area (Hongwei H. 2004). The presence of zinc is within the prescribed limits of NEQs average value is 3.5 mg/L in the sample analysis and specified limits are 5.0mg/L. The presence of Zinc is majorly the effluent of Sunny flour Mills as a wheat constituent majorly(Grains of Truth about wheat Flour 2005), Elastomer Engineering and express News printing Press as a part of effluent but within the range 0.34mg/L and the NEQs value is 1.0mg/L.



CONCLUSIONS

Water and air are the basic need of the humans and contamination of these basic fundamentals of life in the current scenario is adversely affecting the human beings around the globe. One of the biggest issues nowadays is the population explosion and in return the over consumption of the resources that has generated the environmental pollution. The rationale of the conducted research was the monitoring of the water quality of N-Block Gulberg II, Lahore to measure the environmental pollutants. The sampling area divided into three different zones comprising of Residential, and Industrial. The analytical studies showed the poor quality of water as compared to NEQS standards. It was further concluded based on heath survey conducted during the study that the water pollution was affecting the human health. The diseases chalked out were mainly related to the contamination in water and non-acceptable limits of noise pollution. Thus, the water quality problems need to be addressed on immediate basis as the continuous growth of industrial activity in the vicinity shall be further deteriorating the environment.

RECOMMENDATIONS

The main purpose of the research is the identification of the Water contaminations in the study area for the basic needs of human health that is air, water and noise.

The deteriorating human health as concluded from the study needs a serious attention by adopting the remedial measures.

For healthy environment the following remedial strategy should be adopted:

Drinking Water Management

The sewage and distribution pipe lines of drinking water should be changed and installed separately. The quality of drinking water should be analyzed after every six months regularly and should be shared after every six month and publicly shared. Drinking water should be boiled effectively before use. Chlorination should be done by public agencies before coming into municipal pipes. A Water filtration plant should be installed in the community along with a community development plan. In order to avoid any bacterial contamination there should be construction of new deeper extraction point tube well.

Waste Water Management

Implementation of cleaner production techniques to reduce the effluent characteristics significantly by convincing the industries to work in clean production environment. There should be equipment modification and change in the advancement in the production techniques, their volumes and over production of raw materials, simultaneously reduce the health and environmental impacts on the surrounding community as well as the labor force. Chemical usage, energy, process and equipment modifications for water can be optimized to enhance in line treatment of waste resulting due to input resource consumption for reduction in production cost and the pollution control facilities in end of pipes. There should be four categories of cleaner production processes, Water Conservation, Energy Conservation, Modifications in equipment's, and Chemical Usage optimization.

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Increasing Dependency and Stress on Surface Water and Violation of Fundamental Human Right: A Perspective of Safe Drinking Water Issues, Challenges and Recommendation from Rural Sindh

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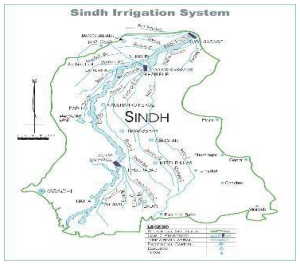
Abstract

The access and use to safe drinking water is well recognized human right. UN General Assembly passed a resolution in 2010 and explicitly recognized water and Sanitation are basic Human right. Hence, it is mandatory for the states ratified to introduce policies and laws accordingly and accept and legally protect fundamental Human right. As per National Drinking Water Policy (NDWP) of Pakistan Government drinking water has precedence over other uses of water. But ironically, the adequate, uninterrupted and quality supply of drinking water have been remained a dream. The dependency on surface water is getting increased day-by-day. The mounting pressure on surface water sources is due to various factors such as speedy population growth, extensive cultivation to meet food and fiber needs, rise of industries, depleting and getting contaminated aquifer etc. All these factors further aggravated the situation for drinking and domestic water users particularly in rural Sindh. The governed polices and laws are contradictory to each other which leads to injudicious distribution of water. The pertaining laws in Sindh are of old British Era or incompatible to address the real issues and prioritize the needs. In Sindh water laws made surface water specific to irrigation and strengthened the role of landholders and leaseholders to have the right of access and use. The last unit under irrigation system at field level is watercourse, here the laws categorically clearly define that watercourses belongs to the agricultural land occupier who use it for irrigation purposes only. The 80 percent of groundwater is contaminated and unsafe for human consumption and drinking and domestic user switching over to surface water sources. The prevailing water laws are silent to discuss drinking and domestic water. Presently the drinking and domestic water is being provided on the basis of humanitarian grounds not as fundamental human right. Consequently the safe drinking water is expensive than the commercial purposes for agricultural and industries**.** This paper is an attempt to analyze the gaps in policies and laws related to surface water in Sindh Province and its impact particularly for rural inhabitants.

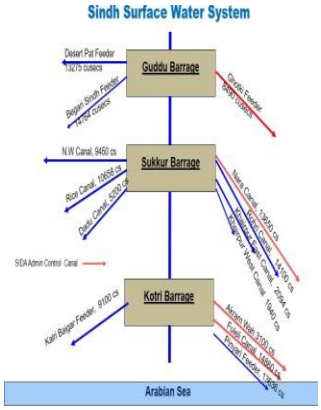
1. Introduction



Though water is life, but presently it gives message of death. The flowing rivers, canals, distributaries associated tertiary channels and

saline ground water is getting increased lethal water-borne diseases for the people of Sindh. Besides, the extreme shortage of water for thetail-endersatrespectivecommandareasofirrigationsystem.The dependency on surface is getting increased day-by-day owing to depletion of aquifer and uncountable contaminationsources.

Thoughwateriswellrecognizedfundamentalhumanright,butironicallythenegligenceandpoor governanceandservicedeliverysystemmakethebasicnecessitytobeinaccessibletoitscitizens. Although round the year the drinking and domestic consumption is very minimal from available water sources inPakistan.



The water woes of Sindh province reached at its worst particularly for the tail-end water users in Sindh irrigation network system. Sindh is known as lower riparian in Pakistan's Irrigation Network. Water shortage not only affects the agricultural economy but also caused difficulties even for dirking and domestic in both Urban and Rural. Pakistan Water Apportionment Accord 1991 pledged the quantum of water for Sindh is 48.76 MAF (59 billion cubic meters BCM) for its fourteen canals on three barrages[1]. The aggregate length of canals is 19,066 km, which serve a gross command area (GCA) of 5.8 million ha.[2] The number of branchcanals,distributariesandminorsis1462with15049kmlength.[3]Outoff ourteencanalsix areattherightbankandeightareontheleftbank.Thesecanalsarementionedasbelow,atthe rightbankoftheIndusRiversuchasatGuddoBarragetwocanalsnamelyDesertPatFeederand BegariSindhFeeder,SukkarBarragethreecanalsknownasNorthWest,RiceandDaduCanaland at Kotri Barrage Kalri Begar Feeder respectively. While on the left bank there are eight canals named as at Guddo Barrage only one canal Ghotki Feeder, Sukkar Barrage Nara, Rohri, Khairpur East and Khairpur west, at Kotri Barrage Akram Wah, Phulleli and Pinyari Feedercanals.

[1] APPORTIONMENT OF THE WATERS OF THE INDUS RIVER SYSTEM BETWEEN THE PROVINCES OF PAKISTAN
http://mowr.gov.pk/wp-content/uploads/2018/05/APPORTIONMENT-OF-THE-WATERS-OF-THE-INDUS-RIVER-SYSTEM-1991.pdf 28.11.2018
SINDH IRRIGATION AND DRAINAGE AUTHORITY FINAL REPORT, 2006.
http://documents.worldbank.org/curated/en/622141468085741405/pdf/E1264010VOL102.pdf
[2] SINDH IRRIGATION AND DRAINAGE AUTHORITY FINAL REPORT, 2006.
http://documents.worldbank.org/curated/en/622141468085741405/pdf/E1264010VOL102.pdf
[3] Sindh Irrigation and Drainage Authority Sources

TheapproximatenumberofTertiaryChannels(watercourseWC)ismorethanfiftythousandwith 30,000km length. Somewhere it is also mentioned that total number of watercourse is 44, 0004 andapproximatelengthis12,900[5].Traditionally,theentireirrigationsystemisapublicproperty except the Tertiary Channels (water courses WC). The WC are, however, the joint responsibility of the landowners who construct, operate and maintain WCs based on the water quantity sanctioned by the concerned department. Over 90 per cent of the surface water used for agriculture and remaining for multiple uses industry, municipal services and soon.

The distribution at farm level is in accordance with size of the land occupied by the landholders.
ThequantityofwatereitherinWCsordistributariesisdefinedasperculturalcommandareaCCA (thecultivatableland),whichfurtherdistributedthroughshare-listspreparedbylinedepartment as per land revenue record for landoccupancy.

Along with high water losses the bad governance, overwhelming political interference and rampant corruption further deteriorated the situation. Thus rural domestic consumer is at absolutedisadvantage.Only7percentofruralhouseholdshaveaccesstotapwater.Themajority of rural population dependent on ground water using hand-pumps to meet drinking and domestic needs as well as forlivestock.

Since last two decades the climatic change, old age irrigation practices, erratic raining pattern, excessive ground water exploitation for agricultural and industrial needs and deforestation substantially depleted ground water sources. In addition, the extensive use of pesticides and diversionofcitiesdrainintofreshwaterbodiescontaminatedgroundwaterbothchemicallyand biologically.

However,itiswellnotedthattomeetthefoodandfiberdemandofgrowingpopulationneeded more agricultural intensification along with industrialization will require more and more water. Hence, the stress on declining surface water sources will further increase which could have a far reaching consequences in nearfuture.

According to Pakistan Council of Research in Water Resources (PCRWR) last year, that 75pc collected water samples from both surface and ground water sources of 13 districts found unfit for human consumption. Agha Khan University research findings presented at National Immunization Technical advisory group meeting revealed that Extensively Drug Resistant (XDR) typhoid appearing in various parts of Pakistan particularly in Sindh.

The potentially lethal disease caused by contaminated drinking water and poor sanitation. This is also verified by the Pakistan Center for Advanced Study in Water PCASW during a seminar on identification of Antibiotic Resistant Bacteria (ARB) in the different Source Waters of Hyderabad City. The presence of ARB is found in the groundwater, surface water, and wastewater in Hyderabad and its surroundings due to industrial wastes, agricultural runoff, and humans and animals waste in irrigation canal system.

Theuseandaccessofsafedrinkingwatereitherinruralorurbanareasremainedachallengedue to a number of factors. But the major hindrances towards the provision of safe, clean and

adequatewatertoruralhabitantsisduetodiscriminatoryandincompatiblewaterlawsinSindh.

Ironically,therearetwoparallelwaterlawsarebeingimplementedinSindh.TheSindhIrrigation Act 1879 was promulgated by colonial masters in 19th century and second Sindh Water Management Ordinance SWMO 2002. Both laws are quite different in nature which further creates disharmony, imbalance power mechanism which further leads to conflicting situation among water managers at alllevels.

The old British law emphasizes the surface water management is solely responsibility of water bureaucracy or water managers. Whereas, SWMO introduces the Participatory Irrigation Management (PIM), which reinforces the inclusion of the farmers at different tiers to manage anddistributethesurfacewateratfarmlevelaswellasresponsibletocollectwatertax(Abiyana).

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[4] Planning and Development Department Government of Sindh. (2018, April 16). Sindh Agricultural Policy (2018- 2030). Retrieved Fromhttp://www.wsip.com.pk/documents/publications/Sindh%20Agriculture%20Policy%20(2018%20-%202030).pdf

[5] SIDASources

Both laws consider surface water only for irrigation needs. Therefore, it safeguards the rights of landholders (farmers) not landless water users' dependent on surface water for drinking and domestic needs. For Example; somewhere water supply scheme is needed in rural areas, they used to deduct water share from the landholders' legally allocated water share. It is very interesting to note that what will be the justification to cut approved water share without knowing the shareholder.

Accordingtoanirrigationofficialthattheyonlyfulfildocumentationformalitiesandmentionthat somewhere agricultural land is no more cultivatable. Hence they divert spared water quantity towards water supply scheme. But legally allocated proportion of water for drinking and domestic is not mentioned in water laws.

The article 9 of Constitution of Pakistan guarantee that "No person shall be deprived of life or libertysaveinaccordancewithlaw".Pakistanalsovotedinfavormeanstopledgeinternational community by ratifying the UN general Assembly resolution passed in 2010[6]. Where Water and Sanitation recognized as Fundamental Human Right. Therefore, it is obligatory to take appropriate measures to remove legal hindrances and review exiting water laws to safeguard it as a basic human right with legalprotection.

In this regard, government of Pakistan made some efforts and introduced National Drinking water Policy (NDWP). Though after 18th amendment water is provincial subject and respective provincial governments are responsible to take concrete steps for legal protection to achieve policy objectives.

NDWP goal is to improve the quality of life of people of Pakistan by reducing incidence of death and illness caused by water-borne diseases through ensuring provision of adequate quantity of safe drinking water to the entire population at an affordable cost and in an equitable, efficient and sustainable manner[7].

The first goal is very conspicuous and clearly portray the future course of action as "Provide access to safe and sustainable drinking water supply to the entire population of Pakistan by 2025"[8]. However, Sindh government also followed the course and approved Sindh Drinking Water Policy (SDWP) in accordance to the NDWP[9].

Though national and provincial drinking water policies are committed that drinking water shall have the priority over other uses of water. But there is a dichotomy between water policies and waterlaws.Likethewaterlawsdoesn'tmentionorallocatespecificproportionofdrinkingwater in such quantity at respective canals or distributaries specifically for rural areas. The specific allocation is necessary to avoid misunderstanding and will facilitate the line department for get share of water for newly approved water supply schemes either in rural or urban areas. Instead the ministers frequently reiterate the officials to ensure water flow for tail-enders to meet their drinking and domesticneeds.

Whereas, water quantum at WCs exclusively belongs to the landholders, not a public property which is evident from legally prepared and stamped water-share lists. In absence of legal protection no one can claim or justify to have the right of access and use to available surface water from system. Only Kalri Begar feeder on the right bank of Kotri Barrage is an

exceptional canal to carry water for drinking and domestic needs for Karachi ties. In addition the perennial andnon-perennialcanalconceptfurthercreatingcomplexitieswhenthereisnowaterduringthe dry period considered insystem.

[6] General Assembly Adopts Resolution Recognizing Access to Clean Water, Sanitation as Human Right https://www.un.org/press/en/2010/ga10967.doc.htm

Moreover,theconceptofperennialandnon-perennialcanalsinirrigationsystem,againitcreates uncertainties in terms of supply of water for the people of the non-perennial command area. Non-perennialcanalsdoesn'tcarrywaterroundtheyear.So,howitwouldbepossibletoprovide drinking and domestic water to the rural and urban settlements dependent on canalwater.

InSindh,thewatersectorismostneglectedafteragriculture.ThereisnoProvincialWaterPolicy (PWP)whichcouldbeacatalysttopavethewayforfurtherimprovement.WhileSDWPismerely a cosmetic arrangement in the wake of mounting pressure by the court action against the renowned lawyer Shuhab Osto's petition in Supreme court and following the constitution of water commission.

The Sindh province's economy is based on agriculture and water doesn't have any formal water policy and master planning for the use of water resources efficiently and judiciously regardless ruralandurban.Afteroneanother,thenewconceptsbeingconceivedtoaddresswaterissuesof Sindh such as the establishment of Sindh Irrigation and Drainage Authority SIDA and now the floating of new concept of Integrated Water Resource ManagementIWRM.

2. Methodology

This is a descriptive research. The uniqueness of the research is the link of surface water for drinkinganddomesticforruralareasisnotconsideredwidelyowingtouseofgroundwater.The contaminated and depleted aquifer compelled user to switchover to surface water as primary andsafesource.Therefore,thewaterneedsfromsystemandservicesprovisionaccordingtothe prevailinglawswasmajorconcerntostudy.Therefore,toanalyzethegapsbetweenlaws,policies regardingdrinkinganddomesticwaterserviceswhichconsideredasbasichumanright.However to identify the gaps the following methods have been used to drawconclusion.

Hence water related water laws, policies at provincial level and national and other concerned governmentlinedepartmentdocumentsreviewedaswellaspublishedreports,scientificarticles, and daily regional press were used as secondary source. The key informative interviews from watermanagers,officialsfromboththeareasofpracticedwaterlaws asTheSindhIrrigationAct 1879 and SWMO 2002 have been conducted. The visit of the communities' dependent at the single source of surface water for information was also part of the research. Additionally, impressions from field visits and meeting with indigenous communities are incorporated in this paper.

[7] National Drinking Water Policy 2009- https://waterinfo.net.pk/sites/default/files/knowledge/Pakistan%20National%20Drinking%20Water%20Policy%20 -%202009.pdf

[8] Ibid

[9] Sindh Drinking Water Policy 2017- http://www.sindh.gov.pk/dpt/phe/drikingpolicy2017.pdf

3. SourceofDrinkingWater

Drinking water is one of the vital and important needs for humans. All persons on this earth require about 20 to 50 liters of drinking water in a day, and also for other purposes such as cooking and washing.[10]

In Sindh, there are two major water resources which include artificial and natural. Artificial resources consist of the surface water from rainfall and rivers, which is more than the supplies forirrigationandotheruses,isstoredindamsandreservoirsthroughNationalIrrigationSystem. Whilenaturalresourcesincludestreams,ponds,rainfall,rivers,lakes,andwellsetc.Thewater from dams and reservoirs is not simply consumed for irrigation. Though, it is also supplied for daily consumption and for hydroelectric power generation.[11]

Aboveall,themightyIndusRiveristheprincipalsourceofdrinkingwaterfortheSindhprovince. Qualityandavailabilityofdrinkingwateristhebasicquestion,whichneedstobeanswered.The water sources have been changed by the influences of the various industrial, agricultural and humanactivities.[12]

The courses of the Indus and its tributaries differ broadly from year to year and within the year. There is momentous difference in annual flows to the sea due the water availability. The waters of the Indus Basin Rivers are diverted through reservoirs and barrages into waterways and main canals.Themainchannelsthendistributetheirrigationwaterintotheircommandareasthrough a network of branch canals andwatercourses.[13]

InSindhprovincenearly28percentoffreshgroundwaterisappropriateforirrigation -thewater haslessthan1000mg/lTDS.Freshgroundwatercanbefoundat20-25mdepthintheboundaries of the irrigated lands. Bulky parts in the province are underlain with groundwater of very poor quality. Undiscriminating water pumping has caused in pollution of the aquifer at many places where the salinity of tube well water has amplified. The areas such as Thar, Nara and Kohistan have highly brackish drinking water. Also the situation is further complicated by the occurrence of high fluoride in the groundwater in Tharparkar andUmerkot.[14]

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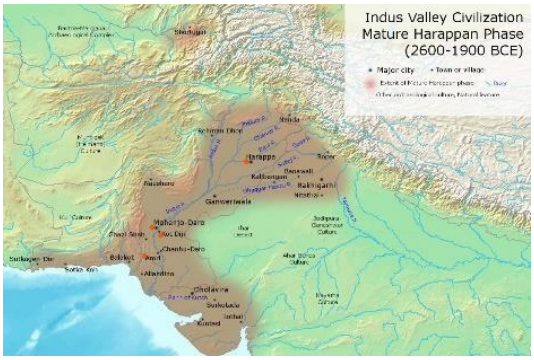
[10] Impact of Clean Drinking Water and Sanitation on Water Borne Diseases in Pakistanhttps://sdpi.org/publications/files/Impact-of-Safe-Drinking-Water-and-Sanitation-on-Water-Born-Diseases-in-Pakistan.pdf

4. AnalysisofWaterLawsandpractices

1. SindhWaterHistory:PracticesandUse



The main source for agriculture is surface water and since the evolution of societies, the humans learned to control the waters to divert for cultivation as well as to meet their other needs such as domestic and drinking. Before the invention of modern technology human preferred to live nearby the riverine belt to have access ease to use water. The same practice still continued, the majority of population of dwells in citiesandtownsatthecommandareassurfacewater.

The Moen-jo-Daro and Harapa at the Indus River are one of the examples of societies lived and flourished at the banks of rivers which turned them into great civilizations around 2500 BC. The importanceoftheuseofsurfacewaterfordomesticanddrinkingpurposescanbeseenatMoen- Jo-Daro such as the remains of Great Bath and number of dug-wells to catch underground riverine seepage water by the inhabitants of Harapacity.

Before, the British rule in Sub-content the Mughal's attempts to control water through constructing man-made small canals and fast flowing streams to maximize the reach of surface watertowardsnewlyconstructedcitiesatfar-flunginwaterlessregions.TheGreatMughalswere alsoknownfortheirbeautifulgardensinhistoryandobviouslythisshowsthatsurfacewaterwas also used for other purposes besides agriculturalneeds.[15]

During the reign of Mughal the construction of Shahnahr which took off from Ravi and carried water to Lahore at the distance of 84 miles[16]. Though in absence of technological advancement
andmechanization,theextensivehumanresourcesusedforciblyforconstructionofcanalswhich werecalledasBegarandfollowingtheman-madeconstructionwasalsoknownasBegarWahin upperSindh.[17]

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[11] AYAZ AHMED, HENNA IFTIKHAR, and G. M. CHAUDHRY. (n.d.). Water Resources and Conservation Strategy of Pakistan. ©The Pakistan Development Review 46 : 4 Part II (Winter 2007) Pp. 997–1009. Retrieved
from http://www.pide.org.pk/pdf/PDR/207/Volume4/997-1009.pdf

[12]Technical Assessment Survey Report of Water Supply Schemeshttp://www.pcrwr.gov.pk/Publications/Water%20Quality%20Reports/Water%20Suply %20Schemes%20Sindh.pdf[13]Water Sources of Pakistan https://www.waterinfo.net.pk/sites/default/files/knowledge/Water%20Resources%20of%20 Pakistan.pdf

[14] Water Sources of Pakistanhttps://www.waterinfo.net.pk/sites/default/files/knowledge/Water%20Resources%20of%20Pakistan.pdf

1. SindhWaterLawsandFlaws

Presently there are two parallel laws are in practice, one is The Sindh Irrigation Act 1879 and secondisSindhWaterManagementOrdinance2002calledSWMO2002.Thoughtherealjourney for the development of modern irrigation system starts during British rule where a numbers of canalsaswellasbarragesconstructiontookplaceinbothagriculturalprovincesPunjabandSindh simultaneously. The first formal water law was introduced by the colonial master in sub-continent. The law was specific to deal with surface water regulations and named as The Sindh Irrigation Act 1879. This law was specifically focused for enhancing water reach to maximize agriculturalcultivation.AtthattimethedrinkinganddomesticneedsofSindhwereverylowdue toverylimitedpopulation.Whilethedrinkinganddomesticneedsweremetbyextractingground waterthroughdough-wellspondsandlacksfillbyinundationandhigherprecipitationandplenty groundwaterrecharging.

Even after 72 years of promulgation of first ever water law in Sindh the populations as per 1951 census was merely 6.47 Million inclusive migrant flux after partition of sub-continent. The number of coming migrants in Sindh as per Pakistan Bureau of Statistics was 1.16 Million. The 1931 census in India shows the population figures of Sindh was more than 3.88 Million[18], while 1941 census before partitions the population of Sindh was 4.53Million[19]. Hence the number of population get increased substantially in Sindh after partition and reached to more than 6.4 Million.AccordingtosixthpopulationcensusofPakistanin2017thepopulationofSindhis47.89 Million.Therefore,theconsiderationfordrinkinganddomesticwaterconsumptionandinclusion ofspecificprovisionundertheformulatedwaterlawin1879ADwasnotconsideredasimportant.

The Article 71 Title Saving of municipal water-work in The Sindh Irrigation Act 1879 said that **"NothinginthisActshallbedeemedtoapplycanal,Channel,reservoir,lakeorothercollection of water resting in any municipality"**. This is categorically define that nineteenth century old lawsdidn'tconsidersurfacewaterforevenmunicipalitiesfordrinkinganddomesticuses.Hence, no provision was made for such needs and issues to behighlighted.

In1997duringthePeoplePartyledgovernmentintroducedanewlawsknownasSindhIrrigation and Drainage Authority SIDA. The establishment of new institution was envisaged as an autonomous organization with the objective to devolve power in water sector to take over the Sindh Irrigation and drainage system for the Sindh irrigation and power department[20]. The attributed responsibilities were mentioned asunder

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[15] GARDENS OF THE GREAT MUGHALS, By C. M. VILLIERS STUART, Oxford University Press

[16] Habib, Irfan. 2014. The Agrarian System of Mughal India 1556–1707, Third Edition. New Delhi: Oxford University Press, 37)

[17] Ibid

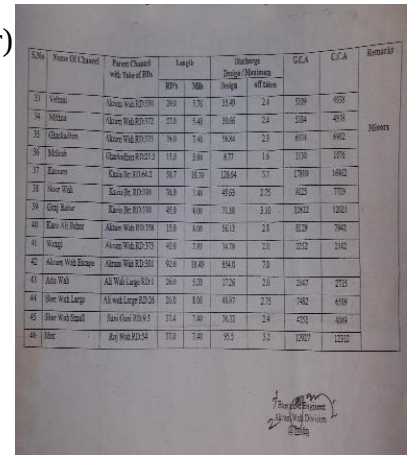
[18]http://censusindia.gov.in/Census_And_You/old_report/TABLE_1931_1.HTM

[19]http://censusindia.gov.in/Census_And_You/old_report/TABLE_1941_1.HTM

- Supply water from the barrages to the canals, while the canals will be operated bythe Areas Water Boards AWB
- Levey water charges from the AWB and other waterusers
- Construct, operate and maintain irrigation, drainage and flood protectioninfrastructure 21

Later this law has been made the part of the constitutional amendment package with minor amendmentduringtheMusharrafruleandknownasSindhWaterManagementOrdinance2002 SWMO.

This laws is quite different in nature in relation to The Sindh Irrigation Act 1879 (TSIA). The TSIA law emphasized that bureaucracy is responsible for water management in province and will act as water manager. Whereas the SWMO 2002 reinforce that the water management will be the joint through a participatoryirrigation



Management model where farmer (Agricultural landholder or Land leaser) Will be the part of the management. This model is based on the three tier Institutional framework from bottom to top as Farmer organization (FO), Area Water Board (AWB) andthe governingbodySIDA.Againthislaws also doesn't mention any article for the provision of drinking and domestic water allocation for other water users such as landless and marginalized groups as well as other water consumer.

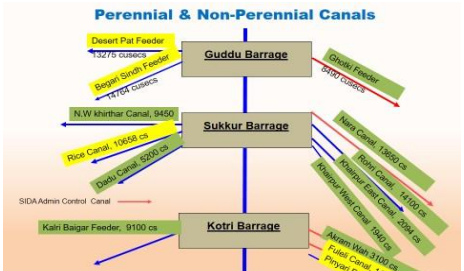
The last unit for water distribution at farm is Water Course where a Water Course Association (WCA) is mandatory to be formed. All representatives for FO comes from WCA which called the Executive committee of FO. Hence the FO representatives are further represent the AWB. The criteria for the membership of WCA is mentioned as below

"MembersofWCAarethelistedLandownersandleaseholdersbenefitingfromthewaterflow in the water course. This list of the membership is deposited at the FO, which shall issue a certificate of registration to the WCA and such certificates shall be the proof of the WCA's membership of theFO"[22]**.**

The above mentioned article categorically define that the membership criteria is limited to land owner and leaseholder. Whereas the water quantity to be received will be based on the agricultural land size occupancy. Hence the surface water is made specific to only irrigation purposes not for drinking and domestic at the canal command areas. Further it also can be verified by the legally allocated water share by the concerned authorities with its signature.

[20]http://sida.org.pk/pages.aspx?id=55

Therefore, it can be concluded that under the existinglaws



Water is not considered as basic human right but water is given on the basis of mercy and it depends on the land ownerandleaseholderstoallowsomeonetotakewaterto meet their drinking and domestic needs. The use of water is first and foremost is for Agriculture in rural areas. Hence the majority landless people don't have the right of access anduseofsurfacewaterfromthecanalirrigationsystem.

Another dichotomy prevails in water allocation systemas

The concept of Perennial and Non-Perennial canal system. Simply the perennial canal receives water round the year. On other hand, the non-perennial canal receives water only in Kharif Season as per allocated water according to Water Apportionment Accord of 1991. The Water accord also doesn't mentioned any specific quantity of drinking and domestic needs for the citizen except mentioning the urban and industrial uses for Metropolitan Karachi[23]. The water accord also fix apportionment of water for all provinces for both season as Kharif and Rabi for agricultural. The Accord acknowledges" Industrial and Urban water supplies for Metropolitan City,whichispresumedtobethecityofKarachi,becauseKarachiisexplicitlymentionedinnotes Table1[24]. Therefore, again this is a lack it didn't mention such proportion of water explicitly for drinkinganddomestic.InSindhtherearenineperennialcanalsoutoffourteen,whereasfive canals considered as non-perennial. Six Canals at the Right Bank including Ghotki Feeder at Guddo, Nara, Rohri, Khairpur East and Khairpur West at Sukkar and Akram Wah at Kotri. Three atRightBankofIndusRiversuchnoperennialcanalatGuddoontherightside,NorthWestCanal (KirtharCanal)andDaduCanalandatKotriKalriBegharFeeder.Theperennialandnon-perennial canals in diagram sketch for understanding that how the inhabitants at the non-perennial command areas will receive basic human right water during the unavailability period of water. Though the article nine of constitution of Pakistan pledges that "No person shall be deprived of life or liberty save in accordance withlaw".

