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IN THIS ISSUE

FOR MEMBERS ONLY

Pakistan Engineering Congress is a prestigious professional body established in 1912 dedicated, interalia to technical advancement of Science & Engineering in the country.

BEWARE OF THIS ALSO

Not only are we facing crises of shortage of water for irrigation or for hydropower generation, another big threat, again due to water, but in a different way is looming large over our heads. This time it is shortage of potable, clean drinking water. Not just the villages and small towns, but also our mega cities are facing this problem, whose gravity is on the increase with every passing day. In many of our cities, the biggest source of potable water has been our once very vast natural underground water reservoir. Due to increase in population in general and rising rate of urbanization in particular, towns have become cities and cities have changed into mega cities. Being most readily source of water, we have unfortunately played havoc with this natural reservoir. On one hand this water has been and is being wasted ruthlessly due to its use without proper planning and carelessness of the users. On the other hand, we have with our own hands diminished the large tracts of land that formed open fields and parks which used to be a source of charging of the natural underground water reservoir in annual rains but are now covered by large buildings of all types. This has resulted in drastic lowering of the water table. Another source of charging used to be the ever flowing rivers and canals many of which have now been reduced merely to sewage water channels. To make matters worse, all types of waste water, whether domestic or from industry are being disposed into the channels. Charging of ground water does take place, but with water contaminated with all sorts of toxic and poisonous substances. A recent study revealed the presence of alarming percentage of arsenic in water, making it highly brackish but was still being used for human consumption. Quite a few casualties are also known to have taken place for similar reasons in a locality around Lahore. By spoiling the ground water, we are not only playing with the health of present population, but are also endangering the health of future generations as well. Is it not a food for thought for the people who matter?

Address of Welcome
By
Engr. Riaz Ahmad Khan
President
Pakistan Engineering Congress
On
World Water Day
Held on
25th March, 2013

Honorable Chief Guest, Engr. Dr. Chaudhry Mazhar Ali
Distinguished Delegates
Members of Pakistan Engineering Congress
Fellow Engineers

Ladies & Gentlemen

Assalam-o-Alaikum!
I take this opportunity on behalf of Pakistan Engineering Congress in general and on my own in particular, to welcome you all, to this gathering, in connection with the "World Water Day", which is observed annually on 22nd of March. The event was declared by the United Nations to be observed annually in view of the increasing importance which water is assuming in the face of its growing scarcity globally. This day is observed throughout the World after the 1993 convention of the International Commission on Irrigation and Drainage in The Hague. The conference had agreed that providing Water Security is a key dimension of poverty reduction. Water Security "FOR ALL" is an achievable goal and there is enough water for everybody in the World, provided we change the way we manage and use it. The "WORLD WATER DAY", calls on each nation, and each one of US to maintain and improve the quality and quantity of fresh water available to future generations. The "World Water Day" event is now gaining importance worldwide. This year the World Water Day is being celebrated on the theme of;

"WATER COOPERATION"

Ladies & Gentlemen!
It is hoped that World Water Day will gradually make all nations and people of the World realize that availability of fresh water is something we cannot take for granted, and that water is indeed one of the earth's most precious as well as the most threatened resource. It is therefore imperative that all water users and stakeholders use this scarce commodity responsibly and judiciously.

I, in particular extend my heart felt gratitude to all of you for finding time to attend this important event, which is of a global significance, yet of much more relevance in the context of Pakistan. It draws attention to the fact that the demand for fresh water is soaring as supply is becoming more uncertain. In Pakistan there is already an increasing competition between domestic, industrial and farm users. Population growth, rapid urbanization and industrialization will be imposing growing demands and enhanced pressures on water in the years to come. The rising imbalance between supply and demand has led to shortages and unhealthy competition leading to bitter

feelings amongst the water users both at farm level and sub-basin and basin level. Instances are not lacking where nations are in bitter controversy on water usage and water rights.

The UN Convention on the Non-Navigational Uses of International Watercourses, approved in 1997 by 104-3 votes, requires watercourses nations to participate in the use, development, and protection of international watercourses in an equitable and reasonable manner. In spite of the UN Convention, riparian nations pitch their respective claims and counterclaims based on their interests and interpretations. This raises fundamental questions on formal arrangements for peaceful sharing of river waters, particularly in regions where the political climate is hostile.

Ladies & Gentlemen!
Pakistan shares the rivers of the Indus Basin with India, Afghanistan and Iran to some extent. While legal mechanism exists between Pakistan and India, there is no similar mechanism in place as yet with Afghanistan.