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[22] Sindh Water Management Ordinance 2002, Chapter V: Water Course Association, Article 56 Registration

[23]https://waterinfo.net.pk/sites/default/files/knowledge/The%20Water%20Accord%20-%201991.pdf

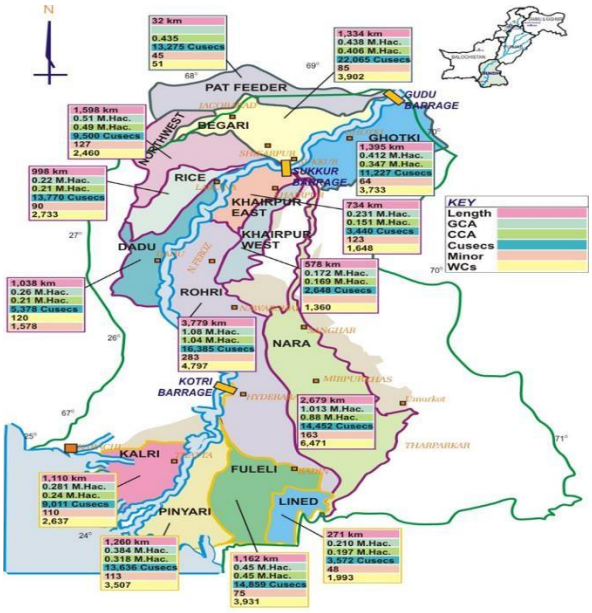
[24] Pakistan's Water Apportionment Accord of 1991: 25 Years and Beyond, Arif A. Anwar, P.E, M. ASCE and
Mohammad Tousif Bhatti

2. SurfacewaterSystemreachandcommandareas

Sindh is tail end of irrigation system of Pakistan. The Sindh irrigation system reach expands to 30462 km including canal, branch canal and sub-branch canal, distributaries, minors and watercourses as mentioned in below table.

Table: 1

Type of water sources	Length in KM
Mani Canals	2513
Brach and Sub Branch canals	4450
Distributaries	4276
Minor Canals	6323
Watercourses (43,000)	12900[25]



CANAL COMMAND MAP OF LOWER INDUS BASIN IRRIGATION SYSTEM, SINDH PROVINCE, PAKISTAN

The canal command area is mentioned in detail in a diagram which cover almost all the major citifies of Sindh. Though the following cities are not included at canal command areas such as Tharparkar, 35 percent of Umerkot District, 15 percent of Sanghar district,30 percent of District Dadu and 30 percent of district Jamshoro are not dependent on irrigationsystem.

Hence, the majority population of Sindh is dependent on surface water sources for irrigation as well as for drinking and domestic needs. The largest irrigation network is the single sources for people and their associated economic activities in provinces. The system even has too much potential to fulfil the needs of people through its largest and contiguous canal network system with some improvements at policy level and better infrastructural development. The encounteredissuesarerelatedtothesystemaregovernanceandabsenceoflongtermplanning toconsidertheincreasingdependencyonsurfacewatersources.However,thespecificallocation of water for drinking domestic including for both rural and urban is extremelynecessary.

3. WaterShortageandContaminationIssues

Though water is life but unfortunately the water scarcity and contamination issues are a serious challenges to overcome. This happened owing to poor governance issues, political interference, difference of opinion for formulation of laws such as one Sindh Two water laws, and the water bureaucracy stanchly adhered to the old British laws and other water experts and policymaker's view as revitalizing the water sector is imperative. The nexus of water bureaucracy and feudal-cum-politicians in power is a major resistance force to change.

Hence,theindividualstookthemattertothecourtssuchasthefamouscaseofAdvocateShuhab Osto related to water contamination and following the constitution of Judicial Commission are some outstanding example. The court hearing and order and frequent follow up visit by the Judicial Commission are the very key to sensitize and realize the importance of surface water in province and immediate measures. Hence, the public cry and pressure compelled the

governmenttotakeactionandreleasewaterinevenforthenon-perennialcanalintheprovince for drinking and domesticpurpose.

[25] Data Source Sindh Irrigation and Drainage Authority SIDA

Though the non-perennial canals don't have share round the year as per defined Water ApportionmentAccordof1991.Butthisisanexclusiveactiontorealizetheimportanceofsurface waterforevengeneralpublicfortheirbasicneeds.Furtherthecontinuedcourtmatterwillhave a long lasting impact on the future course of Sindh Province watermatter.

4. GapsinPrevailingWaterlaws

a) TheSindhIrrigationAct1879

The old British era law still exists and used to govern large part of the irrigation network in the province. This act mainly deals the areas such as Construction and maintenance of canals, Removal of obstruction and power to enter land, Canal crossing, Removal obstruction to drainage, Construction of drainage works, Construction of new water courses, Supply of water and settlement of dispute with the perspective of agricultural use, Compensation and penalties, Water rates, Powers of different irrigation bureaucracy.

This is very primitive law when the system was put into place, even the first barrage was built after 50 years of this act. There was abundance of water in Indus and was no challenge in diverting it to irrigate the virgin land. However, as mentioned above the land reforms did not initiate as it was hoped after the completion of sukkur barrage.

The law is quite silent about the drinking needs and contribution or role of other stakeholders such as landless people of the province in irrigation water management. Similarly, there is no provision to engage sharecroppers or tenants those who are solely dependent on surface water for drinking, domestic for livestock at any stage of water management or their legal share. The rights, privileges and duties mentioned are applicable to the land owners only.

Sincemuchhasbeenchangedwhenthislawwasadaptedin1879.Populationhasincreased,food and fiber demand is sharply increasing. The scarcity of water leading to unequal distribution which consequently leading to unrest and conflict. The non-perennial canal doesn't ensure the supply of water for drinking anddomestic.

The World Bank experts notice the flaws that system faces several challenges including unequal distribution,unreliablesupply,inefficientwateruse,insufficientcostrecovery,waterloggingand salinity threatening future of agriculture, inadequate operation and maintenance, aging of infrastructure and centralized management system.

To address these challenges and transform the system, it was advised governments to change the management system by ensuring the participation of farmers in irrigation management and giving them responsibility to manage distributary where they should be made responsible for water distribution, maintenance and operation as well as collection of water charges. The assumption was that it will help in achieve distributary level water distribution fairer and locally organized farmers will decide on their own.

Hence in the acts was promulgated by Sindh assembly in 1997 and it was called Sindh Irrigation and Drainage Authority (SIDA) act.

b) SindhWaterManagementOrdinance2002

Later on, this act was further amended and is now called Sindh Water Management Ordinance (SWMO) 2002. The analysis of policy gaps for this law is important because, this law is perceived a second generation legal system for water.

Under this law Sindh Irrigation and Drainage Authority (SIDA) was established. SIDA considered as highest decision making body at provincial level with important functions to perform. Following core function have been identified:

- Operate and maintain the parts of the irrigation system such as barrages andoutlets assigned toit;
- Operate and maintain the parts of the drainage system assigned to it including spinal drains and inter-AWBdrains;
- Carry out river flood protection and maintain the infrastructure in the province ofSindh
- Advisegovernmentonanymatterstrategicortechnical,relatedtoitsfunctionsandtasksor to the water management system as a whole e.g. irrigation or drainage contribution rates, drought management and sea waterintrusion.
- Manage the transition process, to promote the formation, growth and development of the AWBs and FOs into self-supporting and financially self-sustaining entities within a period of seven to ten years of theirestablishment

Identified Gaps

- ❑ Silent for drinking and domesticneeds

- Doesn't Considers the Water Course (Last unit of Irrigation Network System) andits share of water as public property
- Don't control over the use and decision making of water from onward Canal toMinor and distributaries to Watercourse, it considers surface water as legal propertyof landholders and don't allow drinking and domestic stakeholder to be part of participatory irrigation management system and receive water for their basic needs
- don't take responsibility of Operation and maintenance at the watercourse levelwhich caused a great loss of water, while as separate department is responsible such as Agriculture Engineering and on Farm waterManagement
- The Agriculture Engineering and on Farm Water Management namecategorically defined that this department only works for Agriculture andFarmers

Boththelawsareexclusivelyrelatetotheirrigationandagriculturalwater needsanddon'thave anyarticleorprovisionfordesignatinglegalspecificwatershareforthepeopleofSindh.Though the Water Apportionment Accord of 1991 categorically clear and put the Karachi in its table 1 and mention included water share for urban and industrial needs in Sindh aggregated water share. Therefore, consequently fresh surface water bodies remained out of the legal jurisdiction and regulations to stop pollute these sources of water. Even the local government's legally approved drainage schemes affluent have been put directly put in canals, minors distributaries and watercourse in entire Sindh which as a common practice. This is owing to discriminatory water laws and doesn't consider the drinking water policy. The Drinking water policy at National and provincial level are a step forward to improve the quality service regardless rural and urban inhabitants. The women and landless marginalized groups particularly in rural areas are at absolute disadvantage by the old age and incompatiblelaws.

5. Recommendations

Itissignificanttosynchronizethelawsandpolicies.Withoutlegalprotectiontodeclarewateras fundamental human right under the water laws, the implementations will remain a challenge. It needs to allocate specific water quantum from surface water sources for drinking and domestic as per defined standard of WHO for per capita per day water requirement. Therefore, to review the existing water laws is extremely imperative to achieve the envisioned objectives of water policies at provincial level as well as to review the Water Apportionment Accord 1991 to pool waterquantumfordrinkinganddomestic.Hence,consideringtheabovementionedgapsrelated to water laws the following are the recommendation to consider for improvement and incorporation of key aspects to address theissue.

- The introduction of one water laws is extremely essential which covers all aspectsof use of surfacewater
- The introduction of ONE WATER LAWS for entire Sindhprovince

- Water Should be declared as Fundamental Human Right both in provincial waters and in Water Apportionment Accord1991
- The introduction of Provincial water Policy necessary and expedite the process with wider consultation of all stakeholder and waterexperts
- The SPECIFIC ALLOCATION OF WATER QUANTITY from national pool for drinking and domestic as per defined WHO standard for per person per day water requirement at the each barrage and its associated canals, Branch and sub-branch canals, distributaries, minors and watercourses.
- The land owners and leaseholder should not have to be considered as owner of surface water. Water is common commodity and essential and fundamental human right to be acknowledged in water laws as pledged in National and Provincial drinking waterPolicies.
- The concerned line department should be revitalized and make them well equipped as well as arrange necessary trainings to understand and realize the importance of drinking and domestic water needs in terms of both quantity andquality.
- The role of Rural Development Department should be enhanced particularly for providing water supply schemes in rural areas ofSindh
- The establish an extensive Network of rural Development department to enhance its reach particularly for designing and finalizing water supply schemes taking their legal share from surface water system even till the tail end ruralareas
- The concerned line department should be revitalized and make them well equipped as well as arrange necessary trainings to understand and realize the importance of drinking and domestic water needs in terms of both quantity andquality.
- For each district, city and town, UCs and revenue villages in rural areas should have approved and allocated water share from surface water system according to populationsize
- The innovative water conservation technologies should be introduced for all water users either commercial orhousehold
- Old age agricultural practices should be replaced with modern day cost efficient and advanced technologies
- Improve the efficiency and efficacy of concerned line department for better service delivery at the grass rootlevel.
- Public and private partnership can play a vital role to overcome the water issues of the province. Therefore, Government should have to device a policy framework and make provision for encouraging private investment for this keysector
- It should be mandatory for water manager and officials to ensure the water till the tail-ender in irrigationsystem.

Water Service Provision in Small Communal Islands of the Maldives: Addressing Barriers for Social Enterprise via Business Model Innovation

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Abstract

Municipal water and sewerage services, for the capital city Male' in the Maldives, housing a third of the nation's population, are provided by MWSC a JV company of Government of Maldives and Hitachi Plant Technology of Japan,operatingasaPPPunderaBOTconcessioncontract.Whilefinanciallysustainable,thePPPbusinessmodel with its limitations in municipal water and sanitation service provision finds no business case in smaller island communities,leavingthegovernmenttoexplorealternativearrangementstoservicethewaterinfrastructure.Such infrastructure being built rapidly in communal islands under development assistance for climate adaptation and building water resiliency in the face of Climate Change are gradually slipping into deterioration for lack of adequateoperation,maintenance,communityownershipandfurtherdevelopmentaswellashightransectioncosts of infrastructure building and O&M.

Thisresearchoffersanexplorativeassessmentfornegotiatingbarriersforestablishmentofsocialenterprisewater utilities in small outer islands of the Maldives employing business modelling focusing on hybrid value creation, delivery and value capture. The study will be framed around the opportunity created by SDG6 on WASH and SDG17 on the means of implementation and Global Partnership for sustainabledevelopment.

The resulting conceptual model will be tested and improved in the second stage of this research using mixed methods. The study is expected to spur debate, discussion, stakeholder action as well as social entrepreneurship forinitiatingtransformationofwatergovernanceinMaldiveswiththeengagementofthecivilsociety alongwith the other WASH stakeholders in the competitive value chain operating in the disruptive new technology environment.

The findings will have implications for policy and practice in creating an enabling environment for social entrepreneurships in the water sector in Maldives. Social enterprises thus developed can become a tool for operationalization of National Water and Sewerage Policy Goal 4: building institutional capacity, Goal 6: Maintain financial and environmental sustainability and SDG 6.6b: Support and strengthen the participation of local communities in improving watsan management as a means of achieving sustainable development goals by 2030.

Key Words

Sustainable Development Goals, SDG6, water sanitation, utility service, business modelling, social enterprise, sustainability, value creation, value delivery, water user, water governance, small islands, water and sanitation.

1 Background

ContextandHistoricalperspective

MaldivesisanarchipelagointheIndianOceancomprisingof1190verysmallislandsofwhich194areinhabited withathirdofthispopulationlivingintheMale'urbanregion(Musthafa2013).Traditionallywaterwassourced fromrainwateroffdomesticroofsandgroundwaterfromdomesticwells.However,increasingpopulationdensity andpollutionoftheshallowgroundwaterassociatedwithchangingenvironmentalandhumanbehavioraleffects has called for scaling up of rainwater collection, treatment, seawater desalination, ground water management, storage and distribution coupled with supporting technical aspects (ibid), Nouri (nd). However, it is important to havearationalcasebycaseapproachtowardswaterservicesdevelopmentconsideringneedsagainstaffordability and willingness to pay over the life cycle of infrastructure during which needs are changing due to external as well as the direct effects of the project. In this regard Hukka & Katko (2003) observes water acquisition, treatment,storage,delivery,metering,billingandcollection,wastewatercollection,conveyance,treatment,reuse or disposal services as the most important public infrastructure services embodied in the spectrum of water services.

Water is defined in the industry as an economic good or a public good. Proponents of the former view water as any other commodity that private entities can service better than public institutions. The later view however is that water is essential for life and that allowing business to service water would be unethical on the basis that collective ownership than private would be more appropriate for a common good. Between these two views we have the concept of water as being an economic, social and environmental good proposing a balanced approach where conflict resolution gives priority for human and environmental requirements without direct cost recovery or profit making (Hill 2003).

Communitybasedwatersupply

Communitybasedwatersupplyarefoundintheruralareasofthedevelopingworld,operatedandmanaged often bycooperativesownedbythewaterusers.Howeverassocietiesdevelopedthewatersystemsbecametoocomplex for communities to manage (van Wijk, Sari et al. 2002) without additional capacity development which is attainable according to an Australian government funded research project which studied 20 detailed case studies of successful community managed rural water supply in India. (CranefieldUniversity)

Unlike in the other countries in the Asia region, social business such as cooperatives are still not visible in MaldivesinspiteofeffortsofsomeinternationaldevelopmentpartnerssuchasIFAD,UNDPandFAO's startup assistance for agriculture and fisheriescooperative.

WaterChallengeandcommunityengagementinwatermanagementinMaldives

Thewatersectoriscomplexandchallenginginthelowlyingislandsof theMaldiveswiththeGovernment having tobuildwatersupplyinislandsrangingfromthesmallestpopulatedislandshavingtothelargestpopulatedislands with populations ranging from less than a hundred to over five to hundreds ofthousands.

Privateparticipationwillbringintheinvestmentandtechnology,communityengagementwillreducetransection costs significantly through unified ownership and vertical integration (Hukka & Katko 2003). The water sector beingdependentonimportedheavyinfrastructureoftenlaidunderthegroundrequiringprofessional maintenance the effect of which is observable only under managed operational regimes, savings on transection costs has the potential to make or break sustainability of the venture. The business case in this gap is very clear. However combination of resources and capabilities of a single entity will not be sufficient; rather it requires multi sectoral approaches.

Waterutilityserviceprovisioningmechanisms

Waterbecomingacommodityandrightsallocationtocommercialinvestorsandgivingawayaccessrights become barriers to access requiring multi-sectoral and multi-objective analytical approaches in broad societal context (Savenije 2002). Private public utilities comprise of a varied mix of agencies from formal enterprise to non- formal enterprise, local or multinational, (Hill 2003), for profit or not for profit needed to overcome failures of public or private provisions (Blatter and Ingram 1998). Under the PPP category different forms of ownership and operational responsibilities there are further combined options such as Build transfer operate (BTO) , Build operate transfer (BOT) and Build Operate Own Transfer(BOOT).

Ministry of Environment and Energy in Maldives is responsible for policy making as well as developing and implementing water and sewerage schemes throughout Maldives. (Denise 2015). The researcher who has spent over 20 years in the water sector in various capacities at senior levels of policy, regulation, design, operations management, is a consultant who is managing the consultancy component of a water and sewerage schemes for over 50 islands throughout Maldives being implemented by MEE. The researcher has discussed water utility operatingmechanismbasedonacommunitymanagedbusinessmodelwhichthegovernmentiswillingtoexplore furtherbasedonhowcooperativesinMaldivesareperforming.Therefore,ithasbecomeparamounttodetermine an approach to navigate barriers to social value delivery while appropriating sustainable economic value for the water operator.

Table 1Main actors and value addition of this research

Players	**Relevance**	**How the research will add value**
CSOs	Potential Water Utility SEs. The civil society organizations can be NGOs or even Cooperatives. Cooperatives are better placed since they are already familiar with economic working towards objectives in product and service delivery to clients.	

MED	Responsible for policy and regulation of SMEs and Cooperatives.	This report will give ground for CSOs to advocate policy institutions to develop the cooperative/ SE regulations mentioned in the Cooperative law which is to follow the Legislation.
MEE, EPA	Responsible for policy and regulation of Water and Sewerage services.	EPA has the responsibility for water regulation. Currently there is an issue on the table for EPA to formulate a plumbing code. This initiative will incentivize the private sector capacity building, development of a skilled work force Promoting private business in the sector.
Island Councils	Responsible for operation of existing community rainwater water schemes	Policy and regulation by MEE and EPA can incentivize the island councils to rise to the Occasion for participating to fill in the water governance regulatory gaps.
Utility Companies	Operate existing municipal water and Sewerage infrastructure following development installation byGOM.	
Public Enterprise Monitoring Board (PEMB)		Government of Maldives (GOM) can enable PEMB to become active in the regulating of the private sector organizations including SOEs SMEs Cooperatives. This means theinitiative Would initiate drivers for strengthening the local water institution.
Island Community	Potential owners/ customers of Water utility SE.	Water user community will be able to operate ownwatersupplysystem,andreducetrans ection costs as well as intermediary commission. With capacity building they will be able to assure quality of water more effectively being useras Well as producer.
Maldives National University (MNU)	State tertiary education institute who plays the role of designing tertiary educationandresearchasrelevant for the society. Currently there is a special course offered with the support of MEE and water utilitieson Water system operation and maintenance.	Indirectly, academia and training institutes will benefit with more demand for professional training for the water industry.

Otherstudiesandcurrentknowledge

Otheracademicstudiesofwatergovernanceorevensocialenterprisearelackinginmaldives.MWSC,the private commercialwatercompanythough,isapracticalexampleofwaterprivatization,monopoly,andunregulateddue to absence of a water law and an under resourced regulator that is unwilling to operate the water supply systems of small communal islands in spite of the government providinginfrastructure.

Some reference to IFAD, FAO and UNDP initiated cooperatives established in the agricultural and fisheries sector are found in the internet which have not managed to catch the policy makers attention to formulate regulations, guidelines or even mainstream capacity building efforts as anticipated in the local Cooperative Law.

Comprehensive knowledge on Social Enterprise (SE) is not available in Maldives, nor are there any promotional activities at any institutional level apart from the government's micro credit schemes for women and youth empowerment through small to medium sized enterprises (SME) s. The proposed business model concept combining the social enterprise mechanism with the water utility model (Figure 4) is a novel but conceivable ideatothestateministerofMEEtowhomthisapproachwasinitiallyproposedaspartoftheconsultativeprocess in the development of concepts for sustaining the operation and management phase of the 45 island rainwater scheme being developed under GCF. Further, in a preliminary data gathering interview held with a cooperative pioneer in Maldives Mohamed Shahid sees the potential of an SE for managing municipal water services operation in small islands that are too small for public utilities to run, in spite of being already mobilizedon the island providing electric power to the samecommunity.

Purposeandvalueadditionoftheresearch

ThepurposeofthisresearchistoexploreapathwaytoincreasewateraccesstosmallcommunitiesintheMaldives takingadvantageofavailableresourcesandcapabilities.Thechosenconceptattemptstobringtogetherthewater sector stakeholders including, the civil society, the private sector, academia and the government under an institutionalumbrellatodevelopamechanismforincreasingwateraccessascountrieshavecommittedinSDG6. With inter-sectoral collaboration potential capabilities can be harnessed and developed into valuable sustainable human capital to develop more resources through derivers and incentives, creativity andinnovation.

The value addition of this research to the primary water sector stakeholders as shown in Table 1.; is expected to, based on the performance and impact of global and regional social enterprises, have a whole economy of factors startoperatingacrossstakeholderecosystemleadingtoindustrialandeconomicdevelopmentandpro

sperity.This being the purpose of sustainable development goals, the research is a vehicle that can support and promote SDG implementation.

1 ProblemSituation

Whilewaterisessentialforhumandevelopment,basichealthandlivelihood,waterscarcityandshortageofgood water governance has led to water crisis (OECD 2012) among world community. This has encouraged nations to addressthisissueatinternationalplatformsleadingtorecognitionofaccesstowaterandsanitationasbasichuman rightsandcriticalsustainabledevelopmentchallenges;embeddedinSDGiswaterandsanitationasSDG6:Ensure availability and sustainable management of water and sanitation for all. Goal 17 of SDG represents the means of implementationofthethreedimensional-environmental,socialandeconomic-agenda(UNwater205).According to OECD (2012) the water governance challenges are institutional fragmentation, capacity gap of local parties, poor institutional frameworks (legislative, regulatory) lacking integrity and transparency extending to resource allocation, financial management, accountability, policy objectives, strategies, and monitoringmechanisms.

In Maldives, a small island nation with scarce natural water sources water security calls for water production from seawater, relatively large storage and distribution which are technically challenging and capital intensive. The capital city, Male' housing a third of the nation's population the water utility function was privatized on full financial recovery basis through a joint venture of the Government of Maldives and a Danish water technology company,HOHsigninga20yearconcessiononBuildOwnOperateTransferbasis(Rasheed2018).Commercially the company has fared well however by undue value appropriations with the help of technology, sound management (USAID 2012), a lucrative water tariff and a weak regulator. The situation can best be understood and altered for societal good using an institutionallens.

TheMalemodelhavingacrosssubsiding3tieredtariffhasprovedtobeunsustainableinsmallislandswherethe limited population and absence of large institutional and industrial water consumption render the cross subsidy business case inoperative. As GOM's program of building water infrastructure in the communal islands progresses,regionalelectricpowerutilitiesaregivenlicensetooperatethesefacilities.However,thesecompanies already loosing on electricity will not voluntarily take over the responsibility of water operation even when the infrastructure is built for them by GOM in order to avoid additional lossburden.

The governments ongoing 45 island water scheme is meant as a water security project to cater to emergencies during the dry period, with water is to be drawn from 3 tap bays in each of the islands in which case the current tariff model will not be appropriate; the author being the project manager of the consultancy design and supervision team has recently presented the Client, Minister of Environment and Energy a conceptual operation and management approach for this water scheme; this study will expand on the PPP social enterprise model.

Meanwhile such small communities survive on traditional water sources such as domestic rainwater catchment and shallow groundwater wells for daily consumption during the rainy season. However several of these islands dependonshipmentsofreliefwaterfromMale'suppliedfromdesalinatedwaterproducersduringthedryperiod.

MWSC although successful commercially is not meeting its social obligations. the lack of water laws, shortage of regulation, ineffective consumer protection regulations, un-empowered national water regulator and low awareness of the civil society leaves MWSC as an untouchable enterprise providing healthy dividends to its shareholders (GOM 80% and Hitachi 20%) at the expense of infrastructure development addressing aging of underground infrastructure, rapid urbanization and increasing water demand: From a sustainability context the PPP model (BOOT) in the current institutional context is unable to provide for sustainability of public water supplyevenintheurbancenterswheretheseisabusinesscase.Inthemeantime,withtheprivatewateri nstitutions cherrypickingalltheurbancenters(USAID2012)[1]leavesthewaterandsewerageschemesofthesmal lerisland communities with no incentivized operating mechanism in spite of government's installation of infrastructure, as in the case of the 45 island GCF funded rainwater project[2] for building climate changeresiliency.

With several water infrastructure schemes built by GOM and contracted to SOEs and PPPs failing over the years for lack of proper operation and maintenance government is in dire need of developing an operation and service management model that will be environmentally, socially and economically sustainable particularly in small communityislands.RealizingthatthecommerciallysuccessfulPPPmodelisnotincentivizedtotake upthesmall island water schemes a working hybrid model that can serve the social objective while remaining economically sustainablehasbecometimely.Thisresearchprojectisfocusedondevelopingsuchahybridwaterutili tybusiness model via addressing internal and external barriers for value creation and delivery comprising of resource pooling, value chain relationship management, trading activity and performancemanagement.

The research is driven by the following research questions framework. The research objectives, indicators and instruments will guide the research to wards effective solutions to be validated and generalized.

Research question 1: How can institutional barriers to value creation, delivery and capture be navigated for a water utility in a small communal island setting with a particular focus on the Social Enterprise model.

Research question 1.1: What are the characteristics of the product and services expected in terms of water supply needs of the target population and the other stakeholders?

Research question 1.2: What is the value proposition of a water utility SE of a small communal island. **Research question 1.3:**What is Social Enterprise identity and therefore what are the success factors of a water utility social enterprise in terms of stakeholder expectations and demand.

Research question 1.4: How can value be created, delivered and captured through a social enterprise water service value chain.

Research question 1.5: What are the barriers to value creation, value delivery and value capture in a sustainable water utility SE responsible for operation and maintenance of public water infrastructure in a small communal island in the Maldives.

[1] MWSC operates water supply and sewerage systems on seven islands serving a total population of 150 000 which approximates to 45 percent of the entire

population of the Maldives.
[2] The author is the local project manager of the international consultancy team of the project.

Whiletheresearchproblemaroseoutofasocialsituationthatcanpotentiallybesolvedusinginnovativebusiness mechanisms the search for this solution into literature was guided by the research questions and the associated framework described in the followingsections.

1 Literaturereview

Literaturereviewinsearchoftheoriestoformulateawaterutilitysocialenterprisebusinessmodelforthecurrent institutional ecosystem (Table 1) of the Maldives provided a list of relevant theories (Table 3) as well as their relevance to the business model development as shown in Table (5); as stated by Perrini and Vurro, (2006) a social entrepreneurship can create and deliver value to end customer via sound business model implementation. In order to achieve this end, the business model will be built on the resource base view - an effective tool for analyzing value creation (Amit and Zott 2001). Strategic capability of the social enterprise will be supported by its resources (Barney 1991) and competences (Hamel Prahalad 1990). The firm will build capabilities through bundling of these resources, and leveraging them for creating and maintaining value for thestakeholders.

For the Maldives situation where social enterprise concept is novel and support institutional set up lacking, substantial barriers to entry of social enterprise mechanism into the water service market will pause several challengesforthesenewentrantsastheyscaleup.However,thesecondaryresearchshowsthatasocial enterprise business model has the potential to bring together available capabilities, technology, investment, training and capacity building in the presence of incentives and commitment for engagement of supply chains to leverage human capital and the other resources for value creation and delivery needed to provide sustainable access to water in small island communities.

Table 2: Water supply governance model comparison (adapted from Bakker 003)

	Public Utility	Private Sector	Community/Co-operative
Consumer role	Citizen	Customer	Community member
Form of consumer participation	Collective, top-down	Individualistic	Collective, Bottom-up
Accountability mechanism	Hierarchy	Contract	Community norms
Primary decision makers	Administrators, experts, public officials	Companies, experts, individual households	Leaders and members of Community organizations.
Primary goals	Guardian of public interest Conformity with legislation/policy	Maximization of profit Efficient performance	Serve community interests Effective performance
Key incentives for water conservation or other goals	Expert/ managerial feedback in public policy process Voter rate payer opinion	Price signals Customer opinion	Agreements and shared goals Community opinion
Key sanctions for failure to maintain			Livelihood needs Social pressure

safe, adequate services			Litigation (in some cases)
Primary conception of water	Public good/commons	Commodity/ Economic good	Public good/commons

Not for profit	mixed	For profit
Community owned, citizen or member based -Formal community based organizations (CBOs) legalized as cooperatives or foundations (Indonesia) -Membership based formalized associations of CBOs operating rural water supply. These provided the member CBOs with technical and financial support services. (Timore-Lestel) -Membership based formalized associations of sanitation entrepreneurs providing their members support services: training, networking and access to cheaper martials. (Indonesia)	**Community owned, citizen or member based** -Membership based formalized associationsofCBOsthatinclu dea fee for service revenue stream in addition to other forms of revenue such as membership fees and supportfromgovernment)and may use profit from this revenuestream to cross subsidize other activities or expand theirservices (Indonesia)	**Privately owned** -Sole trader and small scale sanitation enterprises, informal or formally registered, providing sanitation products and services -Small scale private enterprises providing water supply services (Indonesia & Vietnam)
	Privately owned Local WASH NGOs engaged in business activities including selling water supply or sanitation products or providing consultancy services through a separately established private enterprise with the aim of supplementing its income and reduce dependencyon Donor funding. (Timore-Lestel)	**Government owned** Local or village government owned enterprises providing water supply services (Indonesia, Vietnam)

Purely Commercial	Commercial enterprise	**Mixed for profit social enterprise**	Mixed nonprofit social enterprise	Nonprofit social enterprise	Traditional NGO	Purely philanthropic

Figure 1 Conceptual social enterprise spectrum (source: adapted from Kupolokun 2014 & source: ISF-UTS 2016)

Table 3 Relevant theoretical perspectives from literature on social entrepreneurship research

Table 3: Relevant Theoretical perspective from literature on social entrepreneurship research

Author	Focus of Study	Theory/ relevance
Robinson (2006)	Identifying and evaluating social entrepreneurship opportunities	Framework presented based on two theoretical approaches to social entrepreneurship
Tracy and Javis (2007)	Relevance of resource scarcity theory and agency theory to social venture franchising	Resource scarcity theory and agency theory
Coroner & Ho (2010)	Identifying and exploiting opportunities	Rational/economic and effectuation
Meyskens, Robb-Post, Stamp,Carsrud,& Reynolds (2010)	Resource based operational process of social ventures	Resource based view
Ruvio & Shoham (2011)	Organisational outcomes of social ventures using a multilevel model	Hypothesis followed Garner's (1985) model for describing the phenomenon for new venture creation.
Haigh & Hoffman 2012	SE success depends on collaboration with multiple stakeholders	Stakeholder theory
Tracey, Phillips, & Javis 2011	Organisational structures that balance differentiation and integration can support competing logics.	Institutional Theory

The operating space of a water utility social enterprise in the sector can be investigated in reference to the institutional arrangement of the water sector in the Maldives. Rasheed (2018) described the institutional arrangementofMaldiveswatersectorusingScott'sInstitutionaltheoryshowshowtheScott'spillarsrelatetothe Maldives drinking water sector; Scott's institutional theory is framed with cognitive, normative, and regulative structures and activities as regards providing stability and meaning to social behaviorFigure 2. The cognitive element allows meaning to be made of shared concepts against social reality. The normative aspect defines objectives andways of pursuing Values,normsandroles.Theregulativepillar consists of laws and rules supported by sanctions to guide how individuals must behave. At the cultural - cognitive pillar, the Maldives drinking water supply sector has shared understanding that drinking water must be provided through effective management.

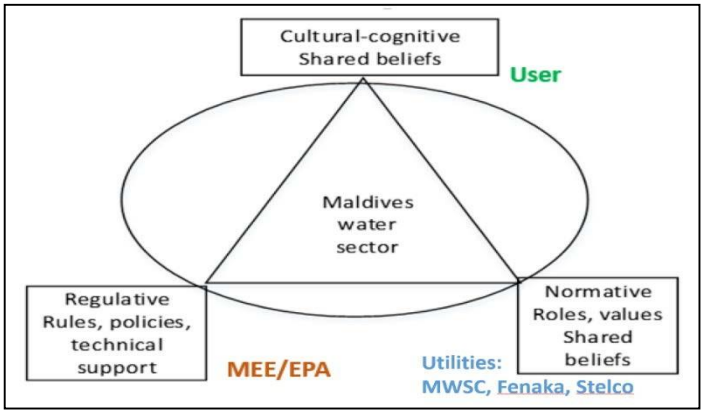

Figure 2: Institutional pillars of Maldives water sector source: adapted from Scott (1995)

Therefore, the sector creates a culture involving actors and institutions such as Ministry of Environment and Energywhichisresponsiblefor"policyformulationandlegislationsrelatedtowatersupplyandsewerage"(MEE 2017, p42), and the Utility or operations service sector to fulfil this concept. Normatively, with roles, vision, mission statement and values consistent with provision of the community access to safe water for meaningful social livelihood through PPP model for the Male' urban regions, and SOE model in the outer islands, it is the smalleroftheseislandswhereSEentrywillfindagapinitially.Attheregulativelevel,somerules,standards and guidelines have been developed while MEE endeavors to have a Parliamentary Water Act passed (Mustafa 2018) creating legal entities giving those responsibilities, incentives and punitive measures for actors and institutions towards provision of safe and adequate universal water access in theMaldives.

Table 4: Relevant concepts and their linkage to the social enterprise business model

Relevant concepts from literature	Relevance to social enterprise business model development

Non-government organizations	Generalgoodofsocietyistakencareofbythegovernmentinmanysocieties, voluntaryorganizationsseekingtoimprovesocietyaccordingtocertainvalues And ideologies are founded outside ofgovernments are typically not-for- profit organizations (NPOs), or nongovernmental organizations(NGOs).
Private Enterprise	Enterprises or Businesses are for - profit organizations to generate positive revenuefortheirshareholders.Thepurposeofbusinessistomakemoney,not improve social conditions, even though some see the advantage of contributing to social causes (Aguinis & Glavas, 2012). Private enterprise is generally referred to as the first sector, government as the second sector, and NPOsasthethirdsector(JiménezEscobar&MoralesGutiérrez, 2012).Recently the Social Enterprise, SE, has emerged significantly contributing to social change work (Develtere & De Bruyn, 2009).
Social Enterprise:	An SE is a for-profit business founded and operated to generate revenue and improve social conditions, with increasing in number over the last decade (Defourny & Nyssens, 2010b) active and prospering in the developed as well as the developing world to address gaps in government spending. The conceptual social enterprise spectrum **Error! Reference source not found.** Shows location of the SE between for profit and not for profit, thus referred to as mixed in the enterprise spectrum.
Impact measurement, Social Enterprise and Blended Value	The author's literature search for a concept to assess the impact of social enterprise led to blended value; according to Anner (2016) there is a lack of imperial studies on impact measurement in SEs. Since the mid-1990s (Dart, 2004), Emerson (2003), one of the pioneers in the field , created the term blended value to describe the combined financial and social results generated by SEs; blended value accounting (Nicholls, 2009) is a generic term for the methods that can measure blended value. Blended value accounting is expected to offer multilevel instruments for management and transections for SEs with their numerous stakeholders relating to such critical issuesas Human, financial and reputational resources (Emerson 2003) in social enterprise..

DefinitionofSocialEnterprise

According to Grassl (2012) there is no agreed definition of social enterprise in literature; vague concepts, terminological varieties of social enterprise, philanthropy, non-government organizations, charity, third sector, usedwithsmalldifferenceorinthesamecontext;thetermreferstoorganizationalformsrelatingtothe non-profit, co-operative and even conventional business (Defourny and Nyssens 2010, Altre2007).

Santos rejects the dichotomy between economic and social outcomes and defines value in terms of increase in the utility of the society bringing clarity into organizations that create value and those that appropriate value; central to an organizations identity is their predominant focus on value creation or value appropriation. The formerasthemainfocuswouldmaximizeutilityfortheclientssubjecttosustainabilityoftheorganization,while the later would set the price of its product at the point that maximized its profit potential: arguing this as the differentiation of social entrepreneurship from commercial entrepreneurship.

For the purposes of this study, social enterprises can be defined as entrepreneurial organizations operating: economic purposes, creating surplus revenue for economic sustainability, and second, to create social value (Alter, 2007); a demonstrative example of a similar social enterprise is seen in the Victorian Government of Australia which defines SE as "as organizations that are driven by a public or community cause, derive most of their income from trade, not donations or grants and use the majority (at least 50%) of their profits to work towards their social mission. Example of this definition applied to context is seen in Australia's first-ever strategy for the social enterprise sector launched by the Victorian Government in February 2017 which identified four areas of action including increasing the impact and innovation of social enterprise, building business capacity and skills, and improving market access."[3]

Conceptualframework

When research questions are theory driven authenticity in a field is attainable, and quantitative approaches are mainly in data gathering and analysis (Cummings 2007). A variety of relevant theoretical and industrial relationships -Figure 1 Conceptual social enterprise spectrum,Table 2: Water supply governance modelcomparison and Table 4: Relevant concepts and their linkage to the social enterprise business model -have been usedfordevelopmentoftheconceptualframeofthepreliminarybusinessmodeldevelopedfromliteraturereview and shown in Figure4.

BusinessModel:

The importance of the business model for organizations are explained by Vanourek (2013) ,Amitt & Zott (2011) Margretta (2002) Business models can be defined as the basis by which an organization creates, delivers and captures value (Osterwalder, Pigneur & Tucci 2005). This proposal uses Business model canvas (Osterwalder, Pigneur2010,10)adaptedforsocialenterpriseemphasizingtheaspectsofvaluecreation,valuedeliveryandvalue capture in the Business Model with a focus on closing the gaps in the valuechain.

The business model (Figure 4) developed from theory and industry experience, forms the conceptual model for this research study. The business model canvas (Osterwalder, Pigneur,2010) modified by Massingham (2018) is adapted to couple with the water utility success factors feeding as the value capture indices from the bottom of the model. Meanwhile, value creation and delivery feeds from the top of the model to ensure sustainable performance together with realization of value for the stakeholders. The business functions that this model demonstrate depicts the importance of processes that the water SE has to perform. Need for capacity building, interagencyandmulti-levelcollaborationaswellasbusinessdisciplineisexplicitfromvaluecaptureparameters 3.1-3.9

covering both social as well as economic success indices. It is important to realize that this model cannot be functional outside a collaborative network of organizations built under an appropriate institutional framework as shown in Figure 10: Sustainable Water Service Social Enterprise NetworkLandscape.

Aside from providing a roadmap for generating economic value, the business model for a social enterprise also shows how to create social value in a measurable way (Lujanska 2015), (D.Mills-Scofield 2014). While building social business models relies on some of the same strategic moves as conventional business model innovation (Yunus & others 2009) taking account of all stakeholders, not only shareholders, and the need to define the social profit sets modelling of social business apart from that of a conventionalbusiness.

According to Osterwalder (2004) product, customer interface, infrastructure management and financial aspects are the main constituents of a business model. He then unpacks them into nine essential elements forming the core of the business model: value proposition, target customer, distribution channel, relationship, value configuration, capability, partnership, cost structure and revenue model. Description of the building blocks are giveninOsterwalder2004(p157).AsshowninFigure3thepositionofthebusinessmodelisinbetween strategy andthebusinessorganizationlinkingbusinessstrategytofinancialvalue(Meyer2007),Osterwalder(2004).

This points to the importance of considering external as well as internal environment in developing the business model.

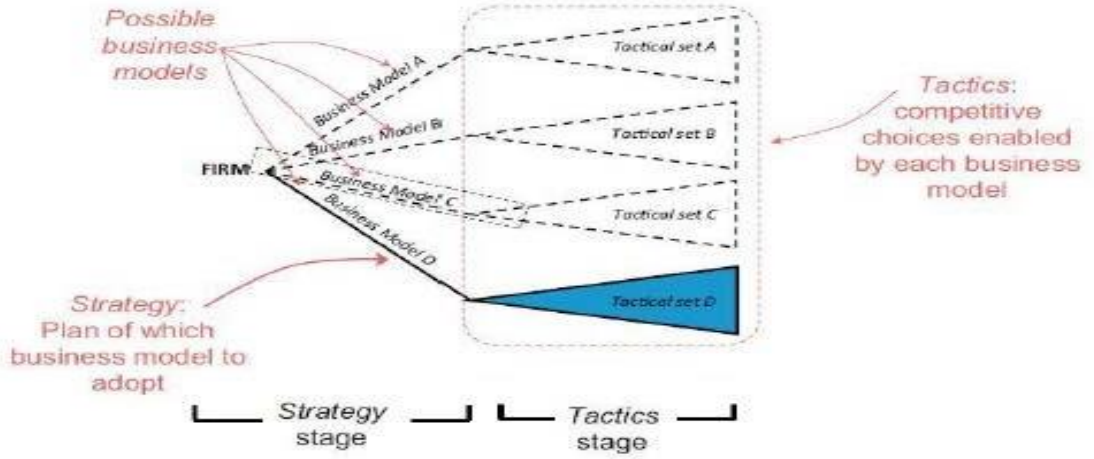

Figure 3: Location of business model among strategy and tactics source: Casadesus-Masanell et al.(2010, p204)

Osterwalder 2004 (P 157) with graphical representation allowing comparison among different business models or model trials in business model design. This tool could be used for content development for stakeholder data collection in this study.

Rural water supply sustainability can be characterized by institutional (organizational), social, environmental, technical and financial dimensions. Sustainable water supply services need interaction of community participation, external collaboration and technical support Water Aid (2011) Interdependent, interactive collaboration is crucial for sustainable water services requiring all stakeholders including communities, Non- Governmental Organizations (NGOs), and government officials and the private sector engage in roles (Harvey, Reed&Skinner2002)inorderfortheoperationtobesustainable;communitymembersneedtotakeresponsibility formakinginformedchoicesregardingparticipationintheprojectactivities,willingnesstoshareprojectcostand commit to contribute as shown in Figure 10: Sustainable Water Service Social Enterprise Network Landscape and Table 1Main actors and value addition of thisresearch.

Identity

With Social problem identification, assessment of identity and value system of the business leading to a vision and mission will guide the way to business modelling which can be used to justify financing the venture; obtaining financing being one of the biggest hurdles (Yunus 2010) in starting and running a social business. Raising finance from various sources will be affected by the legal, regulatory environment, form and purpose of the firm. Therefore identity of the venture as a social enterprise set up to deliver water, a social good and a basic human right will harmonize with the values of integrity, transparency, equity for sustainable community livelihood. Thus sustainable water and sanitation for all is an appropriate vison for theventure.

1. VALUE CREATION							2. VALUE DELIVERY
1.1 Business Entity: Water Social Enterprise							**2.1 Customer Segments:** Domestic, commercial, institutional, industrial water users
1.2 Core Activities: Water Distribution, Wastewater collection and management							**2.2 Superior Value Propositions:** Leave No One Behind, WS, WSP
1.3 Core Values: Integrity, Accountability, Transparency	**1.4 Enthusiasm:** for livelihood improvement and sustainable development, contribute to development of the local water sector						**2.3 Customer Experience end to end:** Stakeholder relationship management, transformative leadership, fair dealings, unaccounted for water management, best practice in procurement, operation and maintenance, infrastructure asset management
1.5 Resources: Financial, Infrastructure, HR, technical knowhow							**2.4 Stakeholder** (customer, partners, venders, management staff, employees) **Process:** Relationship management
1.6 Networks: Donors, philanthropists, Banks, Venders, Engineering and Management Professionals							**2.5 Channels:** Potable Piped water distributed to households or community tap bays, Wastewater connected to individual homes and buildings.
1.7 Partners	1.8 Collaborations						
1.8 Risk Management: Water Safety Planning, Water Security							
3. VALUE CAPTURE							
3.1 Sustainability, Social mission	3.3 Cost	3.4 Budget	3.5 Revenue streams	3.6 Cash flow	3.7 Economic Sustainability Margin	3.8 Customer Value	
3.2 Sustainable Development Indicators	3.9 KPI: Financial, Operational						

IDENTITY:

Mission
Vision

Strategic Intentions: Improve human livelihood & social development in Small island communities

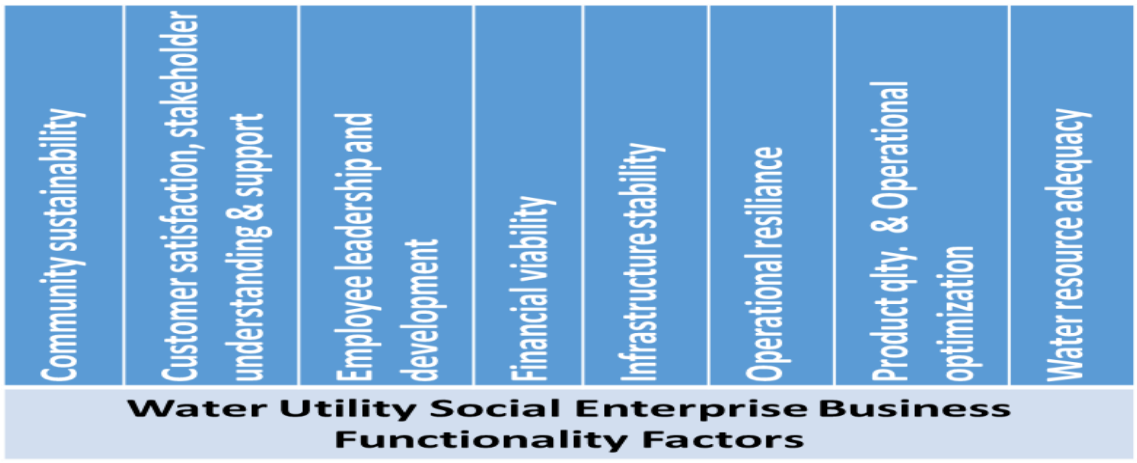

Figure 4 Sample Business model of Water Utility Social Enterprise source: adopted from DBA seminal works of Massingham 2017

Table 5 Theories of relevance to specific interest themes for addressing the gap in water access for small island communities in the Maldives

Author	Title	Relevance	Specific interest themes
Coupet J. 2017	Integrating Organisational Economics and Resource Dependence Theory to explain the persistence of quai markets	Performance of profit seeking public service areas with the understanding that for profit organisations will deliver public services more efficiently than the government can.	Agency theory, resource dependence theory, transection cost theory, probity hazards, theory vs. reality, agency theory and public organisations, property rights and public organisations
Tan, J. (20015)	Water privatisation, ethnicity and rent seeking: Preliminary evidence from Malaysia	Promotion of infrastructure and water privatisation in Malaysia despite the failure to increase capital investment and improve efficiency	Performance of private firms in water sector
Santos, F. Pache, A. & Birkholz, C. 2015	Making hybrids work: Aligning business models and organisational design for social enterprises	Societal impact creation by hybrid organisation with a social mission using commercial business model	Managing hybrids creating both societal and economic impact avoiding mission drift.
Luzon, PhillipinesAbansi, C.,L. 2016	Beyond prices: The cultural economy of water in the Cordillera highlands of Nothern Phillipines.	Cultural economy of water, new modes of decision making on water source management providing inclusive, equitable and ecologically sustainable outcomes.	
Chetty, S., Luiz, J.,M. 2014	The experience of private investment in South African water sector: The Mbombela Concession.	Enhanced delivery of services associated with private investment. Management structures, capital expenditure, fiscal control, and economic efficiency, improved efficiency vs need to pursue social outcomes.	

Valuecreationandvaluedelivery

This study will examine how to operationalize value creation and delivery in providing access to water and sanitation in small island communities in the Maldives via a social enterprise using business model innovation.

The study considers gaps in the current water utility PPP model operating in the main cities as well as gaps and provisions in the sustainable development goals in relation to Goal6. Value is created through finding ways to fill value gaps and constraints by matching opportunities created by SDG provisions as shown in Elder's (2016) classification of the SDGs into function groups, as shown in Figure 6;interlinkages between the different goals Figure 5also illustrating how a social enterprise operation at the bottom of the pyramid can support the implementationofSDG6(waterandsanitation)andSDG17(meansofimplementation)inparticularwith aforprofit function drawing the knowledge and resources of the spectrum of stakeholders covering government, private, civil society, media, development partners, donors and academia

consistent with SDG targets set for 2030 (Figure10).

Social value creation for water utility social enterprise

Creating value means knowing the target customers well. CSOscanconductformativeresearchtobetterunderstandwhatcustomersvalue,andtheycanusethisunderstanding to inform how they work with new or existing enterprises. User-centered design principles may be helpful. For social enterprises, value propositions may be strongly focused on achieving a social purpose. For instance their objective may be to create value through serving the poor anddisadvantage

ValueProposition

The service operator will need to function at the professional level as that of any water utility, say for instance the water company, Male' Water and Sewerage Company providing service levels appropriate for the community, in accordance with EPA water quality guidelines, and own Water Safety Plan set in alignment with SDG6 and IWRM in particular.

EnablingandacceleratingprogressonSDG6

SDG 17 (Strengthen the means of implementation and revitalize the global partnership for sustainable develop- ment) offers a framework for enabling and accelerating progress in all aspects of SDG 6, including the challenging issues of IWRM and eliminating inequalities, which will be essential for achieving SDG 6 and leaving no one behind. Means of Implementation (MoI) for water and sanitation include governance, finance, capacity development and data acquisition and monitoring. These are interlinked, and effective policies in each activity are mutually reinforcing. They are all essential elements in meeting SDG 6 targets.

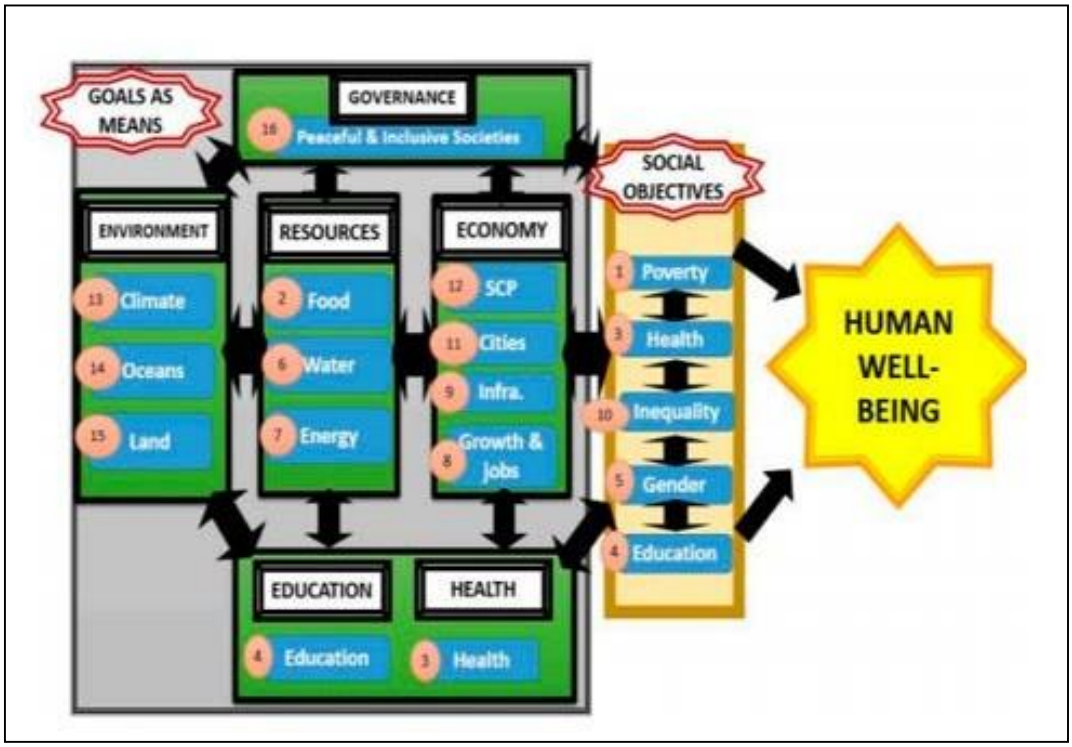

Figure 5: Interlinkages among SDG goal functions
Source: Elder 2010, p16

Goal Categories		Corresponding SDGs
1.	Social Objectives	• Poverty Reduction (Goal 1) • Health (Goal 3) • Education (Goal 4) • Gender (Goal 5) • Inequality (Goal 10)
2.	Resources	• Food (Goal 2) • Water (Goal 6) • Energy (Goal 7)
3.	Economy	• Growth and Jobs (Goal 8) • Infrastructure (Goal 9) • Cities (Goal 11) • Sustainable Consumption & Production (Goal 12)
4.	Environment	• Climate (Goal 13) • Oceans (Goal 14) • Land (Goal 15)
5.	Education	• Education (Goal 4)
6.	Governance	• Peaceful and Inclusive Societies (Goal 16)

Figure 6: SDGs classification in function groups
Source: Elder (2016,p12)

Water is critical for socio-economic development and human survival and justifiably occupies a central position in the SDGs. According to SDG 6 Synthesis Report 2018 on Water and Sanitation countries must tackle weak funding, planning, capacity and governance of water and sanitation services as a top priority. New partnerships are needed, of stakeholders within and beyond the water and sanitation sectors, to address these issues, balance competing needs to attain SDGs by 2030.

ValuedeliveryforallStakeholderthroughwideconsultatio

n,public participationandcommunityengagement

Public participation includes the use of procedures and methods to inform, consult and involve local communities and citizens (OECD, 2015). Participation means that stakeholders play an active part in decision-making.

Community participation is a key component of increasing sustainable WASH service provision, particularly in rural areas (SDG targets 6.1 and 6.2), and also for IWRM (target 6.5).

Achieving this can contribute towards increased participation of women in political, economic and public life (target 5.5), and empower and promote social, economic and political inclusion (targets 10.2 and 10.3). It can also contribute towards ensuring conservation, restoration and sustainable use of freshwater ecosystems and their services (target 15.1) and ensuring responsive, inclusive, participatory and representative decision-making at all levels (target 16.7). Policies to promote and incorporate public participation in water and sanitation management were considered so important that an entire target was dedicated to stakeholder participation. Water SE owned by water users can help increase quality and the extent to which

participation is effective. water user associations.

Target 6.b aims for the participation of local communities in water and sanitation planning and management. This is essential for ensuring that the needs of local users are being met and that the impact of development decisions is fully understood by local communities.

Participation implies provision of mechanisms to enable affected individuals and communities to meaningfully contribute to decisions related to water and sanitation planning and management. This can promote "local ownership" and lead to long-term sustainability of services.

Stakeholder engagement, which implies, beyond civil society, the involvement of several actors such as governments, the private sector, regulators, service providers, donor agencies and investors. Effective and sustainable water and sanitation management depends on the participation of a range of stakeholders, including local communities, which is the focus of target 6.b.

It is essential in any business that value creation is for the entire chain of stakeholders, including customers and shareholders. Operating at the base of the pyramid creating and delivery value for the customers or BOP consumers, beyond just focusing on profiteering as in the case of capitalist ventures abolishes the perception of selling to the poor, while empowering the people at the BOP as entrepreneurs by providing them with economic and social opportunities for mutual growth and linking them to developed markets.

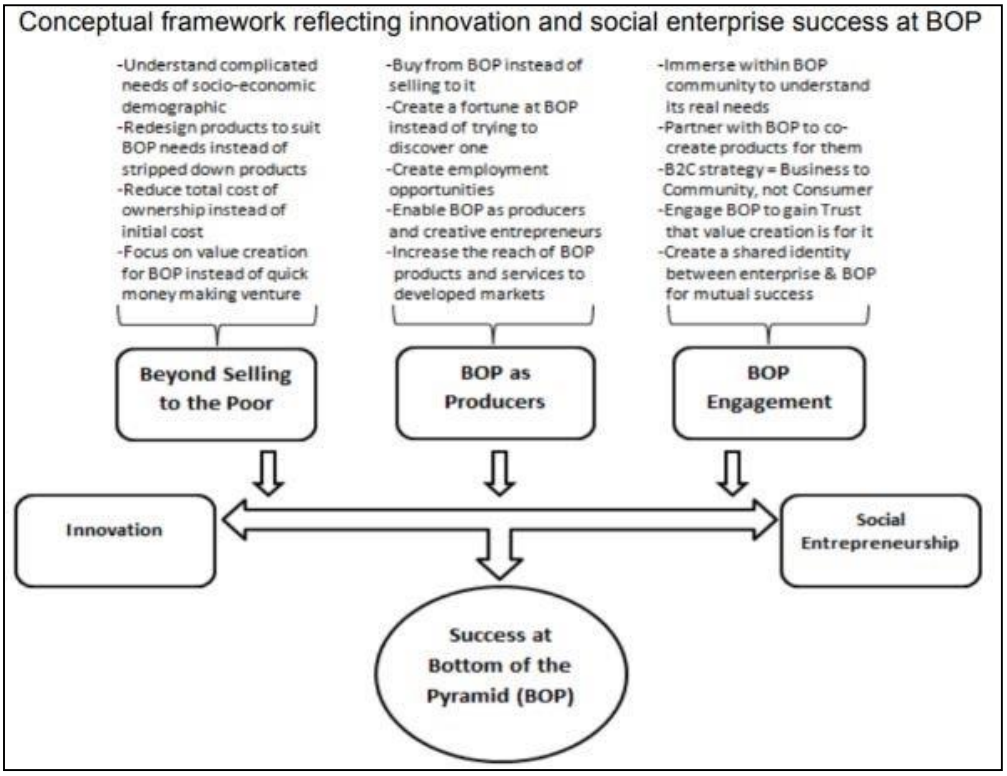

Figure 7: Conceptual model reflecting innovation and social enterprise success at Bottom of Pyramid.

The enterprise embedded within the BOP community will have the ability to fully understand its needs, develop trust and a shared identity with the potential consumers to co-develop for their needs so that the value offered is perceived as a successful value proposition co-created as an economic and a social success by both BOP and the enterprise.

The proposition, therefore, is **"creating fortune at the bottom of the pyramid"** based on mutual social and economic for the stakeholders in the value chain *Figure 10*. This eventually results in remarkable economic returns for the enterprise as well as the water sector in the Maldives. To be sustainable, the service needs to be designed to give the chosen market access to an otherwise unattainable experience. This can only be truly achieved by complete engagement of the three social enterprises illustrated in *Figure 10* with the water utility service operating firm or entity delivering performance as shown in the bottom of the business model *Figure 9*.

SocialProcurement

Procurement is the mechanism throughwhichorganizations purchase of goods, services and works by with their resources. Social Procurement are being used to drive systemic change, As the profession of procurement develops, it is increasingly moving from an administrative role into a strategic one, employing new approaches to achieving organizational objectives in the way funds are expended in the supply chain. Through social procurement, private and public sector organizations seek social and local economic objectives, in strategic procurement. Elements of a strategic framework developed for G21 Regional Opportunities for Work is shown in *Figure8*.