Between India & Pakistan, Indus Waters Treaty was signed by the two Countries under the aegis of the World Bank during 1960. It allocated waters of river Sutlej, Beas & Ravi to India and Chenab, Jhelum and Indus to Pakistan except for some limited and specific uses as reflected in the Treaty.India has been aggressively following the policy of water resources development and construction of infrastructure on both Eastern and Western rivers, unfortunately no major infrastructure has been started on western rivers by Pakistan after the Indus Basin replacement works. Multitude of projects on the western rivers for hydropower generation by India will impose adverse situation on water flows to Pakistan particularly if mal-operated and will vitiate the very spirit of the Treaty for unobstructed flows to Pakistan. This needs to be proactively defended both at technical as well as diplomatic level.

The effects of Indian projects could only be lessened by timely planning of our own projects. Pakistan has many identified sites on Indus River that include Skardu Dam (27 MAF), Diamer-Basha Dam (6.4 MAF), Akhori Dam (6.0 MAF) and Kalabagh Dam (6.1 MAF). But unfortunately no one could take-off except Diamer-Bahsa Dam, which was taken up only three years ago and its main contract may be awarded this year. However, there are numerous hurdles in its financing which needs to be handled with a strong resolve.

Ladies & Gentlemen!
In the wake of a programme of reconstruction of Afghanistan, planning for rehabilitation of the existing infrastructures like Darunta Dam, Mahipar Dam, Naghlo Dam on River Kabul and construction of new projects like Kama Multipurpose project, Ab-e-Marwareed canal project, etc. in Kabul River Basin (KRB), have been now set in motion by the Donor Agencies. Impact of the water sector projects being rehabilitated on the Kabul River in Afghanistan may not be much on Pakistan. However, the new irrigation projects proposed for construction or Planned, on Kabul River and its tributaries, are likely to affect the existing agriculture as well as power generation uses in Pakistan.

It is, therefore, important to have an international Water Sharing / cooperation Treaty with Afghanistan on the basis of Helsinki rules of "Equitable Apportionment of Waters" of common rivers. It will build mutual respect, understanding and trust between the two Countries and promote peace, security and sustainable economic growth in the region.

Ladies & Gentlemen!

In the end, I thank you again for being with us and providing an opportunity to share these thoughts with you. I am also thankful to eminent experts who will be presenting detailed technical papers on various aspects of water issues and cooperation in the sessions to follow.

Pakistan Paindabad

Address By
The Chief Guest
Engr. Dr. Ch. Mazhar Ali
On
World Water Day-2013
On the theme of
"WATER COOPERATION"
Held at
PAKISTAN ENGINEERING CONGRESS

President Pakistan Engineering Congress
Distinguished Delegates
Members of Pakistan Engineering Congress
Ladies & Gentlemen

Assalam-o-Alaikum!

I feel honoured to be a part of this "World Water Day Programme", organized by "Pakistan Engineering Congress". It is my proud privilege to speak in this gathering of eminent engineers and scientists. The celebration of "World Water Day" seems to be most appropriate in the context of scarce water resources that exist in the world in general and in Pakistan in particular.

We are glad that the "World Water Day" had gained quite significant importance and hope it will make us realize the value of water. Apparently, it seems there is enough water around the World. However, 97% of this water is brackish. Typically, some Islands, surrounded by water, are very dry. These lack fresh water. Most of the fresh water on earth is ice or very deep ground water.

Although water, in all rivers and lakes in the World appears to be in abundant quantity, however, there are two problems. First of all, the World population is growing fast and in the next century it will be doubled. So more people will need water and also water requirements per capita will also grow. Secondly, which is even more serious, much of our waters are polluted. A significant quantity of runoff in the world is being used to dilute and transport waste water and this portion is growing fast. Further it should be realized, that in pre-industrial era rivers could purify themselves as a natural process. We are all governed by the economic principles. If water is scarce commodity and becomes scarcer in future, its price will increase. There is now competition for water between countries between sectors of the economy and between people.

This year, the "World Water Day" is being celebrated on the theme of "Water Cooperation". As you know for water cooperation between India and Pakistan, Indus Waters Treaty (IWT) was signed on September 19, 1960. The IWT is based on the distribution of rivers and not the waters. Under this treaty India was given full flow of the Eastern Rivers on the plea that Pakistan had enough waters on the Western Rivers to meet its requirements, including replacement supplies by building storage reservoirs. Two storage dams, one at Mangla on the Jhelum River and the other at Tarbela on the Indus were built as part of the Indus Basin Project financed under the Treaty.