Social procurement is essential for sustainable operation of the three proposed social enterprise entities embedded in the Figure 10: Sustainable Water Service Social Enterprise Network Landscape.

Launched in April 2018 the Victorian Governments Social Procurement Framework sets out a whole of government approach for engaging in social procurement. Victoria's Social Procurement Framework aims to ensure that government procurement ensures value-for-money considerations are not solely focused on price, but include opportunities to deliver social and sustainability outcomes that benefit the Victorian community.

Figure 8: The Broad Elements of a Strategy for Developing Social Procurement Source: Newman (n.d.),p13

Strategic revenuemodel

The revenue model will be built upon mechanism in the water sector: design consultancy contracting firms and infrastructure construction contracting firms. These firms currently are profitable and are mostly international firms. A water utility social enterprise starting in a small community island would not be able to generate substantial revenue from its core activities. However resource leveraging and capacity building followed by operational license awarded under a social procurement regime to be developed by the Government, funding from water and sanitation trust fund to be created by the Government or Civil Society and social enterprise design firm and social enterprise contracting firm - profits of both of which are donated for the social enterprise utility firm until capacity is developed for scaling up to undertake trading activities of operating water schemes in revenue generating communities- the SE water utility will become economically sustainable while delivering the socialobjectives.

Upon breakeven the water utility SE would operate as a self-sustaining water utility service provider using the profits for scaling up and market expansion. It is hoped that this model would out compete the conventional PPP utility companies or drive them to adopt the social enterprise model as in the case of microcredit financing initiated by Yunus (2008)

Business Model Elements	Challenges/Barriers	Opportunities for SE for Value creation	Opportunities for SE for Value delivery as social impact	Opportunities for value capture for economic sustainability
Identity	Lack of inter sectoral collaboration for water service delivery, current water service models are commercial and profit oriented with customer service ignores even in Communities that can afford the service.	Social enterprise cantered on livelihood improvement of the community operating with the same technology as the corporate sector with the difference: shareholders do not benefit but pass the benefits for improving and scaling the service. on trust, values and philosophies on which the social enterprise and sustainable development goals are founded such as human rights, poverty elevation, equity, gender equity , transparency and integrity and good governance.		
1.1Business entity	Social enterprise/ social business : three tiered into independent entities (consulting, contracting, operating-service provisioning)			

1.2 Core Activities a.Contracting-Water System Design and consulting: b.Contracting-Water Infrastructure Building c.Operating and service provision of water schemes under government lisence	SE is a new concept. Institutional facilitation is needed to scale yet Company Law and Cooperate law as well as NGO regulation is sufficient to start the social enterprise.	**SDG 6: Ensure availability and sustainable management of water and sanitation for all** 6.1 access to safe and affordable drinking water for all, 6. access to adequate and equitable sanitation and hygiene for all,6.3 improve water quality, 6.4 increase water-use efficiency across all sectors , 6.5 implement integrated water resources management, 6.6 protect and restore water-related ecosystems, 6.a expand international cooperation and capacity-building support to developing countries in water and sanitation related activities and programs, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies, 6.b Support and strengthen the participation of local communities in improving water and sanitation management **SDG 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development** 17.1 Strengthen domestic resource mobilization, 17.2 Developed countries to implement fully their official development assistance commitments, 17.3 Mobilize additional financial resources for developing countries from multiple sources, 17.4 Assist developing countries in attaining long-term debt sustainability through coordinated policies. **Technology** 17.6 Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing ,17.7

		Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries **Capacity-Building** 17.9 Enhance international support for implementing effective and targeted capacity-building in developing countries **Multi-stakeholder partnerships** Encourageandpromoteeffectivepublic,public-privateandcivilsocietypartnerships, building on the experience and resourcing strategies ofpartnerships **Data, monitoring and accountability** By 2020, enhance capacity-building support to …..small island developing States, to increase significantly the availability of high-quality, timely and reliable data ,17.19 develop measurements of progress on sustainabledevelopment		
1.3 Core Values	Transparency, integrity, equity	Co-creation, engagement	Trust, learning, building institutional capital	Reduce transection cost of contracting manageable works to private sector/external parties with the potential to add probity hazard.(Williamson 1991)
1.4 Enthusiasm	Enthusiasm for social initiatives in the water sector is not visible in the communities	Engagement in the SE and resulting social benefits can be a driver for innovation, risk taking, pro-activeness, positive interactions and network access (Pearson et al., 2008).		
1.5 Resources	Shortage of social capital in the water sector			

1.6 Networks	Local cooperatives, NGOS, foundations are not seen to have wide networks. Rather there is competition among Them.	Donors, philanthropists, banks, venders, professionals, development partners, INGOs, local NGOs, private sector can be mobilized under SDG initiative.	Access to funding sources to finance the initial costs of starting up and also scaling up in future. Professionaladvise and acceptance among the

1.7 Partners		Government, academia, INGOs, international and regional Water networks, Institutes promoting SEs.	Global SE networks will help increase credibility opening doors to finance and social capital.
1.8 Collaborations	Currently institutions of the water sector work as silos.		
1.9 Risk management	Unavailability of finance for operation of the water scheme due to mismatch between affordability and cost of Operation.	Financialrisk:SocialenterpriseorganizationstructurewouldhaveContractingandConsultingas two independent firms operating in accordance with corporate norms but give away 100% of the profits to the operatingcompany. Governance risk: To be mitigate through collaboration of government by developing an Appropriate institutional framework encamping all stakeholder organizations.	
2.1 Customer segments	Community , industries such as farming, fisheries, tourism and institutes such as schools, hospitals/ heath centers/health posts etc.		
2.2 Superior value proposition	Enabling and accelerating progress on SDG6 Value delivery for all Stakeholder through wide consultation, public participation and community engagement Social Procurement		
2.3Customer/community experience end to end	Co-creation and Production by customer, value chain elements linked by commitment and engagement through motivation using SDGandSEtoolsandresourcescombinationbasedontrust,valuesandphilosophiesonwhichthesocialenterpriseand sustainable developmentgoalsarefoundedsuchashumanrights,povertyelevation,equity,genderequity,transparencyandintegrityandgood Governance.		

2.4 Stakeholders	Community, private sector, civil society organizations, government, media, academia, development partners, donors, the three component social enterprise entities proposed by this study: social enterprise contracting firm, social enterprise consulting firm, social enterprise operating firm
2.5 Channels	Contracting Social Enterprise: Secure contract for development of water infrastructure from the government Consulting Social Enterprise: Secure contractors for development of water infrastructure from the government Service operation Social Enterprise: Secure license to operate water schemes develops by above two entities from the government
Revenue model	Strategic revenue model. The Water Utility SE will initially be supported by a for-profit water and sanitation design consultancy firm and a for profit water and sanitation infrastructure construction firm as well as a trust fund until revenue generating water

	Related trading activities can be undertaken to become economically sustainable in order to scale up. This strategy would require changes in procurement policy to embrace social procurement, establish a trust fund as well as social entrepreneurship, social leadership and culture change as described in section 3.5.4
Social Impact	Blended Value model will be used to assess total impact inclusive of social impact.

Figure 9: Business model element matrix design, Source: (Author 2018)

2 DiscussiononNegotiatingBarrierstoincreasewateraccesstosmallcommunitiesvia socialenterprisebusinessmodelinnovation.

The business model element described in Figure 9: Business model element matrix design, Source: (Author2018)Figure 9 is illustrated in Figure 10 as Sustainable Social Enterprise Water Service Network Landscape which was drawn up based on the six key aspects of business model innovation shown in MITSloan Management review (Amit 2012): Customer needs. Activities to satisfy the needs, interlinkage of activities, actors to perform them, value creation for stakeholders, revenue and impact model. The linkage of services, resources and contracts (trading opportunities given by one entity to the other to help each other in the network based on competency to transfer benefits based on which entity is set up and able to provide service at the lowest transaction cost, so that the benefits can be transferred to the contracting SE that is at the bottom of the pyramid, sometimes unable to recover costs of operation due to low affordability of the community being served. The community is able to receive value by getting jobs intertwined with capacity building and training (by the network of consulting and the contracting company, academia, government, private sector and international NGOs within the network). The user employees will get paid at industry rate from the earnings of the trading activities of the consulting and contracting social enterprise as well as a Trust Fund that will take care of financial risks as well as startupcosts.

This business model concept was drawn based on challenges and opportunities described below via business model innovation; converting a profit maximizing model into a social providing ownership to the water users as in Type II social business (Yunus 2010). The ingredients needed for operationalizing the SE business model are

ChallengesfordevelopmentofsocialenterpriseintheMaldives

Water service social enterprise in the Maldives let alone SE in any sector is unheard of. At the outset it is important to define SE in the context of the socio economic environment of Maldives as well as determine the current challenges relating to policymaking and governance, need for institutional and operational support. Until now there has been no comprehensive attempt to describe the extent of social entrepreneurship in the Maldives and to identify methods to encourage successful innovations at both local and regional levels. It is important for the stakeholders to initiate public dialogue of what policies and practices can better enable social enterprises to start and scale with a focus on the water sector. The baseline situation can be understood by casting a wide net covering all nonprofit entities such as NGSs, foundations, cooperatives operating to achieve social objectives.

LackofenablingenvironmentforsocialenterprisesinMaldives

Social entrepreneurs have pioneered innovative and sustainable solutions for a variety of economic, environmental, and human development challenges in the regional countries. Such awareness among national policymakers and stakeholders would lead them to understand the importance of creating an enabling environment to support the growth of such initiatives in the Maldives. Corporate leaders, educators, philanthropists, donors, and investors seeking ways to apply their strengths and resources to support these efforts need to be led not only by the CSOs but by the

government as well in collaboration creating a conducive environment for the third sector to play a defining role in shaping the social enterprise sector.

Policyandgovernancechallenges

Extent of institutional and operational support, social and cultural awareness and recognition of their work needs to be determined; status of current laws would help entrepreneurs positively use the provisions to create income- generating activities for sustainability. As communities progress the service levels of water utilities need to be stepped up; community based water supply systems need direct policy support of governments in order to be sustainable. Involving users in the operation and management of their own water and sanitation services yields long term sustainability and driven operation. Under favorable policy environment benefits of multi sector collaboration- as shown in Figure 10 Figure 9- could be harnessed for training, capacity building, upgrading water schemes as well as scaling up the operation to other communities.

Lackofaccesstofinance

Many of the local NGOs and cooperatives rely on funding from international donors and private sector note the difficulty of securing funds for their core operations and activities from these donors. Since funding tends to focus on short-term project financing, the sector's ability to engage in long-term planning, develop self-sufficiency, to achieve sustained impact is limited; ways to overcome this constraint needs to be determined and made such activities part of the promotional programs of the social enterprises. A better understanding of access to fiancé, constraints and opportunities will avail strategies to overcome them individually as well as collectively among the social sector and also incentivize potential social entrepreneurs join such initiatives.

According to Means of implementation of SDG analysis report of Elder (2016) MOI (SDG17) should be considered in a broad sense, with much more emphasis on capacity building and governance rather than a narrow focus on finance. Elder (ibid) also points out how closely that the goals are interlinked and that they could be implemented using an integrated approach that will help produce cost-saving synergies, and avoid cost-increasing trade-offs.

The overall costs of SDG are modest and affordable, especially when compared with relevant global financial indicators such as GDP and wealth; that financing should be considered as an investment rather than a cost, and view the benefits and investment returns rather than just the initial spending amount; recommending countries to prioritize capacity building, especially for governance. Spending for capacity building is significantly less than initial investment outlays for sustainable infrastructure; it directly creates jobs. Strengthened capacity and governance will greatly increase the efficiency and effectiveness of spending and investments.

On increasing finance Elder (ibid) recommends to reprogram existing spending and investment from unsustainable to sustainable activities and that countries can use regulation to mandate private companies to make these shifts.

Shortageoftechnicalsupport

NGOs and cooperatives have limited access to technical support, in fact is a general understanding in the sector that the existing NGOs and cooperatives are in competition with one other for the little funding that is available from local and international donors. To enable social entrepreneurs to flourish, wide-ranging collaborations with the private sector and more meaningful support is needed. This research would undertake a survey of the current situation.

Community Water Initiative (CWI), launched by (UNDP) in 2004 supports decentralized, demand-driven, innovative, low-cost, and community-based water resource management and water supply and sanitation projects in rural areas; the understanding is that local management and community initiatives play a key role in ensuring and sustaining water supply and sanitation services to poor communities.

WI channels funds directly to local communities in need of support; also focuses on building local community arrangements and capacity for developing, maintaining and expanding new systems to ensure sustainability of the benefits. It mobilizes local leadership and participation of community women in local water management institutions as well as training local people in maintenance and repair. Management committees or groups have been established and continue managing water systems beyond the completion of the projects, instituting user fee arrangements, as appropriate, to ensure financing for management, maintenance and repair.

Lack of Engagement of Education System, Academia and Promotion of Media

Educational systems and social norms in the Maldives need to create an environment that encourages innovation and draw young people towards acting assertively and creatively on the challenges they face. Academic institutions have yet to capitalize on this growing field of study and to integrate its ideas, impact, and potential in their educating and research programs to partner with CSOs in co-creating solutions for building resiliency in water in the face of climate change and rapid urbanization. Media's role can be enhanced and channeled with a focus of social enterprise through purposive programs of the third sector using social media and mobile technology. Media can also be used for advocacy to channel private sector CSR spending towards to be more meaningful and not a marketing tactic.

Need for wider engagement of CSOs

There is only one NGO active in the water sector. However, in the context of the extent to which SDGs have provided commitment of countries for encouraging participation, engagement, inclusion and capacity building of the third sector there is much that can be done establish stakeholder networks, support regimes and assistance by the government, private sector, regional and international NGOS as well as the development partners as elaborated in the section on SDGs.

Start-up and operation challenges

A social business is more challenging than a conventional business: the business must be responsible and committed to follow social goals without harming anyone, sustainable for the longer term minimizing environmental impact. It should not create more problems while solving one as is the case of the global corporate sector.

A social business may start small since it is simpler to run with the pilot project yielding information from finer adjustments enabling expansion as the capacity for engaging more resources become feasible. The reward is the potential to change lives for the better as well as the fabric of our social and economic systems for creating a sustainable way of living.

Leadership

A social entrepreneur, as an important representative of the social enterprise, holds the key to organization's survival. Social enterprise performance effectiveness research in Korea revealed that the behavior of the social entrepreneur is a success factor (Shin 2018); openness and innovativeness of the leadership favors social and economic performance of the enterprise; Shin (2018) believes that these qualities can be taught. He also holds that Institutional support by the government is also needed to educate and train active social entrepreneurs; without which external support such as tax relief and labor expenses support do not show the intended impact.

Opportunitiesforcreatinganddeliveringvaluefromthevaluechai nin business modelinnovation.

> "I see now a new breed of people. Thinking-feeling individuals who look a problem in the eye and declare war.
>
> These people think like entrepreneurs but feel and work for cause of society.
> And hence they are social entrepreneurs." Bansal 2011

Social business, although a new idea has impulses such as creativity, entrepreneurship and desire to make world a better place is familiar to everyone. "And those feelings are all you need to want to start a social business" (Yunus 2010, p57).

The social enterprise business plan is basically same as that of any other business. It would have employees, mangers, customers and suppliers. It will offer goods or services at attractive market rates. It should cover investment recovery, day to day expenses, pay roll and rents. More than how to do a business, desire to solve a social problem is needed on the part of the owners, established business knowledge sometimes have been seen as counter-productive in SE context. The social business is not about competition and profit maximization or growth for the sake of growth. (Yunus 2010).

Bilateral and multi-lateral donors instead of giving a grant or a loan to the country to build water supply infrastructure, donor could create a " water engineering firm" owned by a trust created for the purpose mandated to ensure operation of the water firm efficiently making a profit . The trust will use the profits to operate the water infrastructure to improve the water access and quality of life of the community. The operation can be scaled up to cover other communities. Existing water companies can also be converted into social businesses in the same model of ownership. The trust would own the company could manage the firm directly or through a management contract with another entity. Examples cited by Yunus are Otto Grameen Trust and another set up with Uniqlo, the Japanese clothing company (to be researched).

PoolingresourcesandlinkingsupplychainlogisticsofBusinessModelElements

In order to engage sustainable value creation and delivery a useful approach could be to identify gaps in performance using SDG 6 as a skeleton so that the solution drives implementation of SDG6 and related goals. This would also open avenues to tap into opportunities provided in the SDG 6.1, 6.2, 6.5 and 17 in particular.

Partners: The SE may start as is the case often with one person or a small group of colleagues who share the same social problem. The necessary expertise that may be lacking in the group can be acquired through joint venture partners who may be profit driven as in the case of Grameen startup with Danone, Veola Water and adidas.

Apartnership between a social enterprise and a company seeking profit maximization is uncongenial in the way of mixing partners with different and sometimes conflicting (Yunus 2010,) goals. Examples of the kinds of organizations and SE can partner with are: another social business, an investor, technology partner, production partner, human resource partner, distribution partner monitoring partner (Yunus 2010) .

Attracting talent: The SE has to attract talent from the same market that the profit enterprises tap into. So competitive salaries and benefits have to be offered. The personal rewards are even greater according to Yunus (2010), based on his own experience. SEs attract talent by inspiring people and offering meaningful work. Cultural shifts are also favoring SEs in securing talent with students now looking for work life balance and meaning (Bornstein 2010).

In contrast, social businesses enjoy the advantages of control, innovation and creativity of the conventional corporations with added motivation to achieve social goals. Yet SEs also face market competition and risks as the corporate sector to innovate and create to be relevant in a dynamic societal and economic environment.

This seems to be the reason why society as well as Governments are encouraging centralized social experimentation on a large scale. Helping scale up creativity and agility and operational excellence of social enterprises combined with resources and legitimacy of governments as well as technical knowhow of the corporate sector as in Singapore.

Financing: Recruitment of funders, board members, staff, Classmates, family, friends, professionals requires funds; the biggest hurdles of a social enterprise venture upon launching is finance (Yunus 2008). Funding activities and bases of support can initiate competitions, cultural events, open houses, bartering arrangements, membership programs, activist television and radio shows. *Table 6* lists programs offered by various social organizations. Today entrepreneurs and investors are to combining various types of financing such as grants, equity, soft loans, commercial debt to maximize social impact. Good Capital, Gray Matters Capital, KL Felicitas Foundation, Investors' Circle, Intellecap, Bridgfes Ventures are examples of blended value of "impact investors" targeting social enterprises. (Yunus 2010). Blended financing has the potential to drive a new industry to develop impact assessment tools, new financial products, Social Investment Exchanges. An example is Impact Investment Exchange Asia (IIX Asia) supported by Singapore Government, ADB and Rockefeller Foundation. The Acuman Fund, anon-profit venture capital firm pools grants and create loans and equity investments in firms delivering water, housing and energy to unserved markets in developing countries. Development of tools to assess risk and impact is necessary for these investment markets to expand among the cross over institutional arena which are not well understood according to Yunus (2010).

Table 6: Fellowship and prize programs offered by social entities

Institution	**Value offer**
Reynolds and Skoll Foundation	offer university fellowships
Echoing Foundation and Draper Richards Foundation	Provide start up financing
Ashoka	Supports SEs from launch to maturity
New Profit Inc., Skoll Foundation, Jensis Group, Venture Philanthropy Partners	Provide growth funding
Several other foundations	Provide support to SEs without explicitly targeting them

Source: Yunus 2010

For profit investors hesitate to invest in organizations seeking social returns. Similarly grant makers have concerns when applicants want profit even for economic sustainability of the venture. The Low profit limited liability company of L3C is intended to simplify the investment process for social purpose while complying with IRS rules in USA. The equivalent in the UK being Community Interest Company (CIC).

Thankyou Australia, a social enterprise started out as an idea among school friends led to a small business in the parents garage, now grown into a thriving SE challenging " the very fabric of the capitalist global business model." (Flynn 2016,p12); a bold idea of a start up by a group of kids with no money, no qualifications, and no business experience. However, " between 2011 and 2013 the business grew significantly.. we were able to fund access to safe water for over 56 000 people through nearly 4000 water solutions implemented in over 100 projects in 15 countries." (Flynn 2016,p129) out of more than 35 Thankyou brand products "our water range exists 100 percent to fund water projects…. all with the aim of empowering communities around the Globe." The products are retiled at major supermarkets –Coles, Woolsworth, Foodland and several other outlets in Australia.

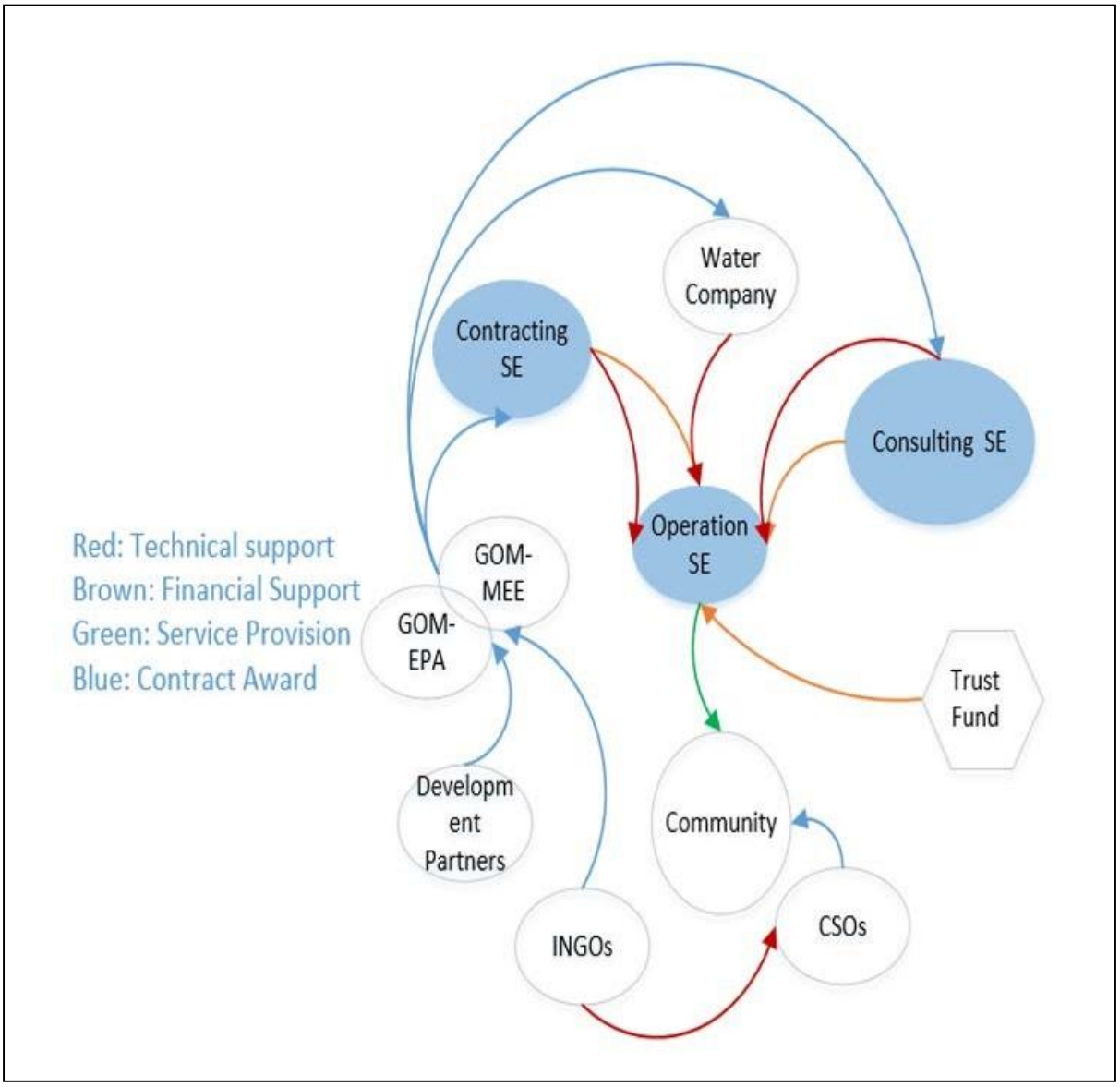

Figure 10: : Sustainable Water Service Social Enterprise Network Landscape

Source: Author 2018

Impactmeasurement

Elder (2016) in his report on means of implementation of SDGs argues that impact assessment can be used to shift both existing and new regulations to support shifting current government spending based on sustainability budgetary assessment and sustainable public procurement policies. Making these shifts happen requires improving governance. The assessment involves multiple stakeholders with different stakes, goals and value creation abilities in the business model. How this assessment is performed in a meaningful manner presents a challenging task for practitioners and researchers

The United Nations' "World water development report 2016: water and jobs" demonstrates that water is related to several other SDGs, including Goal 8, which addresses the promotion of sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Investments in safe drinking water and sanitation have been shown to foster economic growth, with high rates of return. The recent Evaluation of the ACP-EU Water Facility gives some examples of direct jobs creation.

Neglecting water can have potentially catastrophic impacts on economies and livelihoods, and could reverse hard- won gains in poverty reduction, job creation and development. That's driving a need for imaginative solutions. https://europa.eu/capacity4dev/articles/water-becomes-priority-economic-development

December 2017, the Centre for Social Impact at Swinburne University released the Map for Impact research report and website. The report, commissioned by the Victorian Government, detailed the influence that the social enterprise sector is having on Victoria's economy and society. Key findings from the report include the fact that there are now over 3,500 social enterprises in Victoria, employing 1.8% of the workforce and contributing over $5.2 billion to the economy. Map for Impact website, maps the physical location of social enterprises throughout Victoria. 75% of Victoria social enterprises think that their biggest opportunity for growth is social procurement. 50% of Victoria's SE are led by women.

Conclusion

The literature review and industry knowledge led to development of a social enterprise (SE) water service utility concept model that will be management and operated by a user group at the bottom of the pyramid, led by an entrepreneur(s) facilitating co-creation and delivery of value created for livelihood improvement.

The enterprise is designed to be economically sustainable within a network for-profit enterprises, 100% of whose profits are given to fund SE's initial day to day operation, capacity building and scaling the operation to financial self-sufficiency from trading activities. The trading activities being water provision in urban communities that have demand for, higher service levels with matching affordability. The government's role would be to develop policy and guidelines on procurement promoting the SE network firms to secure contracts for design, consultancy and operation as shown in Figure 10.

The next step is to test the enterprise model based on exploratory research. Coupled with impact assessment the hypothesized SE can be tested and improved to the extent that creative innovation is made to fit the external environment and the market, entrepreneurs are incentivized to engage along with the other stakeholders to fill the gap left by existing public and private mechanisms for providing water access to small communities in the Maldives.

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Improving access to safe water and organic food by use of solar energy in Thar Desert (a model of participatory management of water supply with innovation of water metering Thar Desert)

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Abstract

As we know that water is the main problem of world and human life is closely linked with water and water is the founder of civilizations. This study focusses on the water problem of Thar in Sindh, province of Pakistan and it also focuses on the issue of water and problems faced by the population and its solution. Further study shows that lack of access to water is one of the main problems of the local population. Scarce and contaminated groundwater is the only source of water for humans and animals' consumption. The villagers have to collect water from wells and fetching water from 200 to 300 deep well needs a substantial energy to get 50 to 60 gallons of water out. Mainly women and children have to collect water with the help of animals and it takes hours to fetch water. There is more risk of arsenic and fluoride in scarce groundwater. Overall, the region suffers from contaminated groundwater, which brings health consequences for people. The fluoride content of water is usually one part per million (ppm), in many areas of Tharparkar it is 13 ppm. This can lead to dental fluorosis, fluoride osteopathy, osteosclerosis and thyroid and kidney damage, which is common to be found in Thar but the local groundwater has not only a high fluoride content, but also lead and arsenic. Though the government of Pakistan has provided few water treatment plants in the region but all the plants, however, are too far away for the project region. Consequently, people drink rather the contaminated water. For the agriculture the water can be used very well, however, here the access to the water is the biggest problem. Due to limited water and difficult to access, households fetch limited quantity of water for the human and livestock purposes and cannot cultivate agriculture contrary. This study also shows the impact of the innovative model of Association for Water, Applied education & Renewable Energy (AWARE).

Key Words: Water woes of Thar, solar energy, organic food growing, water metering innovation, food insecurity, and participatory water governance

Background

Tharparkar district is spread over 22,000 square kilometers and includes the ecological zones of Thar and Parkar. Administratively it is divided into seven talukas-Mithi, Diplo, Chachro , Islamkot, Dahli,

Kaloi and Nagarparkar with a population of 1,649. However, the geo-physical fabric of Tharparkar features various ecological zones, which are different from the administrative set-up: Kha`ur, Kantho, Parker, Samroti, Vango, Vat, Muhrano and Dhat. Rainfall pattern is not uniform, ranges from 50 mm to 300 mm mostly in the monsoon season. There happens a drought often every four to five years. Rapid growth in population of human as well as animals has exerted pressures on water sources. Only 47 percent of the population has access to the drinking water source, 76 per cent of women travel average 3 km for fetching the water and consume 52 per cent of their working hours (Shaikh2003).

Introduction of Tharparkar

Tharparkar District is located in the east of south-eastern province of Sindh and is one of the most under developed area of the region. The district is mainly comprised of sandy desert. Tharparkar extends over 22,000 square kilometers. The district is one of the areas with the lowest human development (according to HDI) in Pakistan and according to the World Food Programme it is one of the most food insecure as well. The desert region is one of the most sensitive and most insecure regions in Asia. 80% of population derives livelihood through agriculture and animal husbandry, which is dependent on rainfall which often is insufficient and occurs most often from July to September and usually fluctuates annually between 200 mm and 300 mm. Decreasing rainfall is increasing food insecurity, about 47% of families have already been living below the poverty line. Due to the lack of training levels the survival of households depend on rain fed agriculture and livestock. Commercial livestock or agriculture is hardly known in the project region and is not used as a source of income. There is little knowledge about the modern cultivation, natural resources management. Market access or connection to local businesses and markets do not exist. They lack addition to irrigation systems for agriculture (Ziagham 2003).

Major droughts in the history of Tharparkar

Thar confronted severe droughts in the year 1856 & 189 These droughts were followed by famine and known in the history as Chappno &Channo In the 1986-87, Thar again met a severe drought the other drought years were 1995, 1996, 1999, 2001, 2004, 2005,2007 ,2013 finally 2014, 2017 and 2018 frequently. Among those perilous one is the drought of 1899 - 1900 that is remembered as "Chhapno" in local language. That was the period of Lord George Curzon as the viceroy of India. That galloped thousands of lives in Tharparkar, and more 8 million lives in the entire Indo-Pak. Some reports revels that, British and Viceroy did not take mitigation measures or relief work for the

affected people and this attitude also contributed to ignite the spark the movement of independence in India.

Access to Water& its Problems

Depth of dug wells in district Tharparkar is between 50 - 350 feet. Wells are dug manually. The exercise of digging well is very difficult, time taking and risky. Digging the deep wells is not a single problem, but dragging out underground water related other problems are:

- Three persons of each household spend three to five hours daily to fetch water for human consumption and watering the pet animals
- Donkey, bull or camel for pulling the water bucket are used
- In drought, due to fodder shortage animals get weaker-livestock keepers migrate to barrage area
- In case of unavailability of animals and other support, women and children have to pull the rope by hands
- Malnutrition and drop out of school-children are common
- It is affecting the socio economic standard of population
- Due to difficult practice of water collecting women use less water (bath, washing, cleanliness etc)
- In case of droughts or less rains, concentration of salts & other contamination increases because of low or no recharge of underground water
- Unhygienic conditions result into diseases and that results in economic surplus leakage

Introduction of AWARE

Association for Water, Applied Education & Renewable Energy (AWARE) is a nonprofit, non-political and non-religious NGO and registered since 2005 under the Pakistan Association Act of 1860 with the registration number 4142. AWARE wants to contribute to building a society in which people self-determined to take decisions in life. The organization sets its priorities in the organization, awareness and promotion of marginalized groups in order to influence social, political and economic policy, with the ultimate goal of establishing a society driven by social justice, equality, and human dignity.

The Board is comprised of renowned educators, scientists and social activists with the aspiration of a socio-economic development of arid and drought-affected areas of Thar Desert.
In the past decade addressed AWARE poverty, living conditions as well as water, health and

education issues by providing solar energy, scientific research and innovative practices for health and educational development. AWARE is working closely with international NGOs, public institutions, universities and scientific institutes, and local philanthropists.. AWARE uses renewable energy for the purpose of improved access to water, consequently, to increase agricultural production and food security, which in turn contributes to poverty reduction. Similarly, it is possible, through the use of solar energy to promote education in the affected areas. The organization pushed for the scientific development of animal husbandry. In addition, extensive experience with regard to the use of water of wells through utilizing solar energy at the household level and the individual vegetable cultivation has been experienced. Besides, development of physical infrastructure, AWARE in cooperation with DOW Medical University and the Pakistan Council for Scientific and Industrial Research (PCSIR) have conducted various scientific researches on water and health AWARE has been installed more than 100 Solar scheme plants in District Tharparkar and Umerkot.

Process of implementation:

Initially before launching of scheme a meeting was conducted with COs of villages which was initially established in villages. Meetings were conducted for identifying location for installation solar pump. Objectives, importance, and responsibilities of Villagers were shared before launching of this scheme. So it was decided that; each house hold will have to install a pipe line for easy access of water and user will charge nominated water consumptions fees on monthly basis, whatever charged through installed meters,. In case of stolen, caring, maintaining of solar pump, pipe damaging or in case of other situation which may causes solar pump damaged, then community will be responsible of it and to avoid such mishaps an operator has been selected and trained and he is responsible for issuing bills, collecting user charges and taking care of scheme.

- ✓ Formation of Water management Committee
- ✓ Establishment of Solar pumps
- ✓ Monthly meeting with water management committee
- ✓ Role of community after mobilization

AWARE Innovation

Water issue is the main issue of district Tharparkar on this issue many organizations and governmental institutes are working on it. But the governmental schemes are seems non-functional due to lack of interest of community and proper care is the main reason as AWARE is closely linked

with the region so for the sustainability of this scheme AWARE introduced the meter system on the installed solar pump and two persons from each village are trained and these are fully oriented on technical aspect. The monthly stipend of operator is also paid by the community because through the meters we can measure the appropriate quantity of water consumed by household.

Benefits

Dragging out underground water is really a big issue in Tharparkar; a single house hold has to spend three to five hours of three individuals to fetch water for human consumption and watering animals. Solar pump schemehas proved better in terms of facilitating villagers to be free from raring animal which they use for dragging out water, time and energy. Villagers also found using spare time in other constructive work and earning to support their families. Children didn't go school due to such problems of water fetching; now they have opportunity to go to school regularly. Health & hygiene of children and women was another important aspect that is covered by this scheme because previously limited access and uneasy practice of water fetching was an obstacle in getting daily bath and maintaining health and hygiene. Women use to fetch water from well towards their homes, it is very difficult to deal with it, usually women spend more than 5 hours daily, which is main cause of lack of nutrition, because they spend more time and they need more energy, but in real life they don't have enough energy to face this challenge. Following are also main benefits of the scheme.

- Time an Energy Saving
- Burden reduced of animal
- Women saved from taking heavy buckets of water on their heads
- More water available for bathing and other household washing purposes improved health and hygiene
- Due to conflict on turn of the water which sometime resulted into infighting and even blood shed discarded.
- With additional convenient water available, women grew vegetables for household needs which meet the deficiency of composite diet
- Children relieved from finding out animals, keeping and feeding them as well as spending three more hours in driving animals for extracting water; this improved their health and education

- School enrolment increased as boys have no more to run after donkeys and drive them and girls to take water on their heads to home
- Men free from ordeal of fetching water, spend their time on fields
- Women with free time on their disposal busy themselves in handcraft and other activities
- Since the installation of the solar water Pump, people from all over the area visited the facility in curiosity and disbelief and after observing the facility are demanding from government to provide the same in their villages
- Introduction and applying of this technology has also been converted into spontaneous campaign for alternative energy without any social mobilization efforts
- This technology address several problems at the same time

Kitchen Gardening

After installation of Solar Pumps made affordability and accessibility of fresh vegetable which not common in the area.

Established kitchen gardening through providing water at door step this establishment fulfill the nutritional need of the population.

Provision of fresh vegetable at household level and before the implementation of this model the availability of fresh vegetables was difficult.

Conclusion & Recommendations

- ✓ According study people of the area spend most of time to fetch the drinking water and there is no time to another work so the installations of solar pumps completely change the living standard of people.
- ✓ Government should take initiative for the installation of tube wells/ Solar panels at gross root level.
- ✓ Through this initiative health & hygiene of people can be improved.
- ✓ Easy access of water can be utilized for the kitchen Gardening & Agriculture purpose.
- ✓ Easy access of water will improve the socio economic condition of community by saving time.

Manual Mechanism for Water Drawing from Dugwell

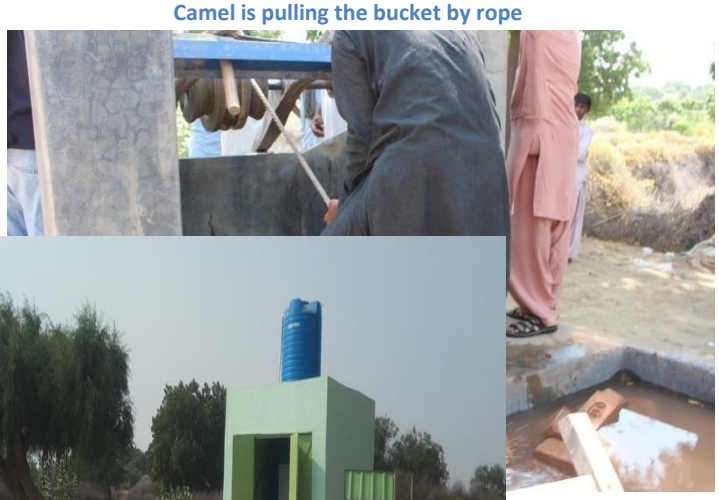
Camel is being prepared for drawing water from Dugwell

Rope is being connected with camel for drawing

Rope of bucket is attached with camel rope

Camel is pulling the bucket by rope

Including an old man three persons are engage in fetching water from Dug well



Water is available

Water Solar Powered Model

WARE Installed & its Mechanism

Relevant Online Links

AWARE has installed Solar System powered submersible pump at dug well

AWARE introduced meter system at pumps through these meters operator is measuring the quantity of water consumed by household

Villagers are digging pipeline from Solar pump to home

Water is available at home

After availability of water at home, Kitchen gardening is common a villager is getting fresh vegetable

Child is carrying radish

https://www.youtube.com/watch?v=jDBt8vzT3qQ

https://vimeo.com/160993676

https://youtu.be/90zGhXs3Byw
https://www.facebook.com/pg/AWARE-tdh-

154136231753968/photos/?tab=album&album_id=214736849027239
https://www.facebook.com/pg/AWARE-tdh-154136231753968/photos/?tab=album&album_id=288253951675528https://www.facebook.com/pg/AWARE-tdh-154136231753968/photos/?tab=album&album_id=288253951675528
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MONITORING OF GROUNDWATER QUAITY OF DIFFERENT TOWNS OF LAHORE

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ABSTRACT

Water is basic necessity for all living creature. Groundwater is one of the main reservoirs containing 2% of the world water. Various contaminants, pathogens and microbes deteriorate the groundwater quality mainly through seepage from drainage system. This is increasing in developing countries like Pakistan where untreated effluent is being discharged in the water bodies which contaminate the ground water and require proper attention to address the problem. Therefore present study was conducted to determine the quality of ground water collected from tube wells installed for the provision of water to all towns of Lahore. To assess the level of contamination and associated risk, samples of ground water were collected through random sampling methodology from 300 tube wells installed in all nine towns of Lahore. To analyses the water quality, physical (pH, Temperature, EC, TDS) chemical parameters (Flouride) were evaluated. Ion Selective Electrode (Meter lab. ION 450, France) was used to determine the fluoride content in water samples. According to results, higher Turbidity (6.6±0.82 NTU) and electrical conductivity (993.5±60.3 µS/cm) was measured in Nishtar town as compare to other nine towns. The average temperature (C°) of tube well water of all nine towns of Lahore was found in the range of 34.5± 0.089 C° to 35.6± 0.098 C°. PH of all water samples was within the permissible range (6.0-8.0) recommended by WHO value. High level of Dissolved oxygen was measured in Ravi town (1.98 ±0.079 mg/L) although it was below the permissible limit. Whereas the value of Total dissolved solids in all water samples was below the range (1000 mg/L) recommended by WHO. Whereas fluoride concentration of tube wells water was found highest in Aziz Bhatti Town (AZT) (2.1 ± 0.63ppm) and Wahga Town (2.4±0.69 ppm) whereas lowest fluoride concentration was observed in Allama Iqbal Town (0.51 ± 0.58ppm). It is concluded that the level of fluoride in tube wells water in Lahore in certain towns is higher than the permissible limits that require immediate migratory and preventive actions to be implemented to protect our human health and ecological impact.

Key Words: Fluoride, Health hazards, Turbidity, Conductivity, Dissolved Oxygen, Temperature, Total Dissolved Solids, pH, Drinkingwater, Contamination.

1. INTRODUCTION

Water is important and basic necessity for the sustainability of human and all other creatures. Human body also contain 57-60% water which is essential for the translocation of food to the tissues, removal of body wastes, flow of body fluids, regulation of body temperature and an emollient in the joints and internal organs (Bates *et al*., 2008). Human health and survival depends on use of uncontaminated water for drinking and other domestic purposes (Desideri *et al*., 2007).Water pollution is definite impairment of water quality due to industrial, agricultural, and domestic wastes to a degree that may not certainly create an actual threat to public wellbeing. Due to increase in industrialization and urbanization, more and more wastewater is being generated and discharged into natural water bodies which cause contamination of ground water (Awan *et al*., 2002). Many industrial units discharge effluent having high load of contaminants like nitrates, nitrites, cations and other toxic metals like iron (Fe), zinc (Zn), mercury (Hg), magnesium (Mg),lead (Pb), cobalt (Co), nickel (Ni) and cadmium (Cd) (Sial*et al*., 2006). Ground water use for domestic and industrial purposes is a common practice all over the world. Water Quality Index (WQI) is an imperative operative tool to transfer information on the quality of water to the policy makers and residents. It indicates the mutual effect of different water quality parameters (Atulegwu *et al.,* 2004).Pure source of drinking water have become preciously scant as a result of ever increasing environmental pollutions due to anthropogenic activities. At the same time, demand for potable water has also been increased due to increased world population, agriculture, industrialization and energy sector. Therefore, instruments for safeguarding the physical, chemical and microbial quality of drinking water are necessary (World Health Organization, 2008).According to IUCN (2006), the annual wastewater generation of Pakistan is about 4.43 billion cubic meters (BCM). Out of this 4.43 BCM, 3.06 BCM is from municipal sources and 1.37 BCM is added by industrial units (IUCN, 2006) thus contaminating ground water. Asadullah *et al*. (2013) analyzed the physico-chemical characteristics of water collected from educational institutes located in various areas of Karachi. The proportions of samples which were not acceptable according to WHO were 6% for pH, 2.1% for taste, 0% for turbidity, 2.5 % for TDS, and 1.3% for hardness. He concluded that overall condition of available water throughout the city was not

up to desired level. Taj*et al*. (2013) designed a study to assess the physiochemical properties of ground water contaminated with industrial wastewater. The water samples were collected randomly from 3 different locations industrial estate, Jaranwala road and drain Khurrianwala. In a whole study sampling was done two times for two types of water samples (ground water and effluent water). Water samples were analyzed for pH, EC, chloride, total suspended solids, nitrate, carbonate, bicarbonate and heavy metals like (Cd, Cu, Pb, and Ni). The results showed that pH, EC, chloride, TSS, were higher than the permissible limits of WHO while nitrate was below the permissible limit.Almost 50% of population in developing countries is suffering from water borne diseases (WHO, 2008). These anthropogenic sources are consequently increasing the level of contaminants in drinking water in various parts of the world (Cao et al., 2000; Manahan, 2000).Water quality and associated problems are becoming a serious concern in Pakistan. Presence of high levels of fluoride and other hazardous substances in drinking water is a growing threat to environment and public health especially in Punjab (Kahlown et al., 2002). This situation demands extensive and detailed studies in this regard. There are some reports also available on incidences of fluoride toxicity in Pakistan. In July, 2000 “Manga Mandi Disaster” related to high levels of fluoride in water is one of the incidence occurred in various villages located about 40 Km on Multan Road near Lahore, Pakistan. The village is located in Punjab, southeastern part of Pakistan, where a flat alluvial plain formed along the Ravi, one of the tributaries of Indus River. A report on drinking water analysis showed that samples collected from these areas contained fluoride contents ranging from 2.62-29.00 mg/L. The level was much higher as compared to the World Health Organization's standard, (2006) ranges from 0.5-1.5 mg/L of fluoride (Ahmed, 2002).

. The main objectives of the work were the:

- Collection of ground water samples from tube wells installed, for water supply, in all over Lahore
- Qualitative assessment of Groundwater samples on the basis of physicochemical parameters
- Identification of non-compliances in groundwater of Lahore with WHO guidelines for health risk assessment.

2.MATERIALS AND METHODS

The present study was carried out to monitor groundwater quality of nine towns of Lahore (Fig: 1).

For this purpose, water samples of 300 tube wells, installed by government (WASA) in all over Lahore, were collected in 500ml polyethylene plastic bottles with tightly capped lid. Samples were labeled with name of town, union councils, location, date, time, batch number and sample code. Depth of tube well was recorded from the available data of WASA on site at the time of sample collection. Temperature, pH and dissolved oxygen were measured on site at the time of sample collection. Temperature and dissolved oxygen of water samples was measured by using Lonolab WTW and Multilab 540 WTW, Germany respectively. The pH of water samples was recorded using an electronic digital pH meter model 350-Jenway U.K (Andrew and Franson, 2005). Water samples of all Towns of Lahore were preserved in an ice box at or near 4 °C temperature. Samples were protected from sunlight which may initiate photo degradation of samples components and were transported to laboratory of Environmental Science Department, Lahore College for Women University, Lahore, Pakistan and stored at 4 °C in refrigerator till analysis (WHO, 2004). Electrical conductivity of drinking water samples was determined using EC meter HI-99300 Hanna, Italy (Andrew and Franson, 2005).TDS of drinking water samples were determined using bench top meter (CON-700, EUTECH) method as described by APHA (1992).The turbidity of drinking water samples was determined using portable turbidity meter model PCH-65277 Lovibond Germany (Andrew and Franson, 2005). Whereas for the analysis of Fluoride concentration, pH of the water samples was adjusted between 5.0 - 5.5 to release fluoride from any complex ions. For this purpose, 6N NaOH solution and analytical grade TISAB (Total Ionic Strength Adjusted Buffer) was used. Fluoride contents in pretreated water samples were determined by using Ion Selective Electrode (Meter lab. ION 450, France). All results were analyzed statistically using SEM, t-test and also using statistical software Minitab V13 and were compared with National Environmental Quality Standards and WHO values for various parameters

3. RESULTS AND DISCUSSION

Present research, conducted on the qualitative assessment of tube well water samples of various towns of Lahore city showed concerning results. Water samples, collected from 300 tube wells located in different towns of Lahore, were analyzed for various parameters i.e pH, turbidity, temperature, conductivity, TDS and dissolved oxygen along with fluoride concentration. The values were compared with WHO. The results of the study are depictive of the fact that the quality of ground water in Lahore city is deteriorating. There may be many factors contributing to this. Unchecked

disposal of untreated municipal and industrial waste water, excessive use of fertilizers and pesticides and rapid urbanization may be the cause towards the deteriorating quality of drinking water and growing threat of contamination of water sources.

According to the onsite analysis, the averagetemperature (C°) of tube well water of different towns of Lahore during the period of study was recorded as 34.5± 0.089 to 35.6± 0.098 (Fig: 2). because the water samples were collected from April to June; when the temperature is usually high. Whereas measurement of pH at the time of sample collection showed that the pH of all water samples was within the permissible rang e (6.0-8.0) recommended by WHO value (Fig: 3). Although pH measures the potential activity of hydrogen ions (H^{+}) in the water sample. That can be affected by various factors such as soil composition and its bed rock through which water moves, organic matter content of water body, types and volume of plant growth on soil, sources and types of chemicals dumping in water body and drainage via coal mining (Aziz, 2005).Dissolved oxygen that was measured directly at the time of sampling, obtained values were further analyzed for comparison. Averages DO of different towns ranged from 1.56±0.093 to 1.98±0.079 mg/L. Ravi town and Aziz bhatti town showed little higher levels as compared with other towns 1.98 ±0.079 mg/L and 1.8 ± 0.169 mg/L respectively (fig: 4) but were well within the permissible limits.

Tube well water samples were also tested for conductivity level. Average value of conductivity (µS/cm) of different towns was compared with WHO value (Fig: 5) Electrical conductivity is a rapid method to get an idea about concentration of ionized substances in water. It was determined from the analysis that the conductivity of all collected water samples of all towns was many folds higher than WHO, 2000 values. The conductivity recorded was ranging from 547±21.6 µS/cm to 993.5±60.3 µS/cm. In Ravi town it was lowest and highest value of conductivity was observed in the water samples of Nishter town (993.5±60.3 µS/cm) that shows the conduction of salt ions and give estimate of salt present (Ali et al,.2008).

Theconcentration of total dissolved solids in water is important for drinking water quality. Results of the TDS analysis showed that the TDS value of all water samples were below the range (1000 mg/L) recommended by WHO as shown in fig 6. TDS is sum of the cations and anions concentration. A high content of dissolved solids elevates the density of water, influences osmoregulation of fresh water organism, reduces solubility of gases (like oxygen) and reduces utility of water for drinking,

irrigation and industrial purposes. The TDS level of Nishtar town (771±15) was comparatively higher than all towns of Lahore.

Turbidity is an important parameter to determine the water quality. Suspended matter such as clay, silt, fine organic and inorganic substances, plankton and other microscopic organism are the major cause of turbidity in water. The average turbidity level (NTU) in tube well water samples of different towns of Lahore was compared with WHO (fig: 7) and among all towns only the Nishtar town showed higher level of turbidity.

Fluoride level in three towns of Lahore was found to be higher than the WHO limits. In Aziz Bhatti town 2.1±0.63 ppm, Nishter town 1.9 ± 0.63 ppm and Wahga Town 2.4±0.69 ppm . Whereas lowest concentration was found in Gulberg Town (0.21±0.68ppm) (fig: 8). Two hypotheses were investigated concerning the fluoride origin: lithotomical affiliation from regional rock or contamination by fertilizers application (Marimon et al., 2007). It suggested from the results that the high values may be due to the extensive use of pesticides and insecticides in these areas before urbanization (Mayur et al. 2008) A study carried out by Chatterjee and Mohabey, *(*1993) found that due to discharge of industrial effluent after production of the insecticide Paris-Green (copper acetoarsenite) by a local factory at the Behala, ground water became contaminated with fluoride.

Even no measurements of depth of tube wells were made during studies but when level of fluoride was considered with reference the depth of the tube wells (from available data of WASA) there appears to be some relationship between the depth and level of fluoride concentration in different samples. It is assessed from the present study that the fluoride concentration generally was lower in samples collected from tube wells with 600-750 feet in depth and comparatively higher in those with 450 to575 feet depth. Fluoride content of well water may be related to well depths. According to the figures collected during study; the depth range of tube wells in various towns of Lahore ranges from 450 to 750 feet (fig: 9).The high concentration of fluoride found in the tube wells water of Lahore City suggest that this may be partly due to the anthropogenic sources most likely the industrial and agricultural contaminants. It is found that the Wagha town of Lahore are the areas that had been sprawled excessively by human settlements and are being transformed into residential colonies. Tracing back the land form of suburban areas of Lahore; now fall within the municipal boundaries of Lahore provides enough evidence that the human activity and agricultural practices may be the main

cause of this situation. Excessive use of pesticides and insecticides to protect crops and also the use of fertilizers for more yields.

Conclusion

Analysis of water samples from different union council of nine town of Lahore revealed that the fluoride concentration is increasing in Lahore city due to many reasons proposed such as urban sprawl, industrial effluents and use of pesticides in agricultural areas etc. It is suggested that more planned and coherent studies be conducted and monitoring strategies be adopted to reduce further damage to water resources and particularly for the availability of the quality drinking water for general public. The situation warrants urgency for reduction of hazards and management the risk before it's too late.

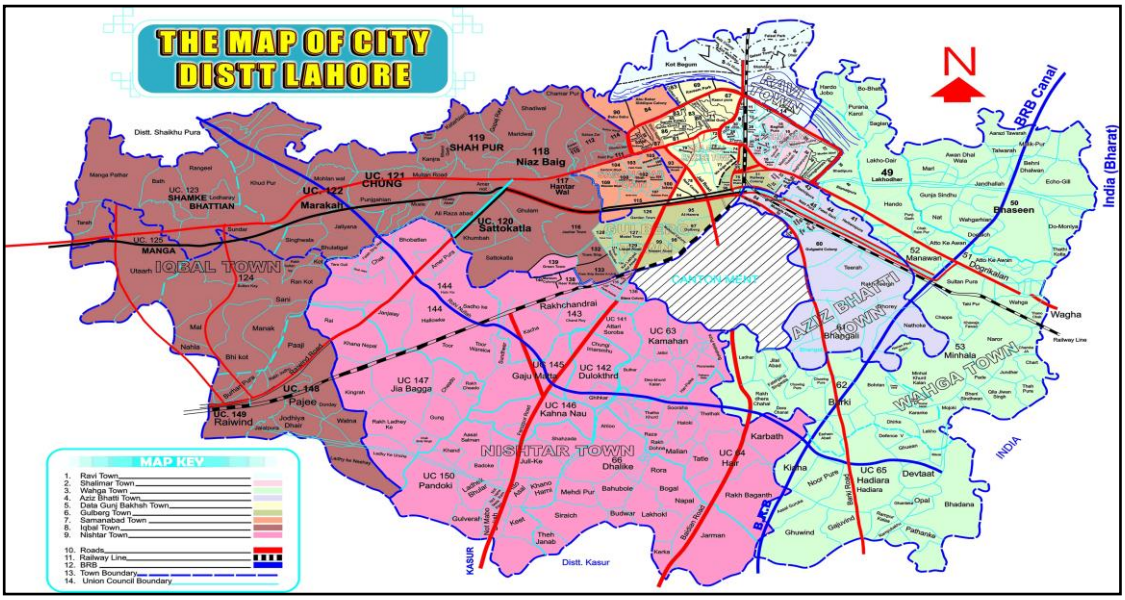


Fig:1.

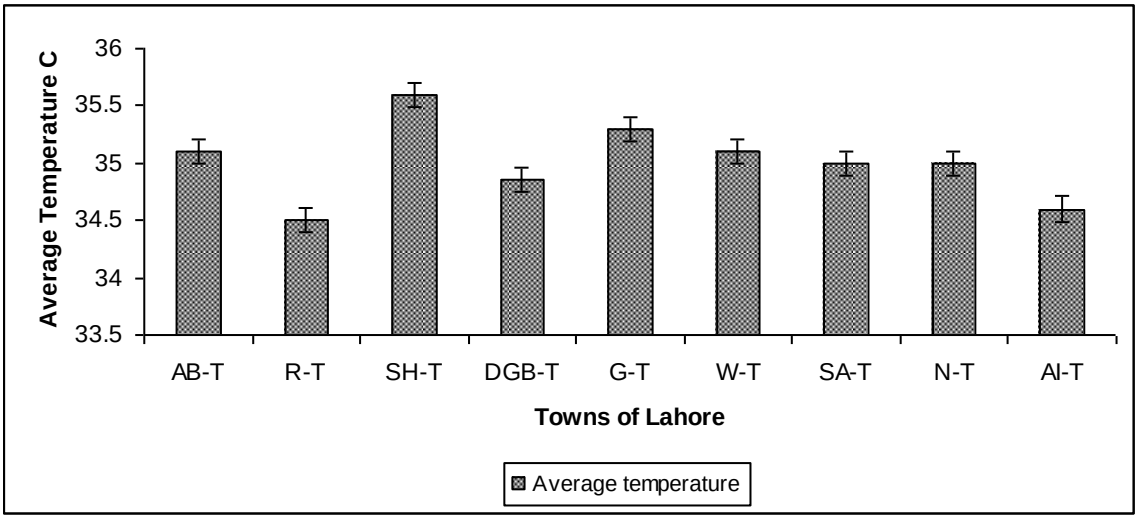

Average Temperature C
36
35.5
35
34.5
34
33.5
AB-T
R-T
SH-T
DGB-T
G-T
W-T
SA-T
N-T
Al-T
Towns of Lahore
Average temperature

Fig:2.

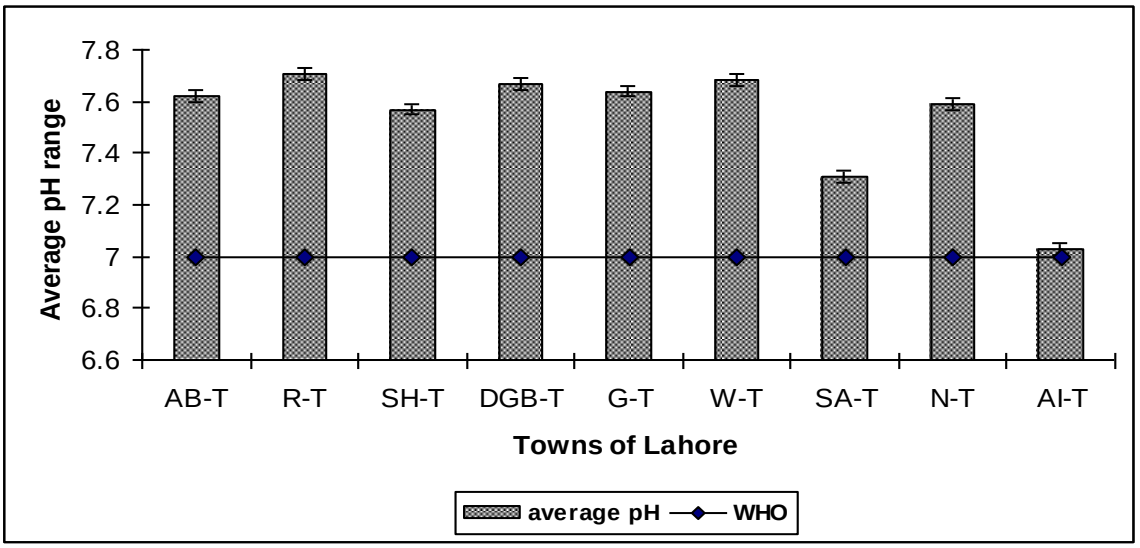

Average pH range
7.8
7.6
7.4
7.2
7
6.8
6.6
AB-T
R-T
SH-T
DGB-T
G-T
W-T
SA-T
N-T
Al-T
Towns of Lahore
average pH
WHO

Fig:3.