In the present day Pakistan's rivers of Indus Basin are playing an important role in Industrial, agricultural and cultural developments in their surrounding area. Almost 75% of the population of Pakistan is centered along the major rivers. The situation of water resources in Pakistan has changed from water effluent country at the time of

independence having about 5650 m3 of water per capita, water availability has now decreased to less than 1000m3 per capita. In fact, shortages of water for domestic and industrial use are already being felt in Islamabad, Karachi and many other places. The situation can become worst in few years due to growing need of water for domestic, industrial and agricultural use.

For an agrarian country such as Pakistan, water not only remains an essential component for life but for economic activity as well. With depleting surface resources and an overwhelming increase in both population and the use of water, the per capita water availability in Pakistan has decreased to threateningly low levels. **TO ADD TO THIS THREAT IS THE UNCONTROLLED INDIAN DESIRE TO USE ITS GEOGRAPHICALLY ADVANTAGEOUS POSITION AS AN UPPER RIPARIAN TO BUILD DAMS/HYDEL PROJECTS UPON THE RIVERS THAT WERE ALLOCATED TO PAKISTAN.**

Pakistan has been opposing projects by India that violate "Water Cooperation Laws", such as the Baglihar, Kishenganga, Wullur projects etc that have water storage reservoirs. These reservoirs are storing water that ought to have been flowing into Pakistan, thus creating scarcity of the resource in Pakistan.

Demand for water and energy is rising. It is recipe for future wars BETWEEN India and Pakistan not for territorial or other gains but for water and energy resources. In fact India is already engaged in such a "Water War", against Pakistan albeit unilateral building of dams and power plants on the Western rivers in blatant breach of the Indus Waters Treaty.

Out of the total availability of about 153 MAF of water, at present we are letting nearly 30 MAF on average basis to go to the sea every year which is about 20% of our wealth of river waters. We need to store and use this water from beneficial use of our future generations. It is our collective responsibility to think for our future generations. By respecting our history and culture, we should start working for a gradual change from a water short country to a situation where sufficient water is available for domestic, industrial and agricultural use of every Pakistani citizen.

I am glad to say that to mitigate the effects of Indian projects, under WAPDA's Vision 2025 Programme, the following projects are at various stages of planning & execution.

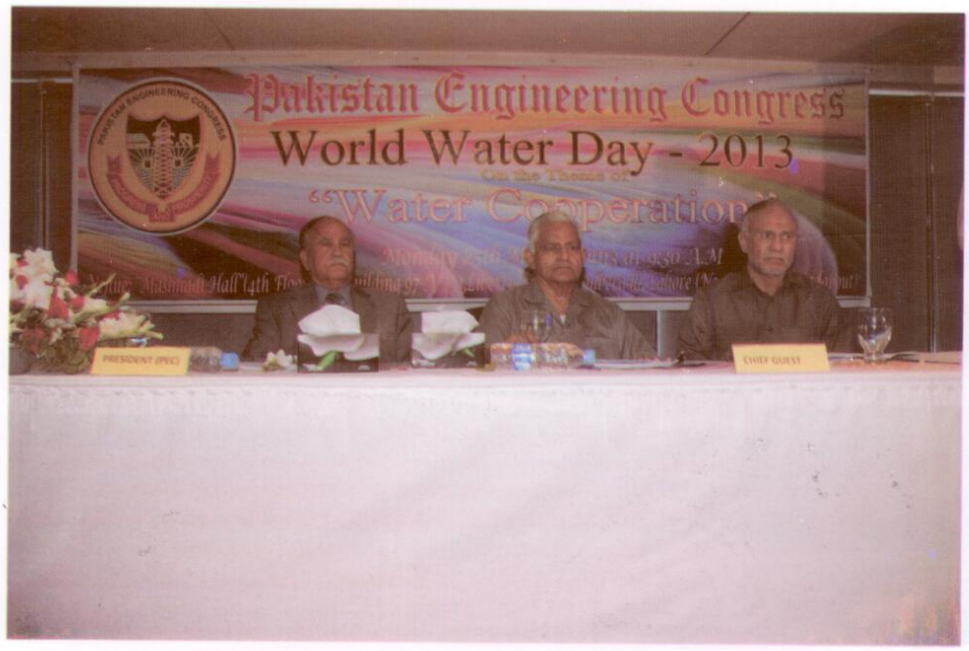
PROJECTS IN PAKISTAN						
Sr. No.	RIVER	NAME OF PROJECT	Capacity		COST (Rs. Billion)	Status
			POWER (MW)	STORAGE (MAF)		
	JHELUM					
1		Dudhnial	960	-	-	Taken up for pre-feasibility
2		Neelum Jhelum	960	-	84.51	Under construction
3		Kohala	1100	-	215.5	Feasibility study completed
4		Mahal				-
5		Azad Pattan				In planning stage