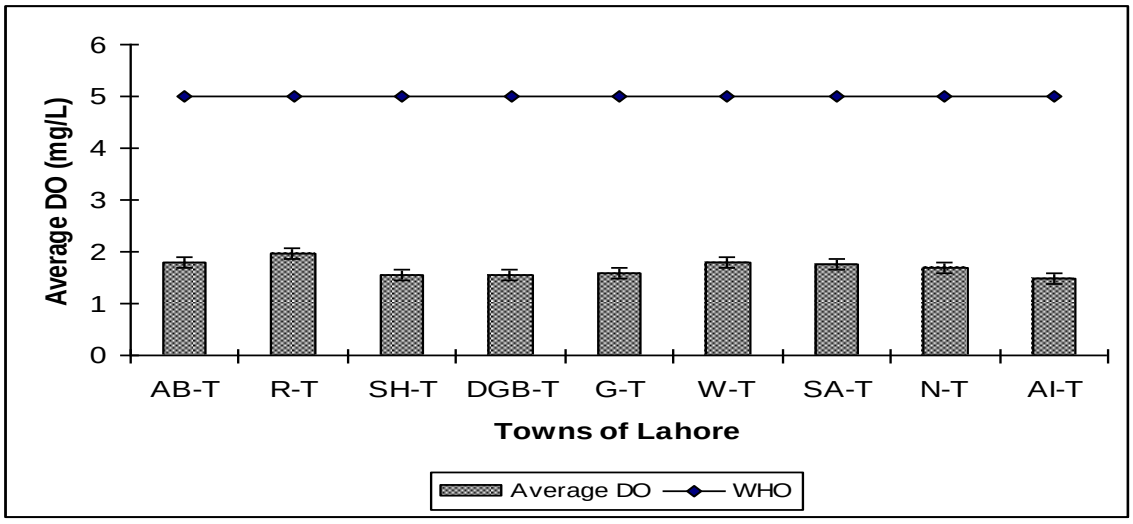

Average DO (mg/L)
6
5
4
3
2
1
0
AB-T
R-T
SH-T
DGB-T
G-T
W-T
SA-T
N-T
AI-T
Towns of Lahore
Average DO
WHO

Fig:4.

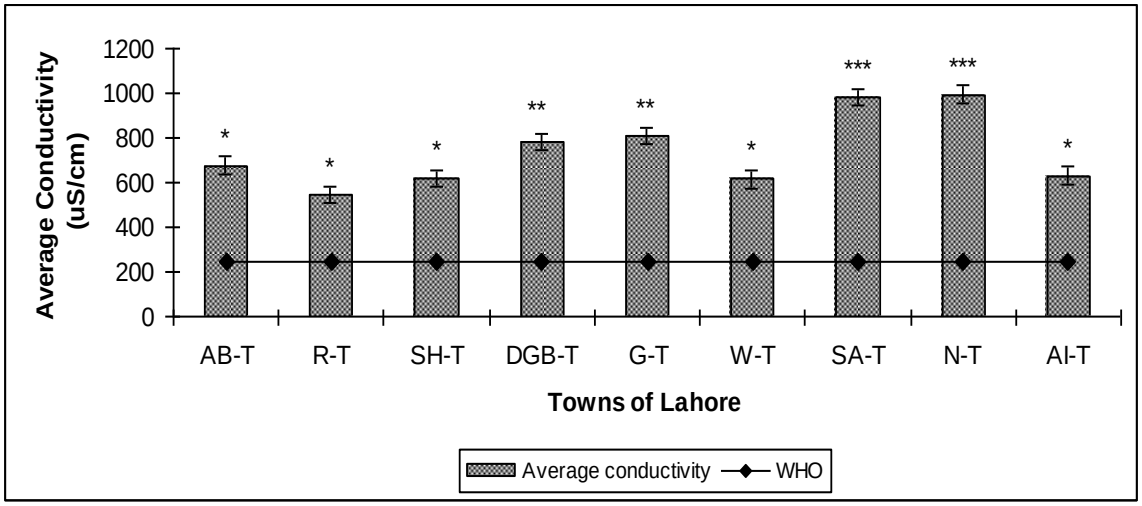

Average Conductivity (uS/cm)
1200
1000
800
600
400
200
0
*
*
*
**
**
*
***
***
*
AB-T
R-T
SH-T
DGB-T
G-T
W-T
SA-T
N-T
AI-T
Towns of Lahore
Average conductivity
WHO

Fig:5.

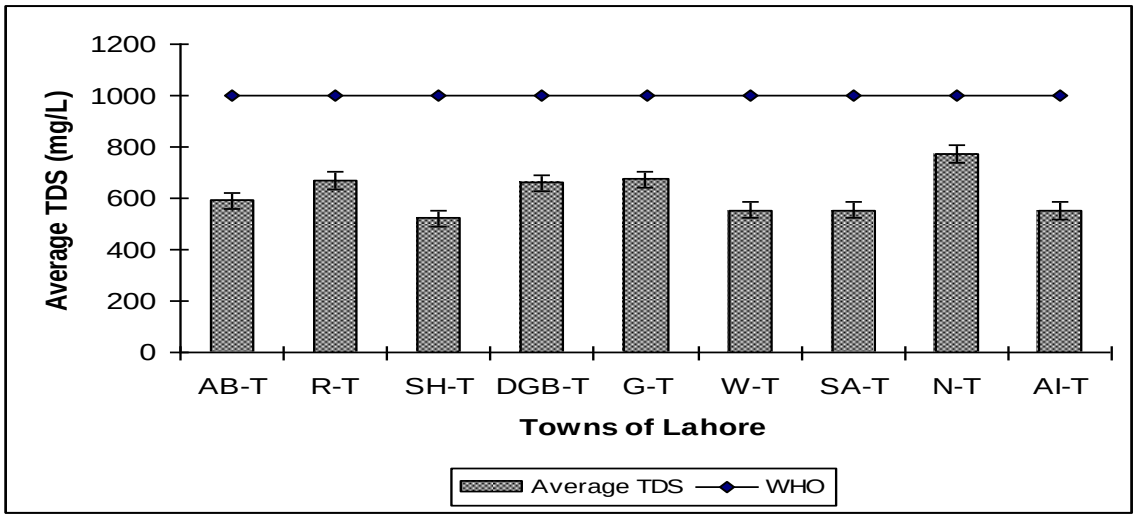
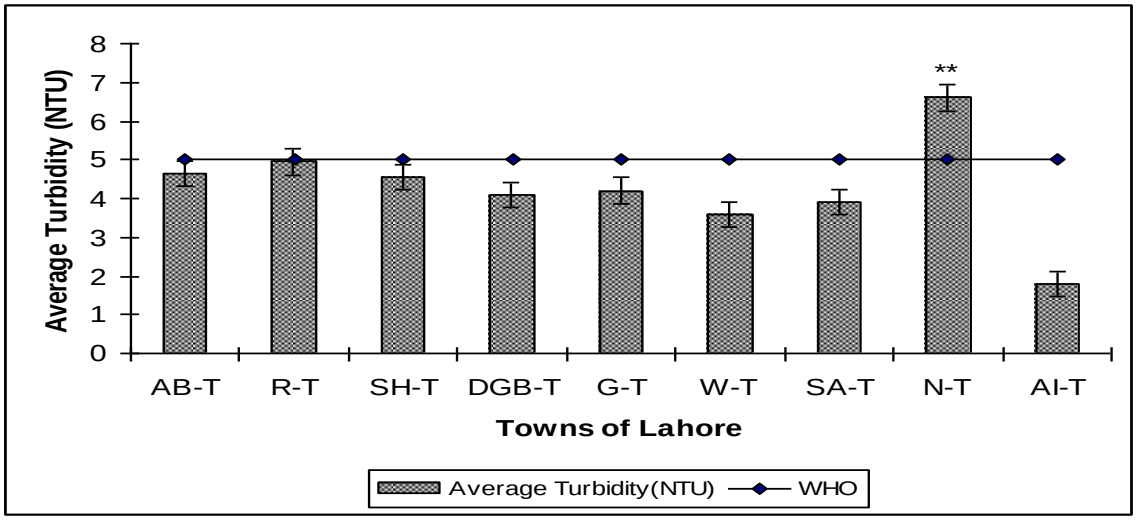

1200
1000
800
600
400
200
0
Average TDS (mg/L)
AB-T
R-T
SH-T
DGB-T
G-T
W-T
SA-T
N-T
AI-T
Towns of Lahore
Average TDS
WHO

Fig:6.


8
7
6
5
4
3
2
1
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Average Turbidity (NTU)
**
AB-T
R-T
SH-T
DGB-T
G-T
W-T
SA-T
N-T
AI-T
Towns of Lahore
Average Turbidity(NTU)
WHO

Fig:7.

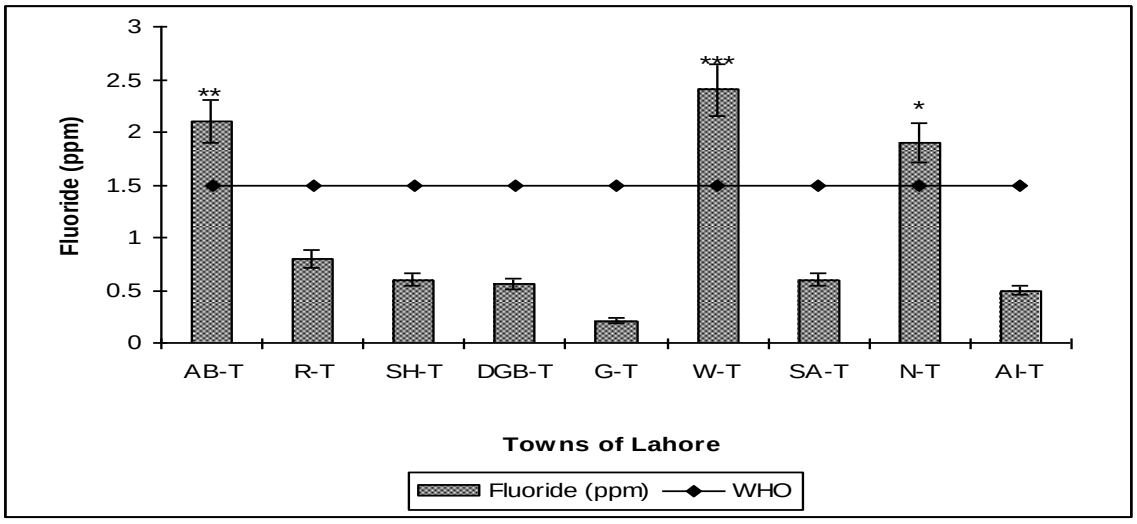

Fig:8.

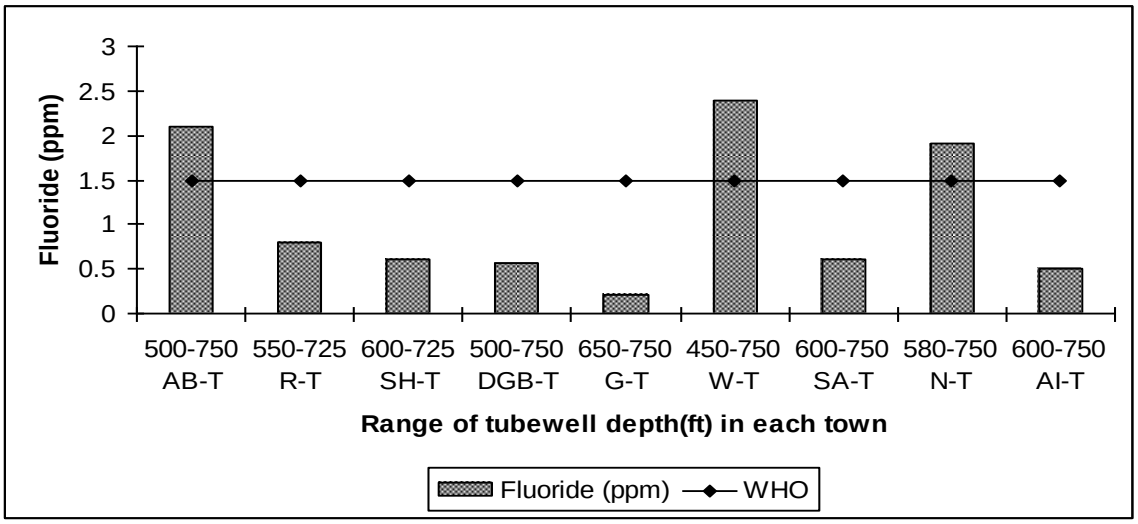

Fig.9

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GROUNDWATER AS A SOURCE OF DRINKING WATER AND ASSOCIATED CONCERNS

GHULAM ZAKIR HASSAN[3], SALEEM AKHTAR[4] and FOZIA YASMEEN[3]

ABSTRACT

Groundwater is a natural source which is not only a basic input for existence of life on planet but also used for other societal needs associated with food, fiber and shelter requirements of mankind. Its major consuming sectors include but not limited to drinking, irrigation, industry, livestock, environment and other commercial uses etc. Freshwater a vital resource for the existence of life and healthy ecosystem on the planet of Earth is under continuous pressure. Rivers, lakes, glaciers, and aquifers are the primary sources of freshwater. Pakistan is the 4th largest user of groundwater after India, USA and China where more than 95% drinking water requirements are met from groundwater. In urban cities Water and Sanitation Agencies (WASAs) are the major actors who are pumping groundwater and in rural areas Public Health Engineering Department, Local Bodies and communities/individuals are pumping groundwater. Major concerns of threats for groundwater low level and deterioration of its quality owing to a number of drivers including deep and excessive pump age, improper disposal of waste, acidic rains, untreated sewerage and industrial effluent(domestic, industrial, agricultural) etc. According to WHO report, 3.4 million people die annually round the globe due to waterborne diseases. As per estimate about more than 80% diseases in Pakistan are waterborne and approximately, 25,000 children below 5 year die every year due to pathogenic in drinking of contaminated water. About 40% of deaths are attributed to drinking polluted water and unsafe drinking water is a source of many diseases including diarrhea, typhoid, intestinal worms and hepatitis. Globally 780 million and in Pakistan 100 million people are exposed to unsafe water. Research studies carried out at Irrigation Research Institute (IRI) have concluded that groundwater levels in urban areas like Lahore are falling at an alarming rate of about 1 meter per year and domestic and industrial effluents being thrown in Ravi River are contaminating the aquifer underlying the city due to which quality is deteriorating with the passage of time. Under the current paper the challenges being faced by groundwater have been narrated and some remedial measures have been outlined in the light of SDG 6.1-6.3 on the basis of different research studies carried by IRI in rural as well as urban localities.

Keywords: Groundwater, drinking, contamination, water-borne-diseases, IRI, Punjab, Pakistan

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1. INTRODUCTION

Groundwater is the 2nd largest available reservoir of fresh water. Out of total freshwater, over 68 percent is locked up in ice and glaciers. Another 30 percent of freshwater is in the ground.It is more than 30 times the water contained in all fresh water lakes and is more than 3,000 times the average volume of water flowing through rivers and streams (Nazir, 1995). Its major consuming sector is not only limited to domestic but alsoin irrigation, industry, livestock, environment and other commercial uses etc. Most of the drinking water supplies are also drawn from groundwater. Groundwater caters for drinking requirements about 75% in Europe, 51% in United States, 32% in Asia and 29% in Latin America (Gull-e-Rana *et al*, 2011). Over recent decades, groundwater use has grown exponentially in scale and intensity in many places, leading to aquifer depletion and groundwater pollution.The total water withdrawn for human use has almost tripled in the last 50 years from 1382 km3/year in 1950 to 3973 km^3/year in 2000 and the worldwide projections predict that human water consumption will further increase to 5235 km^3/year by the year 2025 (King, J. & Clarke, R. 2004).

Pakistan is the 4th largest user of groundwater after India, USA and China where more than 95% drinking water requirements are met from groundwater. It was estimated that about 60-70% population of Pakistan depends directly or indirectly on groundwater for its livelihood (Lashari *et al*, 2007).The per capita water availability in Pakistan at the time of independence (1947) was 5,600 cubic meters (S. Husain, 2012), which has been decreased by over 406 percent from 5,260 cubic meters in 1951 to 900 cubic meters in 2017. If the status continues, then, by 2020, the water availability in Pakistan will further decrease to 660 by year 2025 and will further go down to an alarming level of 575 cubic feet in 2050 (K. Mustafa, 2012).

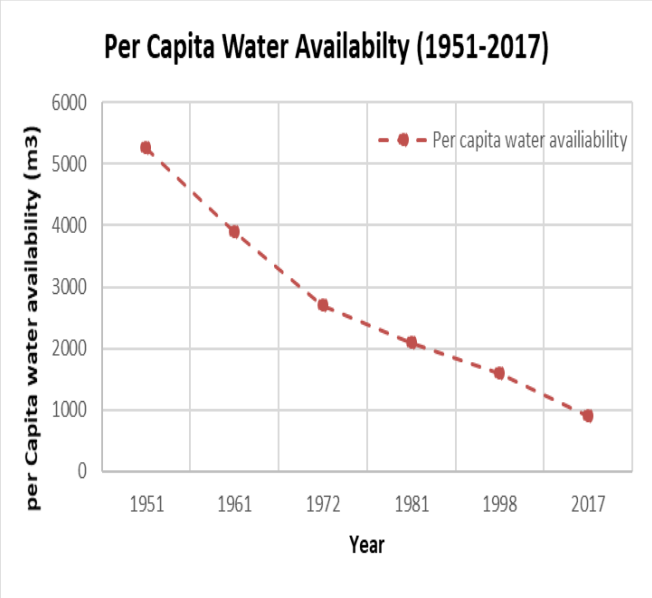


Fig.1: Per capita water availabilityin Pakistan
Source: (Jabeen.A. *et al*, 2015)

In Pakistan, groundwater has a potential of about 55 MAF, out of which about 48.69 MAF is being exploited by over one million public and private tubewells for domestic, agricultural and industrial purposes. Groundwater supplies about 80% of the domestic water usage and more than 50 % of the drinking water supplies.In urban cities, Water and Sanitation Agencies (WASAs) are the major actors in addition to some private entities who are pumping groundwater while in rural areas Public Health Engineering Department, Local Bodies, industries, water bottling plants and communities/individuals

are pumping groundwater for drinking purpose. In Punjab, 7 percent of all the rural population depends on dug wells and rivers for water supply. It seems that Punjab has best water supply system among all the provinces. This ratio is 24 percent in Sindh and people are utilizing water from unprotected sources. The rural communities of Khyber Pakhtunkhwa (KP) and Baluchistan using water from surface and dug well are about 46 percent and 72 percent, respectively (Water AID Pakistan).

Lahore the mega city of the Punjab is also facing the problem of deep-water level and its quality. Water table is continuously lowering down mainly due to excessive pump age compared to its recharge (Gabriel, H.F and Khan.S. 2010). Many studies reported several problems arising due to overexploitation and degradation of groundwater (Gabriel, H.F *et al* 2015). Research studies carried out at Irrigation Research Institute (IRI) have concluded that groundwater is under continuous pressure due to high pump age and its levels in urban areas like Lahore are falling at an alarming rate of about 1 meter per year and untreated effluents discharge into Ravi River are contaminating river water quality and consequently the aquifer underlying the city.

Unsafe drinking water is a source of many diseases including diarrhea, typhoid, intestinal worms and hepatitis.Globally 780 million and in Pakistan 100 million people are exposed to unsafe water (Suleman Chaudhry, 2016). According to WHO report, 3.4 million people (out of which 90% children) die annually round the globe particularly from developing countries due to diarrheal diseases like cholera, typhoid, dysentery which are associated with ingestion of unsafe water (WHO, 2018). As per estimates about more than 80% diseases in Pakistan are water-borne and approximately, 25,000 children below 5 year die every year due to pathogenic in drinking water.

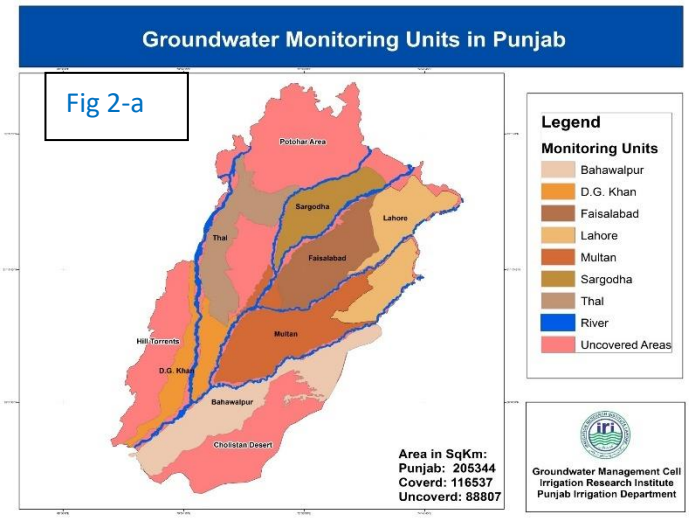
2. GROUNDWATER SITUATION IN PUNJAB

In Punjab province groundwater is playing a significant role in drinking, industrial, agricultural and other uses agriculture being the largest user which consumes about 90-93% of total pumped groundwater. At the same time about 95% drinking water requirements are also being met from groundwater through hand pumps, tube wells, dug-wells, deep turbines throughout the province. Groundwater in urban areas is under more stress as compared with rural areas reasons being the more/concentrated pump age and less recharge due to pavements and urbanization. Major problems being faced by groundwater resource in Punjab include abnormal lowering of water table in sweet areas, deterioration of groundwater quality, saline-fresh groundwater intrusion, increasing cost of groundwater pumping with decline in water table, secondary salinization, negative groundwater balance, lack of awareness and coordination among the stakeholders, lack of regulatory framework etc. There are five possible drivers which affect the groundwater depletion and deterioration of its quality; (i) climate change (ii) pollution through improper disposal of waste,acidic rains, untreated domestic sewage, industrial effluents and agriculture runoff etc.resulting in water quality degradation, (iii) high population pressure on available water resources resulting in water shortage, (iv) high water demand compared to water availability resulting in water stress in an area and (v) groundwater governance and entitlements.

2.1 Groundwater Levels

Groundwater monitoring network of Punjab Irrigation Department is shown in the Figure 2-a below from where the depth to water table are being monitored and mapping is done using GIS software.

The number of existing private tube wells in Punjab is over 1 million. The rate of increase is 20,000 tube wells per year. Groundwater table in Pakistan is falling in almost all the canal commands since 1998. It indicates that current net groundwater abstraction is higher than recharge. Growth of private tube wells is shown in Figure 2-b.



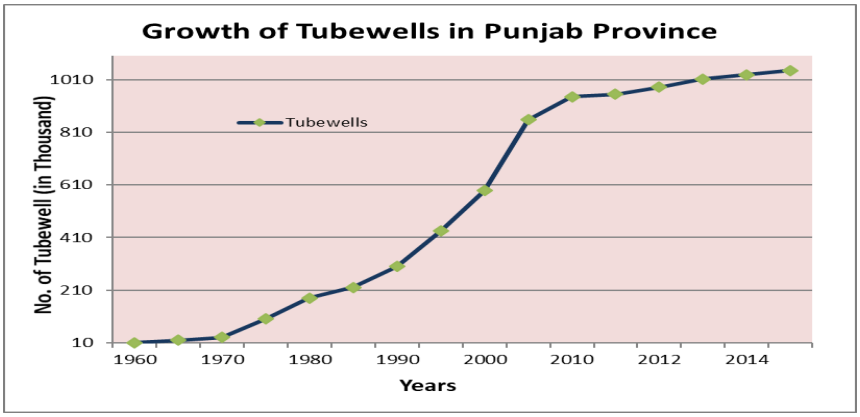


Fig. 2-b: Growth of Tube wells in Punjab Province (PDS Report, 2017)

Punjab Irrigation department has installed about 2500 piezometers in canal commanded areas of the province from where groundwater levels are being monitored twice in the years by field formation. A groundwater management cell has also been established in Irrigation Research Institute (IRI) to conduct various research and investigation studies related different groundwater issues. Growth of private tube wells is going upward continuously in the province due to increasing cropping intensity for food and fiber requirements of tremendously increasing population. This has put the natural resource under pressure resultantly the water levels in sweet areas are going down and quality is deteriorating rapidly.

Situation of groundwater levels in urban and rural areas in the Punjab has been depicted in Figures 3, 4 and 5.

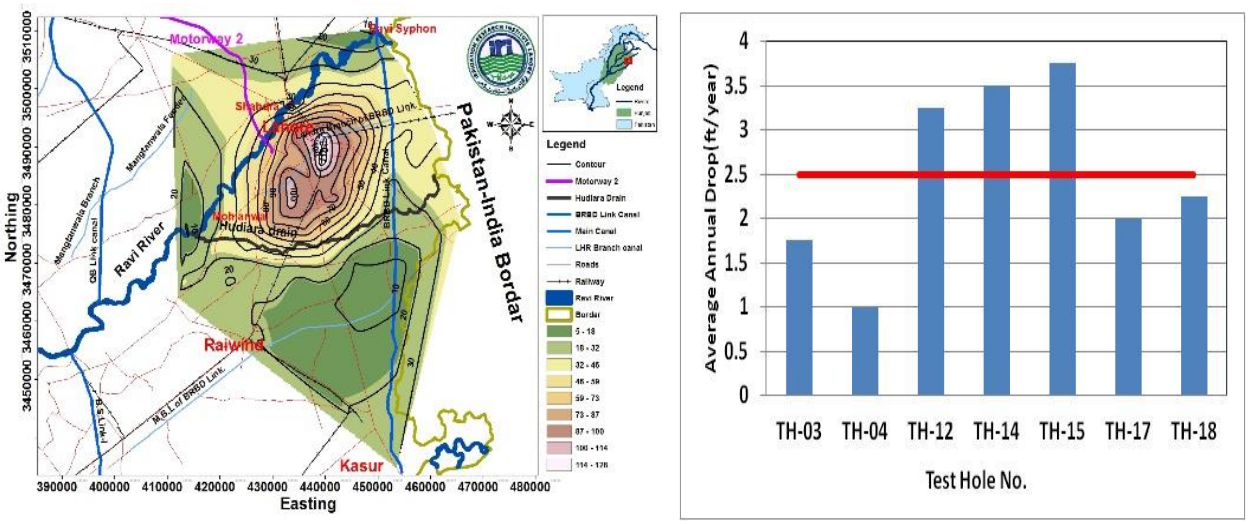


Fig 3:

Depth to Water Table (A) and average annual depletion rates in Lahore (B) (Hassan 2014)

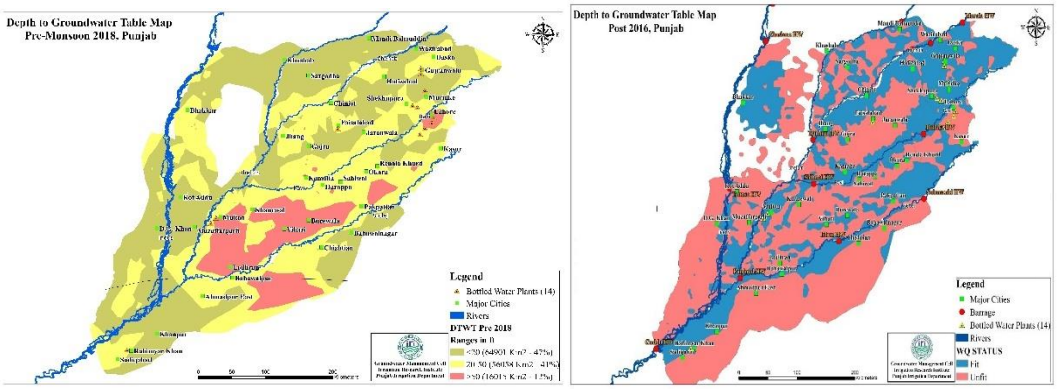


Fig 4: Map of Depth to water table in Punjab 2018 and 2016

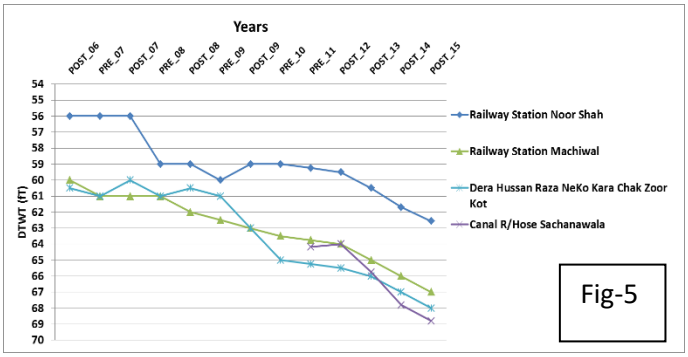


Fig-5

Groundwater depletion most commonly occurs because of the frequent pumping of water from the ground.Groundwater abstraction from 1965 to 2002 has increased from 10 BCM to 68 BCM. Over 80 percent of groundwater is exploited by the private tube well owners/farmers. Unplanned pumpage is creating severe management and equity problems. About 20 years ago, water was pumped from nearly 30 feet depth in Lahore and now it is being pumped from about 400-600 feet depth to get sustainable water supply. Unchecked installation and pumping of tube wells have further aggravated the situation. Water table is going down at rate around onefeet in rural areas while three feet per year in Urban area of Lahore. Due to continuous lowering of water table, groundwater

is becoming inaccessible to small farmers, which is threatening the sustainability of agriculture. Already 5 percent of the tube irrigated Punjab and 15 percent in Baluchistan are wells in reach of poor farmers. This situation is beyond the increase to 15 and 20 percent in the two likely to respectively. (Mohtadullah, K., 2004) provinces, **Groundwater depletion will force us to pump water from deeper within the earth**which results in **saltwater contamination, high pricing and limits biodiversity. Groundwater level situation is worst in rural Punjab as shown in TT Singh district (Fig 6)**


Fig 6

2.2 Groundwater Quality

Due to shortage and increased demand of water in every sector quality of groundwater is badly affected. Major threats for groundwater quality are industrial, agricultural and domestic effluents which are disposed off in waterbodies without proper treatment and consequently leach down causing severe degradation of land and water. Excessive and unscientific use of fertilizers and pesticidesin agricultural sector, industrial and vehicular emission trapped by acidic rains, heaps of solid wastes, underground storage of oils and chemicals are the anthropogenic sources of aquifer contamination. Existence of salts and heavy metals in deep rocks when encountered with changes in aquifer hydrodynamics caused by deep pump age of groundwater also cause deterioration of quality of natural groundwater reservoir. Unscientific and unplanned pump age of groundwater causes intrusion of brackish interface in to fresh aquifer resulting in contamination of aquifer. In coastal areas sea water intrusion is also a severe challenge for groundwater quality. Aquifers once contaminated may take centuries to be reclaimed. Increasing trend in use of fertilizers and pesticides in Punjab is shown in Figure 7-a and 7-b respectively.