Sr. No.	RIVER	NAME OF PROJECT	POWER (MW)	STORAGE (MAF)	COST (Rs. Billion)	Status
6		Karat				In planning stage
	INDUS					
1		Tungus	2100			In planning stage
2		Yulbo	3000		600.00	In planning stage
3		Bunji	7100		684.00	Available for construction
4		Diamer-Basha	4500	6.40	894.00	Approved for construction
5		Dasu	4320		790.7	Available for construction
6		Pattan	2800		600.00	Taken up for feasibility
7		Thakot	2800		600.00	Taken up for feasibility
8		Kalabagh	3600	6.10	511.60	Available for construction
9		Akhori (Off Channel)	600	7.60	440.00	Feasibility Study completed
	CHENAB					
10		Chinot Dam	-	1.60		In planning stage

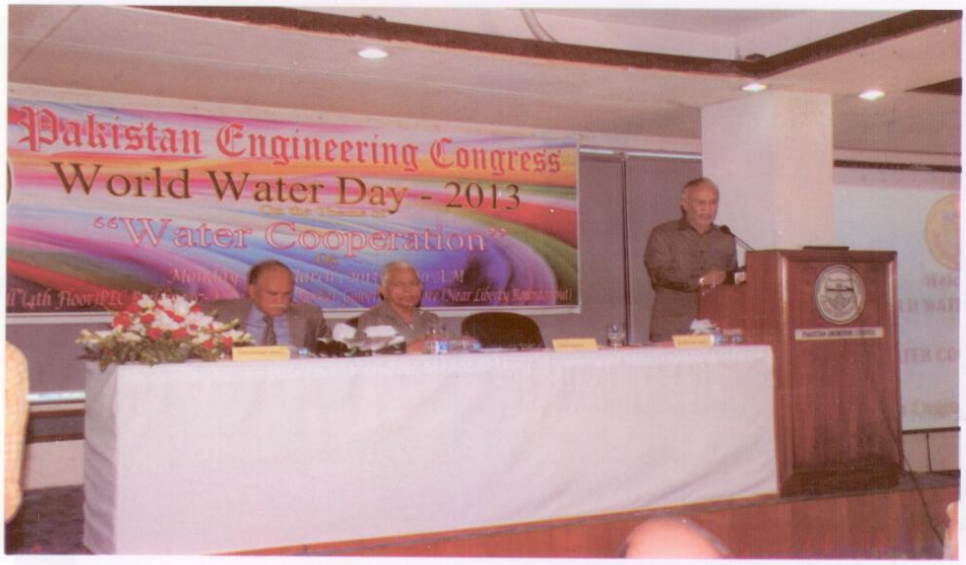
At the end I would like to compliment the Pakistan Engineering Congress, to organize this event for observing World Water Day and I hope that the initiative will create awareness among the Pakistani people and raise public support for Government action. Meeting the challenges in the water sector requires public support and participation and the World Water Day 2013 will help mobilizing both the aspects. In the end, I wish we all, the scientists, engineers and environmentalists will be able to harness every available drop of water for the beneficial use of our present and future generations with peace and harmony with nature.

Pakistan Paindabad

Glimpses of World Water Day-2013

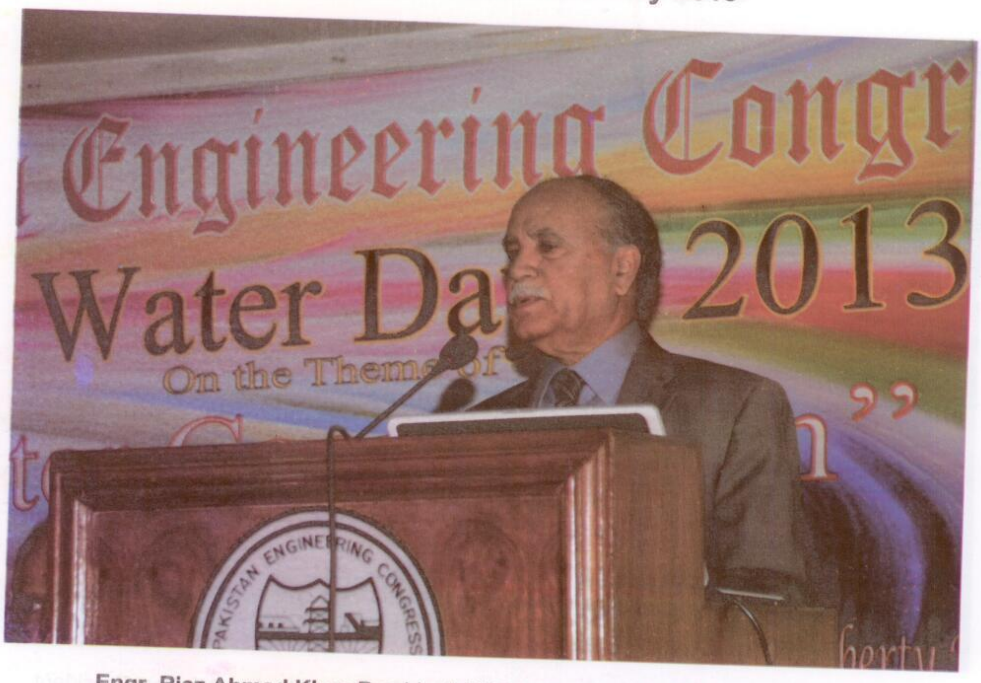


From Left: **Engr. Riaz Ahmad Khan** President, PEC, **Engr. Dr. Mazhar Ali,** Past President PEC / Chief Guest of the Event, **Engr. Akhtar Abbas Khawaja**, Vice-President / Secretary, PEC

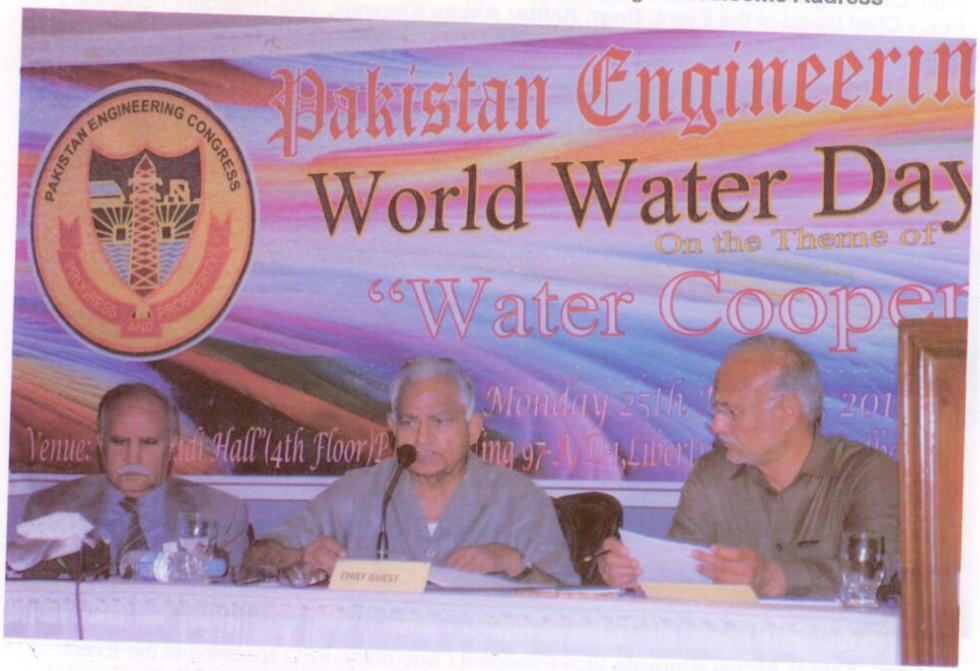


Engr. Akhtar Abbas Khawaja Vice-President / Secretary, PEC speaking at the Event. From Left **Engr. Riaz Ahmad Khan,** President, PEC and **Engr. Dr. Mazhar Ali,** Chief Guest.