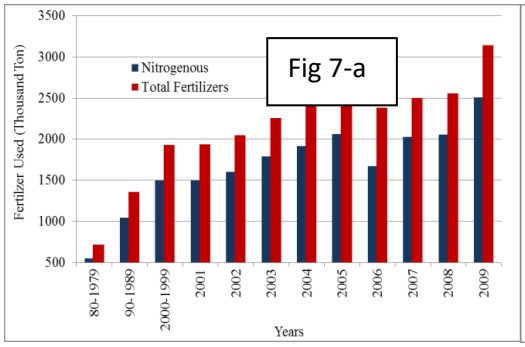


Fig 7-a

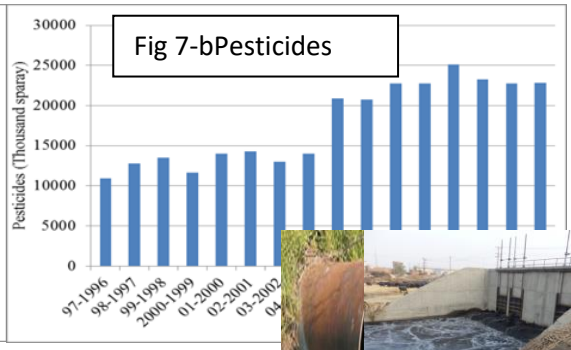


Fig 7-bPesticides

Similarly, contamination of groundwater by domestic/industrial effluents in Ravi River, industrial wastes being thrown in water


Fig 8-b

Fig 8-a Pollutants in Ravi River

bodies and agricultural effluents in surface drains are shown in Figures 8a, 8-b and 8-c respectively.

Fig 8-c

Punjab Irrigation department is monitoring groundwater quality and aquifer mapping is also being taken for irrigation purposes. Drinking water may contain various impurities, which are of physical, biological, and chemical nature. The most dangerous impurity is of biological nature, which causes human health problems or cause deaths (K. Park, 2007). Water pollution occurs when microorganisms and toxic chemicals from domestic waste and industries either come in contact with water bodies or run off or leach into groundwater or fresh water resources (D. R.Arora, 2007).Therefore, various waterborne diseases viz., typhoid, stomach problems, kidney problem, food poisoning and skin problems are very common which account for 20 to 30% of all hospital cases and 60% infant deaths. A graph of water-borne diseases in Pakistan is shown in Fig-9 and a map of

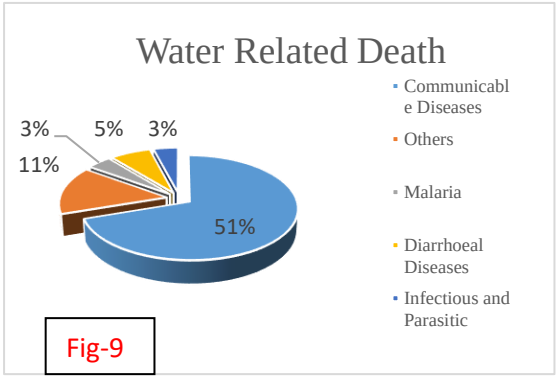


Fig-9

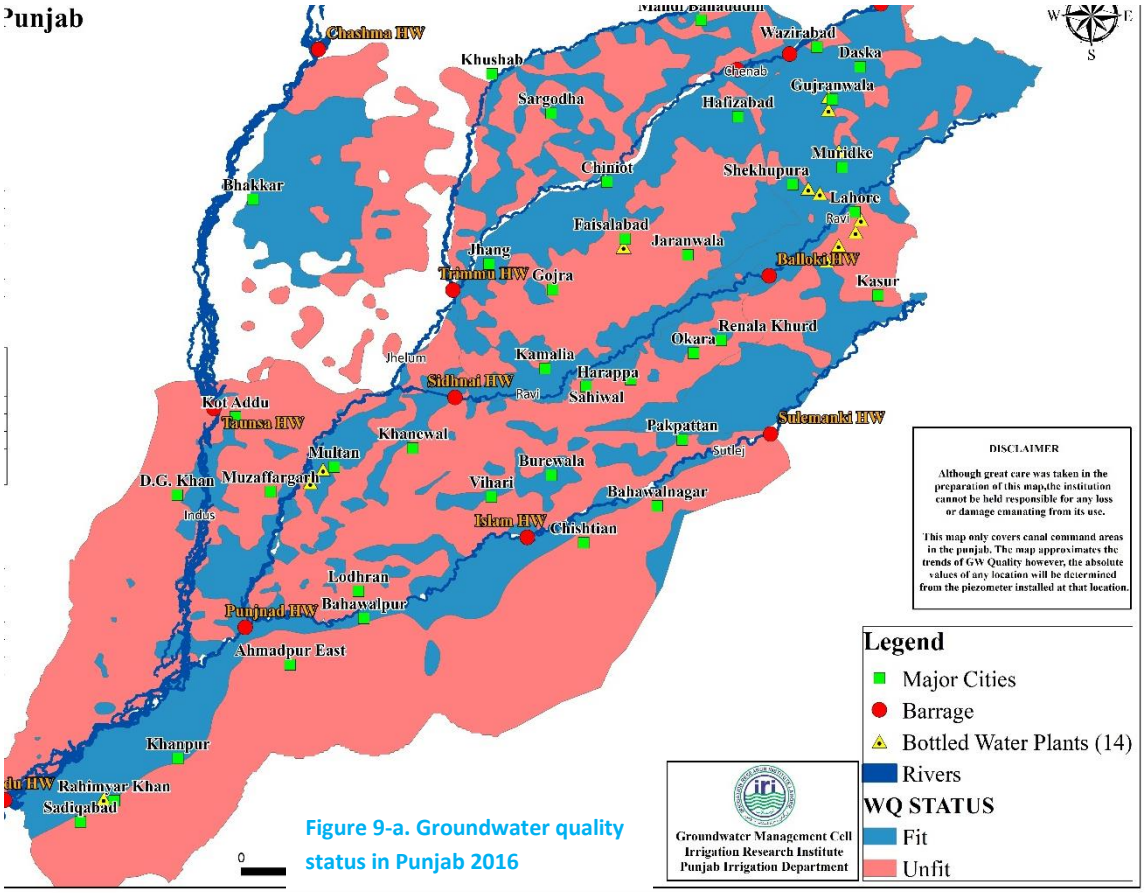


Figure 9-a. Groundwater quality status in Punjab 2016

groundwater quality status in Punjab during 2016 is shown in Figure 9-a

The World Health Organization (WHO) estimates that 500million diarrhea cases reportedly take place each year in children less than five years inAsia, Africa and Latin America. There are numerous other diseases that are transmitted through polluted water. It has been shown that cancer may be caused by the accumulation of certain materials carried out by water to human organs. The excess of cadmium accumulated in the kidney causes hypertension.According to Tahir *et al*., above eighty thousand cases related to waterborne diseases were noted in healthcare units only in Rawalpindi. 20%-40% of hospitals of Pakistan are filled with people that are suffering from waterborne illness, according to United Nation International Children Emergency Fund (UNICEF) diseases such as cholera, typhoid, dysentery, hepatitis, giardiasis, and cryptosporidiosis and guinea worm infections represent about 80% (including diseases due to sanitation problem) of all diseases and are responsible for 33% of deaths. Arsenic toxicity investigations revealed the presence of excessive arsenic in many cities of Punjab and Sindh provinces, which was found to be 50 ppb five times higher than the prescribed limit of 10 ppb by WHO (PCRWR, 2012). Detailed data analysis has identified 4 major water quality tribulations in drinking water sources of Pakistan i.e. bacteriological (68%), arsenic (24%), nitrate (13%) and fluoride (5%). The five years trend analysis has revealed that out of a total 357, only 45 water sources (13%) were found “Safe” and the remaining 312 (87%) were “Unsafe” for drinking purpose. The water quality monitoring (2001-2010) conducted in rural and urban areas of the country revealed that access to save drinking water is only 15 percent in urban and 18 percent in rural areas.According to an official government document (MPD 2004) increased arsenic, nitrate and fluoride contamination was detected in drinking water in various localities in Pakistan. A survey of drinking water samples in Karachi in 2007/08 found that, of 216 ground and surface water samples collected, 86% had lead levels higher than the WHO maximum acceptable concentration of 10 parts per billion (ppb). This mean lead concentration was 146 ppb in untreated ground water and 77 ppb in treated tap water (Ul-Haq.*et.al* 2011). In October 2012, the Sindh High Court issued a notice to the Board asking it to comment on the petition (The News, 2011). The Nation-wide Assessment Survey of more than 10,000 water supply schemes (1808 urban and 8320 rural water supply schemes) carried out by the PCRWR revealed that 72 percent schemes are operational and only 23 percent in urban and 14 percent in rural areas water supply schemes are supplying safe drinking water (Zuhaeb, N., 2012).

3. GROUNDWATER FOR DRINKING PURPOSES

Drinking water requirements are fulfilled from groundwater due to its easy access,availability and purity than surface water. Any person in Pakistan having resources is pumping groundwater for drinking and domestic purposes.It remained the most common and safe sources of drinking water since last many centuries, but its quality has deteriorated rapidly during last few decades due to many factors mentioned above. Now it has become a severe threat for human health on the globe. A significant quantum of our financial resources is being utilized in pumping groundwater and making it worth consumption.

3.1 Rural Areas

Punjab is the most populous province of the country as 110 M out of total 200 M population of Pakistan lives in the province. More than 70% population lives in rural areas. About 89% rural population has access to water supply while piped network coverage is about 48% in rural areas. Public Health Engineering Department (PHED) established in 1960's is responsible to extend water services in rural areas. PHED has reported that department has constructed and handed over more than 3000 schemes (92%) to community groups – called Community based Organizations CBOs and 281 (8%) to Local Governments.Out of these 85% schemes are pumping piped water supply schemes while remaining are gravity schemes but all have house connection. Moreover, 68% of schemes in Punjab are functional while 32 % are dysfunctional. In rural areas hand pumps, small electric pumps and dug wells are being used by the individuals/communities at private levels. However, in some area people are drinking unsafe rainfall water from the small pond locally called "tobas" like in Cholistan desert. At government level Public Heath Engineering Department, Local Bodies, Saf Pani Company are the major entities which are trying to cater for the drinking water requirements of the masses. Some NGOs and other donors have also installed some community-based water supply schemes//tube wells etc. Similarly, some water bottling plants are also pumping groundwater and selling the potable water on commercial basis.

Fig 10 More than 100-year-old dug well in DG Khan Hill Torrents area gets water now when there is water in the waterway

Over depletion of aquifer and deterioration of quality are the major concerns for using groundwater for drinking purpose. This situation has led to extra financial burden and health concerns for human beings. For example, as shown above in Figure 10, people in rural areas of DG Khan and Rajan Pur living in the areas of hill torrents must wait for the water flow of rainfall which allow the water to seep into their dug well which they have to lift and use for drinking purpose. In some parts of the province women must travel a long distances and fetch water for domestic uses. Public tube wells installed by various local governments in Punjab under LG&CD department have been show in Fig 11.

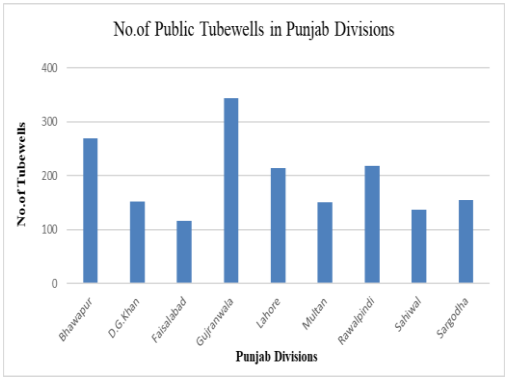


Fig 11 (Source LG&CD Deptt Punjab)

3.2 Urban Areas

The statistics of Pakistan reflect that water supply system is largely dependent on groundwater usage. The most of water supply schemes are designed on the basis of ground water as compared to surface water source. Public Health Engineering Department has the mandate to provide water supply in almost all over the country, except those large cities, where Water and Sanitation Agencies (WASAs) have been established and functioning under HUD&PHE department. A summary of drinking water supplies by WASAs in major cities of the province is given in Table 1.

Table 1: Groundwater extraction by WASAs

Indicator		**Lahore**	**Faisalabad**	**Rawalpindi**	**Multan**	**Gujranwala**
Total Population (millions)		10	3.20	1.5	2.2	2.03
Population Served (millions)		7	2.40	1.35	1.21	0.75
Water Production (MGD)		540	110	56	147	50
Water Demand (MGD)		520	160	60	187	101
No. of Tube wells		575	86	410	102	67
Water Filtration Plants	Operational	419	Nil	146	32	Nil
	In Process	155	Nil	15	50	Nil
Surface water plant	Operational	Nil	3	1	Nil	Nil
	In process	1	1	1	Nil	Nil

Source: HUD&PHED 2018

A breakup of domestic water consumption has been provided by WWF 2014, which is tabulated in Table 2.

Table 2: Breakdown of domestic water consumption in Lahore

Activity	Slum Areas		Non-WASA Areas		WASA Areas	
	Volume (Liters)	Percentage%	Volume (Liters)	Percentage%	Volume (Liters)	Percentage%

Cooking	4.30	1.35	4.30	2.45	12.30	4.57
Drinking	15.80	4.96	14.80	8.50	20.20	7.50
Clothes Washing	114.5	36.0	37.00	21.30	64.00	23.80
Gardening	1.10	0.35	2.20	1.25	4.80	1.78
Car Washing	2.10	0.67	7.25	4.20	23.00	8.55
Bathing	110.50	34.75	73.60	42.30	87.25	32.45
House Cleaning	68.50	21.54	30.25	17.40	42.25	15.70
Other Uses	1.20	0.38	4.60	2.60	15.20	5.65
Total	318	100	174	100	269	100

Source: modified and Updated by WWF (2014) from JICA Report (2010).

Due to absence of any comprehensive regulatory framework for groundwater usage, most of the housing societies and industries utilize excessive ground water, which is a major cause of ground water depletion. Housing societies are extracting ground water at a rate of 0.37 million cubic meters per day, whereas, if there is no water supply in the area extraction comes out to be 0.35 million cubic meters per day, so the total extraction comes out to be 0.71 million cubic meters per day. Ground water usage in Lahore comes out to be 3.79 (MCM/D) by pumping for 14-18 hours per day (WWF-2014).

WASA Lahore is responsible to supply water in urban parts of city. In addition, the other housing authorities like Defense Housing Authority, Lahore Cantonment Board, Walton Cantonment Board, Model Town Society, and Pakistan Railways are responsible to provide water in their respective jurisdictions as shown in Table 3.

Table 3: Groundwater extraction in non WASA areas in Lahore.

Area	**No. of Tube Wells**	**Total Capacity (m^3/day)**
Lahore Cantonment	53	244,512
Walton Cantonment Board	53	259,200
Defense Housing Authority	20	97,632
Model Town society	15	77,760
Pakistan Railway	52	200,448
Total	**193**	**879,550**

Source: Upgraded by WWF-2014 from JICA Report,2010 &Punjab Agricultural Census

4. EXPERIMENTAL LAY OUT ALONG RAVI RIVER BY IRI

The urban area of Lahore has almost doubled in the last 15 years. According to the 1998 census, there were nearly 6.32 million people in this area. The Census of 2017 has determined the population of Lahore as 11.13 million with an annual growth rate of 4.07 percent. Lahore covers a total area of 1014 km^2 and lies between 31°15'-31°45' N and 74°01'- 74°39' E. It is entirely groundwater

dependent city (Ahmed. N*et al* 2002).In the last decade, rate of water use in the industrial city of Lahore has grown more than the rateof population growth. Water stress coupled with urbanization and industrialization is posing a serious threat to Lahore aquifer. Presently, Lahore is facing different types of water scarcity. To address water scarcity problems and achieve a balance between supply and demand of water, it needs improved water governance and demand management. There are two major threats to groundwater degradation; contamination and over pumping. The situation of water shortage is furtheraggravated by discharge of untreated sewage into rivers and leakage to underlying aquifer thereby causing water pollution. To monitor and evaluate the impact of effluents being throw into the River on groundwater quality, IRI has laid down a setup of piezometers along Ravi river in a reach of 60 km from Ravi syphon to Mohlanwal just downstream of the point where Hudiara drain enters the River. This layout is shown in Figure 12.

Water levels and groundwater quality analysis are being carried out from these piezometric network laid in 2009-10. This set up gives 4-dimentional trends in groundwater levels and quality i.e. along the river, perpendicular to the river, vertically downward and with the passage of time.

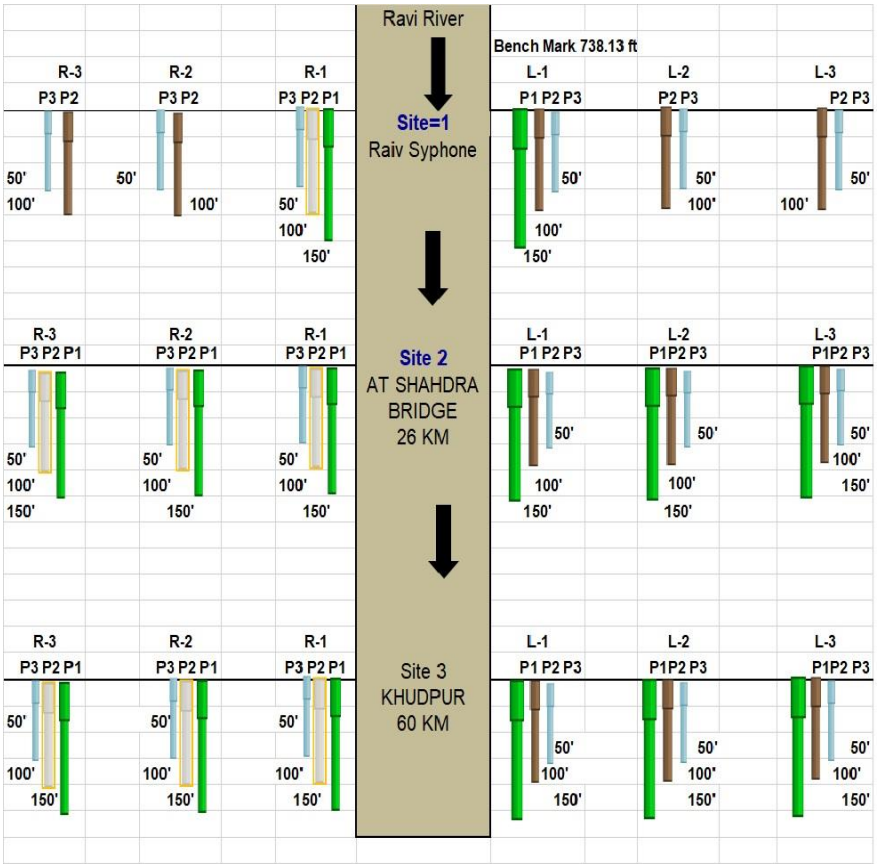


Fig 12. Observation wells at experimental site along Ravi River

5. RESULTS AND DISCUSSIONS

The results analysis of groundwater from piezometers installed at Ravi Syphon site indicate that groundwater quality downstream Ravi Syphon on both sides of the River at all depths (50 ft, 100 ft and 150 ft) is good and is not deteriorating. This indicates that groundwater quality perpendicular to

the river from Left side or right side (L1, L2, L3 or R1, R2, R3) is good and can be used as bench mark for comparison of groundwater quality while moving downward. The data analysis at Shahdara site reveals that EC values at 50 ft depth are more as compared to the value at 150 ft depth on both sides of the River. At Mohlanwal site, EC values of piezometer installed at 50 ft depth are more as compared to those at 100 ft and 150 ft depth on left side while lesser on right side of the river (Hassan. G. Z*et.al*, 2013). It has been found that pollutants in Ravi River are the source of contamination for the groundwater underlying the aquifer. Groundwater quality at Shahdara is the worst due to domestic and industrial effluents leaching down from the unlined drains and the river.

Being a thickly populated, hub of industrial activities and provincial capital Lahore has become a city of complex issues related to groundwater pollution. A wide range of pollutants generated by natural and human activated are contributing towards the degradation of groundwater in the area.Major sources of contamination of groundwater in Lahore aquifer have been identified as under:

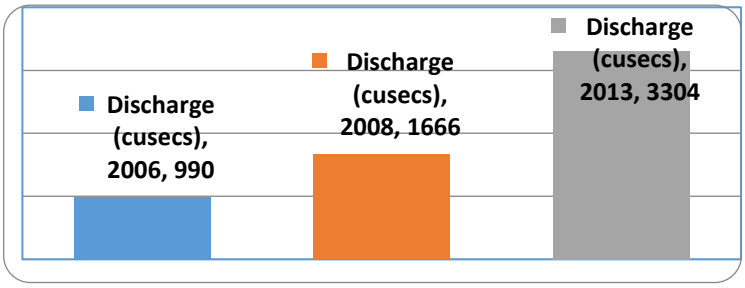


Fig.13: Effluents being thrown into the Ravi River

5.1 Sewage and Street runoff

Urban population in the Lahore is increasing at an alarming rate of 4% per year which is leading towards a continuous increase in domestic sewage. This sewage coupled with street runoff is a severe threat to groundwater as a part of it ultimately leaches down to groundwater. It was estimated that discharge of waste water of Lahore city into Ravi River was about 990 cusecsin year 2006 (Saeed and Bahzad 2006) and now has crossed to 3,304 cusecs through drains and various pumping stations without proper treatment (Hussain & Sultan, 2013) as depicted in Fig. 13.

Different drains carrying effluents entering the River are tabulated in Table 4 which indicates that pollution load in these effluents is increasing with the passage of time.

Table 4: Discharge and Quality of Wastewater in the Major Drains in Lahore city

Sr. No.	Name of Drains	Discharge (Cusecs)	TDS (ppm) (May, 2011)	TDS (ppm) (March,2012)
1	Mehmood Botti Drain	20.87	775	1117
2	Shad Bagh Drain	139	663	1067
3	Farrukh Abad Drain	219	1088	1627
4	Bhuda Ravi Drain	41.99	1006	1100
5	Main outfall Drain	193	627	1154
6	Gulshan-e-Ravi Drain	246.5	897	1035
7	BabuSabu Drain	270.7	760	1135
8	Hudiara Drain	535.7	1197	1506

(Source: Hassan 2013)

5.2 Industrialization

The pressure on water resources caused by industrial growth also merits discussion due to their significant contribution to water pollution problems. It has been estimated that around 2000 million gallon of sewage is being discharge to surface water bodies every day in Pakistan (Pak-SECA, 2006). According to Sial, R.A.*et.al* in Pakistan out of 6634 registered industries 1228 are considered to be highly polluting. Industrial units including textile, chemical, food processing, pulp and paper, poultry, dairy, plastic, paint, pesticides, leather, tanneries and pharmaceuticals directly discharged their waste into the canal system contaminating ground water level as well (Raza, A. 2014). In Pakistan, only 1% of wastewater is treated by industries before being discharged directly into rivers and drains. In Lahore, only 3 out of some 100 industries using hazardous chemicals treat their wastewater. Lahore dumped about 200 million tones liquid and 100 million tones solid wastes into the river Ravi. The discharge of wastewater from domestic, municipal and industrial sectors directly into water bodies without proper treatment is major cause of surface and groundwater pollution in Pakistan.

5.3 Dumping of Solid Waste

Typically Municipal Solid Waste (MSW) consists of household waste, commercial waste and institutional waste. Unscientific dumping of solid waste always poses serious environmental problems on groundwater. Leachate produced at landfill contains thousands of complex components and it becomes part of groundwater after infiltration. With reference to Lahore city, three sites were selected which are located at Mehmood Booti, Saggian and Baggrian for dumping of solid waste. Groundwater is suspected to be contaminated due to unscientific, unsafe, unplanned and traditional selection of these sites. At least three-quarters of the total waste generated (3800 tons/day) in Lahore is dumped at these sites without proper treatment. According to a previous study, it was found that

most of groundwater samples collected from nearby these landfill sites contain pollutants and their concentration level in groundwater is higher than prescribed by Pakistan Standards and Quality Control Authority (PSQCA) and concentration of Arsenic in drinking water Is higher than WHO criteria (Akhtar & Zhonghua 2013). It was reported in the Daily newspaper (20 May 2008), that according to United Nations Environmental Program (UNEP)'s data about 47% drinking water in Lahore city was contaminated due to presence of various hazardous toxic elements (Manan, 2008).Due to open dumping of industrial/municipal wastes, the underground quality of water is deteriorating.

5.4Industrial and Vehicular Emissions-Acidic Rain

Vehicular and industrial emissions comedown with rainfall in the shape of acidic rain which increases the acidity of surface water body like lakes, rivers and drains due to which aquatic life is affected adversely. These toxic pollutants leach down from soil surface to groundwater. Acidic rain dissolves all the useful minerals from the top soil like potassium, calcium, magnesium and leaches them down to the aquifer. Similarly aluminum is also activated by acid rain which causes the death of aquatic life and contaminates the groundwater reservoir. In Lahore being an industrial city, it has been observed in a separate research study the rainfall water more contaminated as compared with the non-industrial areas outside Lahore. This rainfall when flows thorough the drains and rivers and leached down, pollutes the groundwater.

5.5 Low Flow in Ravi River-Reduced Dilution

Ravi River is the smallest of five eastern rivers of the Indus River System (IRS). It enters in Pakistan at Jassar, about 120 km upstream of Lahore and joins the Chenab River near Kabirwala after flowing down about 520 km. The average annual flow of the Ravi River in Pakistan territory was 7 million acre feet (MAF) during the period 1922 to 1961 but due to Indus Water Treaty of 1960 between India and Pakistan, right to use the water of this river were allocated to India. The average annual flow from 1985 to 1995 was recorded as 5-MAF which was further decreased to 1.1 MAF in years 2000-2009 due to construction of hydropower projects/dams on Ravi River (Figure 14). It results in lowering in groundwater level in Lahore and it adjoining area. Ravi River seems to be the main source of recharge in the North-West of Lahore. For the last two decades, Ravi River remained almost dry except in monsoon, so the recharging through River has seriously decreased. Under these circumstances on one side recharge to the aquifer has decreased tremendously and on the other side the ecosystem in the river has suffered badly and river has become a "sludge carrier".

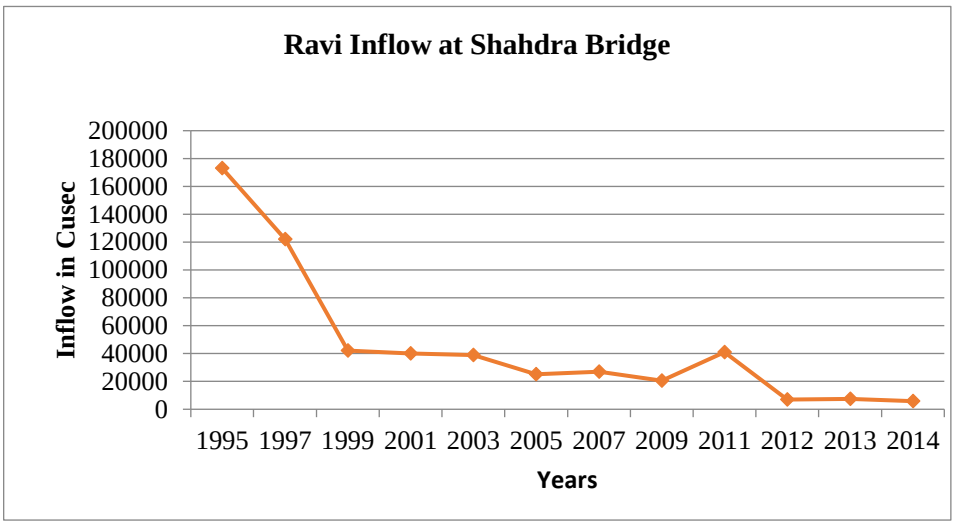


Fig 14

5.6 Population Growth-Over Pump age

Population growth has a direct impact on depletion of groundwater resources. Abstraction of groundwater increases as population grows and over-exploitation of aquifer results in decline of groundwater levels. At present groundwater is the only source of water supply for Lahore city. WASA, Lahore has installedtube wells of different capacities at a depth of ranging from 150 to 200 m for supplying water to the citizens of Lahore. In addition to WASA tube wells, many private tube wells installed in housing schemes are roughly pumping 100 cusec water daily. Water is also being pumped by industries at the rate of approximately 375 cusecs (Hussain & Sultan 2013) and (Hassan 2013).

5.7 Land Development-Urbanization

Lahore has practically no infiltration due to extensive industrialization and increasing heavy construction trends and pavement of roads/streets. Consequently, area of recharge has been reduced. This factor is playing an indirect but a significant role in aquifer depletion and its susceptibility because a large part of the land has become impermeable. Urbanization affects the quality as well as quantity of the groundwater by rapid change in aquifer recharge patterns/rates and establishing new/excessive abstraction regimes. As shown in Table 5, the cultivable area (source of recharge) has reduced rapidly due to urbanization trends.

Table 5: Trends of urbanization in Lahore.

Period	Total Area	Cultivable area	%age of cultivable
-	Ha	Ha	-
1972	177204	166862	94
1973-80	177204	163413	92
1981-90	177204	114298	65

1991-2000	177204	81040	45
2001-2010	177204	52232	29

Source: Khubaib Irshad, 2018

In addition to the threats mentioned above, lack of proper coordination between various stakeholders and awareness among the various groundwater users are also of prime concern and contribute significantly in degradation of the groundwater resources in the city.

6. CONCLUSIONS AND RECOMMENDATIONS

Groundwater is a natural gift and is major source of drinking water globally as well as in Pakistan. Rainwater, floods and canal irrigation network in Indus Basin are the major sources of groundwater recharge. However, this natural gift is depleting due to high pump age and its quality is being deteriorated due to disposal and discharge of polluted water into water bodies which seep into the aquifer. Aquifer is being used as a dust bin by disposing off all pollutants into it like the concept "out of site out of mind" as it is a hidden source. There is myth that it is unlimited and is therefore being used lavishly due to poor knowledge and awareness among its consumers. Unsafe drinking water is causing many health issues to the children and adults. Groundwater which once was the safest, most economical and easily accessible source of drinking water has now gone out of bounds of its consumers both in qualitative and quantitative manners rather has become a major cause of deaths of human being on the planet. There is a dire need of educating the public about the real value of water and associated concerns to make the users more conscious and educated in this regard. This would help in reducing demand, would encourage efficiency of usage, and reduce pressure for unnecessary expansion in certain areas.

Keeping in view the importance of groundwater, its sustainable use is of utmost importance. To address groundwater issues there is need to encourage water metering and effective control over wastage of municipal water, discharge wastewater after proper treatment, and follow the principle of "polluter pays" in the case of industrial effluents. Few suggestions in this regard are treatment of wastewaters, scientific and planned pumping of groundwater, aquifer mapping for resource assessment, adopt artificial recharge schemes to replenish the most depleted aquifers, rainfall harvesting and artificial recharging of underlying aquifer, identification of potential sites in both rural and urban areas, a comprehensive groundwater regulatory framework, use of scientific tools and models for resource assessment and future potential, studies of solute transport for assessment of aquifer pollution at sub-basins levels, rationalize the surface water supplies where possible keeping in view the groundwater potential, awareness raising, strong coordination and institutional set up, promotion groundwater education from the school level and higher education institutions in groundwater.

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Presentation Abstracts

Safe Water & Sanitation Governance in the SDG ERA: Surveillance, and Water Quality Regulation

Kitka Goyal

Abstract

Safe Drinking Water, adequate sanitation and hygiene (WASH) are fundamental to human health and wellbeing. Aside from domestic purposes, water is needed for food, energy and industrial production – uses that are highly interconnected and potential conflicting. These uses generate wastewater which may cause pollution if not properly managed. Water can be instrumental in the implementation of integrated solutions across different sectors. However, water resources are commonly developed and managed by different government departments and within different sectors resulting in little coordination between them and a lack of overview of the state on the resource. Inherent in this sectoral approach is the problem of coherence, where policies and decision making in one sector may contradict or duplicate those in another. To ensure sustainable management of water and sanitation for all, it is essential to look at the water cycle in its entirety, including all uses and users. The shift from the Millennium Development Goals (MDGs) to the Sustainable Development Goals (SDGs) is a game changer for drinking water and sanitation where countries need to transition from a relatively narrow focus on providing access to improved sources of drinking water and basic sanitation to a more comprehensive focus on sustainably managing the whole water cycle in an equitable manner.
The 2030 Agenda for Sustainable Development, the world has a historic opportunity to set a course for the next era of human development that is transformational for children and their families. WASH underpins many of the 17 SDG's. The SDG 6 has 2 targets (i) By 2030 achieve universal and equitable access to safe and affordable drinking water for all (ii) by 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations. These ambitious targets mean we cannot continue do "business as usual" in the WASH sector but we need strong institutions that will ensure WASH services are safe protect the overall health and wellbeing of its citizens. We need clarity in the roles and responsibilities of the different government departments along the lines of Policy formulation and standards, drinking water quality and sanitation surveillance, and regulation for payment for services and quality of services

Appraisal of the Implementation of Water Related Policy Instruments in Pakistan

Muhammad Ajmal Sandhu

Abstract

Policy implementation has a weak track record in Pakistan resulting in deficit service delivery on part of governments at all the federal, provincial and local levels. Even the issue of safe drinking water that is of grave public concern stands no exception to this usual attitude of government. Despite the fact that water related issues in Pakistan have been adequately reported by the domestic and international civil society, experts on water management and others for almost three decades, and good policy instruments have been prepared by and/or provided to government(s), the progress on

implementation has been very dismal. Evidence based information can only be utilized duly when coupled with political will, required infrastructure, administrative capacity and human resource capabilities for implementation.
National Water Policy 2018 is a recent appreciable policy instrument unanimously passed by all the federating units of Pakistan that emphasizes on the governance and administrative initiatives on multiple aspects of water management in the country on war footing including drinking water. Prior to this policy, two very significant policy instruments were in place for addressing water related issues; these being 'Pakistan's Drinking Water Policy 2009' and 'A Productive and Water Secure Pakistan' the report of the water sector task force of the friends of democratic Pakistan prepared in 2012. This paper will review progress, lags and challenges faced in the course of implementation of these two instruments. The aim of this exercise is to raise awareness on demand and promote mass mobilization for implementation of the National Water Policy 2018. Civil society, academia, corporate sector and the market forces must join the efforts aiming at delivery and accountability of the safe drinking water governance in Pakistan in order to positively change the government response. Scope of these policy instruments is wider but this paper will focus only on the drinking water governance.

Understanding And Reversing Drinking Water Crises in Pakistan

Saad Khan (Switzerland)

Abstract

Pakistan has inherited some of the World's best sources for ground and surface water, including superlative sources such as world's largest contiguous irrigation network and grand Indus Basin that are fed by world's largest glaciers and snow bound mountain peaks. Notwithstanding the above, the drinking water status in Pakistan is progressing from "good, too bad, to ugly". The presenter believes that the drinking water crisis could be averted by developing the understanding of the core issues that have contributed in the depletion of ground water and increase in contaminations, and with smart interventions, effective policies, and changes in habits. This presentation addresses the underlying core technical reasons for the imminent drinking water scarcity in the country and offers pragmatic solutions to reverse it. The topics addressed in this presentation include: The gaps in ground water availability, usage, and safe recharge as predicted for 2025 in WASA report published in 2004 (Water Security for South Asia, 2004); Basics on hydrogeology, including morphology of Indus basin, unconfined and confined aquifers, and their recharge; The paradigm of tube-well ground water extraction for addressing high water table issues, for reclaiming land from water log and salinity, and for irrigation of (Rabi) winter crops; The reasons for rapid increase in microbial and chemical (Arsenic) contamination in ground water sources; The Good, the Bad, and the Ugly aspects of use of reverse osmosis(RO)technology for drinking water treatment; Understanding segregation of blue, green and grey waters and best practices for managing ground water recharge at communal and household levels in urban and rural contexts; Making contaminated blue water safe for drinking at household level and for rural small communities; Water conservation's best practices at household level; And understanding "Water-Footprint "for agriculture products and need for changing food habits.

Drinking Water Quality Assessment of District Bhakkar

Zamir Ahmed Soomro

Abstract

To assess the drinking water quality of district Bhakkar, a total of 16 water supply schemes (WSS) were investigated for physico-chemical and bacteriological contamination. Along with that, health risk associated with fluoride and arsenic was also estimated. By using standard procedures and protocols of PCRWR (Pakistan Council of Research in Water Resources) laboratory, one sample was collected from source end and two samples were collected from consumer end of each scheme. Results showed that some parameters like potassium, arsenic, fluoride and bacteriological contaminants exceeded the permissible standards of World Health (WHO) and other local drinking water standards. Additionally, Pearson Correlation Matrix also showed statistically significant relationships (r=0.725-1.00, p< 0.01) between various physico-chemical parameters (TDS, Ca, SO 4 2- and Hardness). Furthermore results showed that there was no significant impact of distribution network on physico-chemical parameters while a significant impact of bacteriological contamination was studied on the quality of potable water. Moreover, Health Risk assessment model revealed very low health risk potential in terms of Arsenic and fluoride among the residents of the district. Hence, the present study acts as a caution, as groundwater quality of Bhakkar is gradually getting deteriorated and it may continue with time. Hence the local government needs to initiate remedial measures in the district to provide safe drinking water for the residents.

Social Power and the Politics of Water Access in Karachi

Daanish Mustafa (UK)

Abstract

Based upon three years of field work in Karachi, I concluded that the geography of access to water supply and sanitation closely follows the geography of power in the city. The access to water supply is closely imbricated with the layers of political, cultural, linguistic and ethnic conflict within the city. While the authorities tend to focus on supply side solutions there is a greater need to investigate and address the social geography of access to potable water. Towards that end, some of the measures, e.g., greater regulation of groundwater pumping, tanker market and suction pumps will be some important measures to make the access to water more equitable. Furthermore, research on modular water systems for the absolute poor should be on the agenda.

Improving Water Resources Governance for Safe Drinking Water Challenges and Opportunities

Engr. Mushtaq Ahmad Gill

Abstract

Adequate and safe water is important for human health and wellbeing, economic production, and sustainable development. Failure to ensure the safety of drinking water may expose the community to

the risk of outbreaks of waterborne and infectious diseases. The scarcity of fresh water resources has been a growing global issue for centuries. Less than 2.5% of the water on earth is fresh water, and of it, about 0.014% is available to humans and the rest sits in untouched ice caps and glaciers. The scenario of drinking unsafe water is most common in developing countries and the problem is exacerbated in rural areas. Safe drinking water scarcity in the form of physical water scarcity (low quantity) and economic water scarcity (low quality) have been elaborated including various non-harmful physical qualities of water (color, taste and smell) which could also render water to be deemed unusable by its contended users. The challenges to water quality stem not only from the physical contaminants but also from the sheer volume of contaminants that can overwhelm an area's infrastructure or resources to treat and remove the contaminants. There is a dire need to identify the challenges of sustainable access to safe drinking water in order to determine the short-term management actions and long-term strategies to improve water quality. Establishing a comprehensive drinking water system that integrates water supply, quality and management as well as associated educational and water literacy programs in order to ensure the safety and sustainability of drinking water supplies is essentially required. Pakistan is amongst the top 10 countries of the world with over 16 million people living without access to safe drinking water. Presently, the country has no law to regulate useful water and erratic supply of safe drinking and domestic water that often affects good hygienic practices. Major issues and challenges confronting access to safe drinking water are:

- Fresh water systems inclusive of shallow groundwater are being polluted through disposal of industrial and domestic effluents in the urban and rural areas.
- Currently, over 65% of the population of Pakistan has access to protected sources of drinking water with 85% of them living in urban areas
- Limited availability of safe drinking water and its in-equitable distribution and system losses have reached alarming proportions in the urban areas and the larger rural settlements.
- Lack of good governance in the water sector institutions at various levels.
- Lack of rainwater storage for drinking and domestic use in urban and rural households through roof top rainwater harvesting.

Policy support is imperative for managing safe water environments because routine concept of water licensing and capping groundwater abstractions cannot be implemented unless civil society is stimulated to manage water resources. Enforcements of required regulation is difficult until the urban and rural masses are sensitized through electronic, print and social media besides the role of academia for judicious use of safe drinking water. Concerned formations need to be instrumental in orienting the state's focus on safe drinking water availability and initiating efforts to formulate legislations for ensuring safe drinking water for all segments of the society.

Drinking Water Supply for the Tail-end Communities of Canal Command Areas and Indus Delta

Dr. Hassan Abbas

Abstract

This paper discusses the concept of 'canal fed critical areas' or CAFCAs in the Indus Basin Irrigation System (IBIS) - defining a CAFCA as an area within a canal command where rainfall is very little and groundwater is brackish, making canal water as the only significant source of freshwater in that area. This makes CAFCA communities totally dependent on canal water supply for all their freshwater needs such as drinking, health, hygiene, and livestock etc., not just irrigation. At the time of inception (and subsequent development) of IBIS, no risk management strategies/plans were conceived/implemented to cater for freshwater in CAFCAs in case the canal water could not be delivered there, including the routine canal closures. For example, people of Gharo in Sindh Delta are

now sharing the trickles of non-saline polluted water with dogs, provided to the communities through sorry-looking engineering works financed by aid-dollars, as the freshwater supplies diminish in Sindh Delta. Similarly, the irrigation command areas which were "made to bloom" with the diverted canals from the rivers, get their domestic water supply from open ponds which could just as easily be mistaken as cesspools. For most communities at the tail-ends of the irrigation canals, such 'engineered' ponds are the only source of potable freshwater. This type of domestic water supplies situation is neither isolated nor trivial. Most of the villages in the Indus delta and over half of all the canal command areas of Pakistan are now in the category of CAFCAs, where people are struggling for drinking water supplies.

The paper, after discussing the current state of affairs, puts forward a vision of the future development of the Indus Basin leading to clean and abundant water for domestic consumption and a dignified lifestyle of local communities.

Community Participation

Atif Hassan

Abstract

Water and sanitation together is an important but ignored sector in Punjab. It is generally underfunded and many groups of population are excluded from the provision of safe water and adequate sanitation. Even if the provincial government assigns high priority to the sector, it is difficult for it to finance public provision of these services to the population. Given this, community participation in the provision of water and sanitation services can help extend these services to the people in Punjab. There is a considerable history of community participation in the provision of these services. Government as well as non-governmental organizations stepped forward to evolve community participation both in enhancing coverage as well operation and maintenance of water and sanitation facilities in Punjab. Some of the successful models like component sharing, operation and maintenance of water and sanitation facilities by local community organizations and by private sector emerged over more than three decades provide a base for sustainable development of the sector.

The central objectives of this paper are to provide critical analysis of the community participation in water and sanitation sector. I argue that community participation has significant prospects for extending water and sanitation services to the people of Punjab. My argument will unfold as follows: Firstly, I will analyze traditional approaches adopted by the water utilities, government departments and local government in service delivery and operation and maintenance of the sector. Secondly, I will highlight the issues related to planning, designing, execution, monitoring and overall management of water and sanitation projects. I will particularly focus on the work of Public Health Engineering Department (PHED), Government of Punjab which has made a shift in traditional approach by delegating operation and maintenance of its water supply and sanitation schemes to Community Based Organizations (CBOs) in late nineties. In Punjab, 2400 CBOs are operating and maintaining rural water supply and sanitation schemes out of 2800 operational schemes of PHED. I will provide insights into the present day scenario of these CBOs and draw critical analysis of their functioning to bring forward concrete actions for future ventures in the sector.

Simultaneously, I will highlight the component sharing approach in water and sanitation which has been established at many places in Pakistan like in Orangi Town in Karachi under Orangi Pilot Project (OPP), Lodhran Pilot Project (LPP) in south Punjab, Anjamn-e-Smaji Behbood (ASB) in

Faisalabad and Bhalwal under Changa Pani Program and low cost sanitation in Lahore by MUAWIN in Lahore. This approach creates ownership in the community for operation and maintenance as well as for other sustainable development initiatives. By analyzing established component sharing models, I will provide insights into the future prospects of community participation in solving water and sanitation problems Punjab.

Mobile Reverse Osmosis (RO) Plant for Thar Desert (An Innovative Initiative)

Ali Akbar Rahimoo

Abstract

An innovative initiative was started to cater the need of drinking water of 15 villages of UC Charnore and Heerar of Taluka Chachro of Thar Desert. There are 15 villages in target area, these villages having dug wells and other water storage tanks but having shortage of water and if available then lot of problems regarding fetching and other issues regarding quality and standards of water. Preserving the quality of raw water is important not only for the drinking-water supply, but also for food production and other water uses. Water quality can be compromised by the presence of infectious agents, toxic chemicals, and radiological hazards.

Water quality deterioration in distribution systems is mainly caused by inappropriate planning, design and construction or inadequate operation and maintenance and water quality control. This has been linked to a significant proportion of the burden of waterborne and water-related illness. Stresses on these systems caused by rapid urbanization, population growth and aging infrastructure further exacerbates the problems. The integrity of well managed distribution systems is one of the most important barriers that protect drinking-water from contamination. However, management of distribution systems often receives little attention. Distribution systems can incorrectly be viewed as passive systems with the only requirement being to transport drinking-water from the outlets of treatment plants to consumers

AWARE installed 14 solar powered submersible pumps in these villages and we come to know that water which we are getting is good in comparison with previous available water but not according to drinking standards, TDS of water comes more than 2000 mg/lit PH is more than 7.5 so discussed within the team and decided to introduce the Mobile RO plant for filtration of water as all villagers get their right of safe drinking water. After seeing result of water all team sit together and discussed the problem and find out the solution. They all agree that we should suggest for a RO plant for all these villages for purification of water, but it is impossible to install that much number of RO plant in

these 14 villages because of limitations of budget, so we decided to recommend Mobile RO Plant means a RO plant which is mounted on a 6x6 vehicle.

By the experience, this is learnt that the vehicle is running 1220 km in one month and consume fuel of 27450 Rs generator consumes 442.95 liter fuel which costs 39867.2 Rs and gives product water of 141750 liter per month, and there is other costs which are also to be included such as oil change maintenance driver operator cost chemicals filter used in this all should be included and after all calculation we come to know that water costs per liter is 0.86 rupee so, this was decided to charge Re 1 per liter to cover all expenditure of mobile RO plant.

Water, Women Everywhere, but Not a Drop to Drink?' Reading Saraswati and Paroshni as Allegories for Water Governance, Ecofeminism and Environmental Activism in Mustansar Hussain Tarar's 'Bahao'

Raza Naeem

Abstract

'But why this happened, Paroshni? We were living in comfort and living life as we wished, and everything was in its place, then why the rains haven't fallen now? Why have the great waters lost their way?' 'We ourselves create a way of life and when there is an upheaval in this way of life, we become lifeless. Yes, we have ourselves created that way of life, so we cannot break it…and when it breaks, we ourselves break with it. Any way of life…when it is broken, somewhere something happens to break it' Mustansar HussainTarar's neglected trilogy of novels ('Bahao', 'Rakh' and 'Qurbat-e-Marg main Muhabbat') pose the question as to the fate of civilizations when rivers supporting them begin to dry up. In the first novel of the trilogy 'Bahao', women play seminal roles as eco-feminists and environmental activists; and thus, by extension, better managers of water. The river which supports Mohenjodaro is conceptualized as a woman: 'Saraswati, who is the mother of great waters…and the seventh stream, its waters come, roaring grandly and loudly'; Gagri is solely responsible for hunting exotic birds; Pakli is the sculptor of exquisite seals which she hopes will immortalize her name long after the Saraswati has dried up; and Paroshni is not only cast as the environmental activist who first discovers and then must warn her fellow countrymen about the impending drying up of the river, but in her own personal relations with men and decisions relating to motherhood, she exhibits a remarkable degree of gender equality. Thus the fate of the land is intimately tied to the role of both water and women as symbols and carriers of fertility. Based on first-time original translations into English from Tarar's masterpiece and in Tarar's 80th birthday year (2019), I argue that the novel and its central question of the drying up and decline of rivers leading to the collapse of ancient civilizations has found a new relevance in our own time, given the perils of global warming (with an added human dimension), water depletion and overuse, and the fact that Pakistan is one of the most water-scarce countries with a rapidly-growing population.

Poster competition cash prize

During the conference 70 posters were displayed and the poster Review Committee was constituted to review the posters and recommend first, second and third best posters for the cash award. The committee comprised the following members:

- Dr. Iftikhar Ahmed, Punjab University
- Dr. GhazalaYaqoob, Kinnaird College University
- Dr. Tahira Mughal, Lahore College University
- Dr. SaimaGulzar, University of Management and Technology

The committee announced the following presenters as (Please add names)

1. Dr. Iftikhar AhmedFirst prize Rs 9000
2. Syed Khadim HussainSecond prize Rs 7000
3. RK Chisti Third prize Rs 4000

Appendix 1

Program of International Conference 2019(15-16 January2019)

AVARIHotel Lahore, Pakistan
International conference
Safe drinking water governance (SDWG), 15-16 January 2019
AVARIHotel Lahore, Pakistan
DAY ONE

Opening Ceremony (KhursheedMahal) Day- 1
15 Jan, 2019

8:00am–9:00am	Registration:	
9:15am	Guesttobe seated	
9:30am	Arrival of Chief Guest	**Remarks**
9:30am TO 9:40am 9:40am TO 9:50am 9:50am TO 10:00am 10:00am TO 10:15am 10:15am TO 10:25 am 10:25am TO 10:30am 10:30am TO 10:40am	• Recitation from Holy Quran & National Anthem • Tribute to late **Dr. Hasan SohaibMurad** by (Mr. Ibrahim Hasan Murad) • Welcome Address by Director SGS, **Prof. RahatUlAin** • Conference Brief by the **Prof.Seemi Waheed.** • Address by Rector UMT, **Dr.Muhammad Aslam** • Keynote speech by **Mr. Saad Khan** • Address by Chief Guest **Ms. Zartaj Gul** (Minister for Environmental Climate Change) **Souvenir Distribution &Group Photograph**	BothSections of BS PA to bepresent. Gr 1A, 1B to write One page Report of the Session: Font 12 Space 1.5 T B L R margins .9. **All MPA students To be present** Both section Groups to write 1 page report Of this sessions 1 page report of the allocated sessions to be written by respec-tive groups
11:00am-11:30am	**Refreshment**	

(PanelDiscussion-1) (KhursheedMahal)Day- 1 15 Jan, 2019		
Timings	**Theme:** Existing safe drinking water legislation policy, and the SDG's achievement **Session Chair:** Dr. AbidBodla	
11:30 – 11:50p	**Panel Discussant** **Mr. AnandaJayaweera** Title: Water Governance to Achieve SDG 6 Targets	**Sec. 1A, 1B, 2A, 2B, 3A, 3B**
11:50 – 12:10	**Mr. KitkaGoyol** Title: Safe Water & Sanitation Governance in the SDG era: Surveillance, and water quality Regulation	**4A, 4B, 5A, 5B 6A 6B** **7A, 7B, 8A, 8B 9A, 9B**
12:10 – 12:30	**Mr. NiazUllah Khan** Title: Accountability and Regulation- A Case Study of Punjab Pakistan **Mr. Muhammad** Ajmal Sandhu **Title:** Appraisal of the Implementation of Water related Policy Instruments in Pakistan	**10A, 10B, 11A, 11B, 12A, 13A All MPA Students to Write separate** report
01:20- 2:00pm	**Lunch and Zuhr Prayer**	

(Panel Discussion-2) (KhursheedMahal) Day- 1 15 Jan, 2019		
Timings	**Theme:** Challenges to safe drinking water availability and improving water resource management **Session Chair:** Dr.Tahira Mughal **Session Facilitator**: Dr. Aisha Azhar	
2:00 – 2:20pm 2:20 – 2:40pm 2:40 – 3:00pm	**Panel Discussant** **Mr. Saad Khan** Title: Understating and reversing drinking water crisis in Pakistan **Mr. Sohail Ali Naqvi** Title: The groundwater challenges in Pakistan and strategy to replenish it **Mr. Zamir Ahmed Soomro** Title: Drinking Water Quality Assessment of District Bhakkar **Ms. Saeeda Batool** Title: Willingness to Pay for Safe Drinking Water and Incidences of Diseases: A CASE STUDY of Pakistan **Q&A Session/ Closing remarks by the Session Chair** **Group Photograph**	**1A,1B, 2A, 2B** **3A, 3B** **4A, 4B, 5A, 5B** **6A, 6B** **7A, 7B** **10A, 10B,11A** **All MPA minus Osama And Amjad**
3:50–4:30pm	**Tea Break**	

(Parallel Session-2.1) (Board Room A) Day- 1 15 Jan, 2019		
Timings	**Theme:** Political, social, economic and governance challenges to overuse of water and depleting water table **Session Chair:** Mr.KitkaGoyol **Session Facilitator:** Ms.Maria Bastos	
	Panel Discussant	
2:00 – 2:20	**Dr. Daanish Mustafa** **Title**: Social Power and the Politics of Water Access in Karachi	**13A, 8A, 8B**
2:20 – 2:40	**Ms. Rummana Khan Sherwani** **Title:** Water Quality Assessment of Gulberg II Lahore and Its Impacts on Nearby Community	**9A, 9B**
2:40 – 3:00	**Mr. Khalid Gill and Mr. Mushtaq Gill** **Title:** Improving Water Resources Governance of Safe Drinking Water Challenges and Opportunities	**12A, 11B**
	Mr. Iftikhar Talpur **Title:** Water Governance Policy Gaps in Sindh and Marginalized Groups: Participation of Women	**6A, 6B** **All MPA minus Amjad and Osama**
3:50– 4:30pm	**Networking Tea**	

Conference Dinner by invitation
Venue: UMT Seminar Hall
Timing: 7:00 Pm

Program of International Conference 2019
(15-16 January2019)
AVARIHotel Lahore, Pakistan
International conference
Safe Drinking water governance (SDWG), 15-16 January 2019
AVARIHotel Lahore,
Pakistan
DAY TWO

(PanelDiscussion-3) (KhursheedMahal)		
Timings	**Theme:** Communities contribution and participation in effective water resources management **Session Chair:** Dr**.** Iftikhar Ahmed **Session Facilitator:** Dr.Aisha Azhar	
9:00am TO 9:20am	**Panel Discussant** **Dr. Hassan Abbas** Title: Drinking Water Supply for the Tail-end Communities of Canal Command Areas and Indus Delta	**1A, 1B**
9:20am TO 9:40am	**Mr. Mohamed Rasheed** Title: Overcoming barriers to water utility service provision for small island communities in the Maldives with an emphasis on social enterprise business model	
9:40am TO 10:00am	**Mr. Atif Hassan** Title :Community Participation	**2A, 2B**
10:00am TO 10:20am	**Mr. Rano khan** Title: Improving access to safe water and organic food by use of solar energy in Thar Desert (a model of participatory management of water supply with innovation of water metering Thar Desert)	
10:20am TO 10:30am	**Q&A Session/ Closing remarks by Session Chair** **Group Photograph**	
10:30am–11:00am	**Tea break**	

(ParallelSession-3.1) (Board Room)		
Timings	**Theme:** Water quality, purification technologies and other issues **Session Chair:** Dr.SaimaGulzar **Session Facilitator:** Ms.Maria Bastos	**Remarks**
9:00am 9:20am 9:20am - 9:40am 9:40am - 10:00am 10:00am 10:20am 10:20am-	**Panel Discussant** **Dr. Tahira Mughal** Title:Monitoring of ground water quality of different towns of Lahore **Mr. GhulamZakir Hassan** Title: Groundwater as a source of drinking water and associated concerns **Mr. Ali Akbar** Title: Mobile Reverse Osmosis (RO) Plant for Thar Desert (An Innovative Initiative) **Mr. RazaNaeem**	**BSPA / MPA** **All MPA minus Amjad and Osama**
10:30 – 11:00	**Tea and Review of Posters by Committee**	

(Panel Discussion-4) (KhursheedMahal)		
Timings	**Workshop with CBO's** **Theme:** Drinking water contaminations and treatment solutions at household and community level **Presenter/ Chair:** Mr.Saad Khan **Session Facilitator:** Prof.Seemi Waheed	**Remarks** **MPA/BSPA**

11:00Am-1:00Pm	• Introduction to the water contaminations and treatment solutions • Interaction with community members **Concluding remarks** **Group photograph**	**10A, 10B, 11A, 11B, 12 A, 12B**
1:00 – 2:00	**Lunch and Zuhr Prayer**	

	(Panel Discussion-5) (Khursheed Mahal)	
2:00Pm-3:30	**Theme:** Industrial Waste Water Management/ Environmental Crises & Water vision **Session Chair:** Dr. Asim Mehmood **Session Facilitator:** Dr. Sammia Saif	**Remarks** **MPA/ BSPA**
2:00Pm-2:20 **2:20Pm-2:40** **2:40Pm-3:00** **3:00pm-3:20** **3:20Pm-3:40** **3:40Pm-4:00**	**Dr. SammiaSaif- Environmental Consultancy and Options (ECO)** Title: Introduction on Water and Environment Crisis **Dr. Shafique** Title: Water Vision and its Potential Crisis **Dr. Saqib Nawaz** Title: Waste Water Treatment & Reuse in Pakistan **Dr. Iftikhar Ahmad** Title: Feasibility of Small Dams/Reservoirs **Dr. AsimMahmood** Advances in Waste Water Treatment and Concluding Remarks **Q/A Session** **Closing remarks by Session Chair**	**1A, 1B,** **2A, 2B** **3A, 3B** **All MPA** **5A, 5B**
4:00-4:30	**Tea and Review of Posters by Committee**	

Closing Session (Khursheed Mahal)	

4:30pm-5:30pm	• Recitation from Holy Quran • Address by the Rector **Dr. Muhammad Aslam** • Address by the **Chief Guest** • Address by **Chief WASH UNICEF** • Keynote speech by speaker **Mr. Naseer Ahmad Gillani** • Remarks by **Mr. NiazUllah Khan** • Declaration of the winners for poster competition • Conference Recap and Concluding Remarks by the Conference Convener, **Prof.Seemi Waheed** • Vote of Thanks by the Conference Chair, **Prof.RahatulAin** **Souvenirs Distribution & Group Photograph**	**All BSPA and MPA to be present** **BSPA Section 8A and 8B Prepare one page Report of the session**

Poster Review Committee	
Committee Members	• Dr. Iftikhar Ahmed • Dr. GhazalaYaqoob • Dr. Tahira Mughal • Dr. SaimaGulzar