Glimpses of World Water Day-2013



Engr. Riaz Ahmad Khan President, PEC presenting the **Welcome Address**



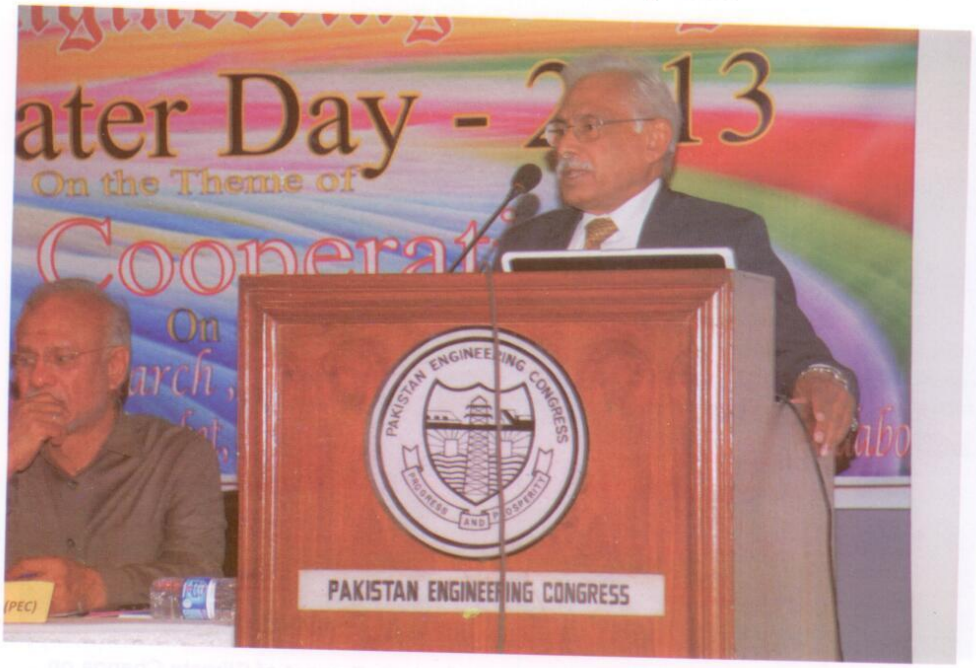
Chief Guest Engr. Dr. Mazhar Ali presenting his address

Glimpses of World Water Day-2013

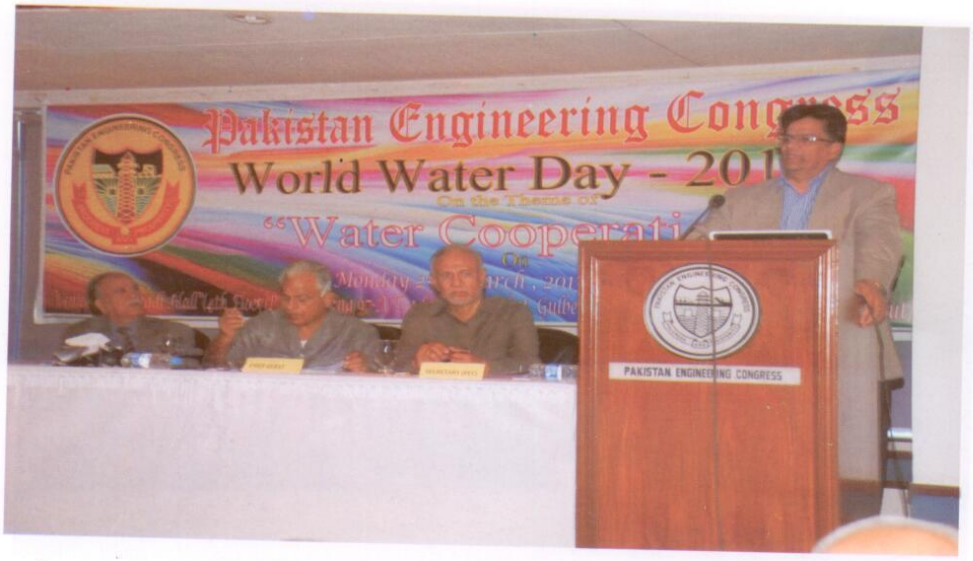
Engr. Riaz Nazir Tarar presenting his paper on the topic "**Impact of Climate Change on Pakistan Rivers, A Case for Cooperative Research**"

From left: **Engr. S. M. A. Zaidi,** Vice-President, PEC, **Engr. Ahmad Khan Bhatti**, Ex-Member, Water (WAPDA) Chairing the Technical Session, **Engr. Akhtar Abbas Khawaja,** Vice-President / Secretary, PEC

Glimpses of World Water Day-2013

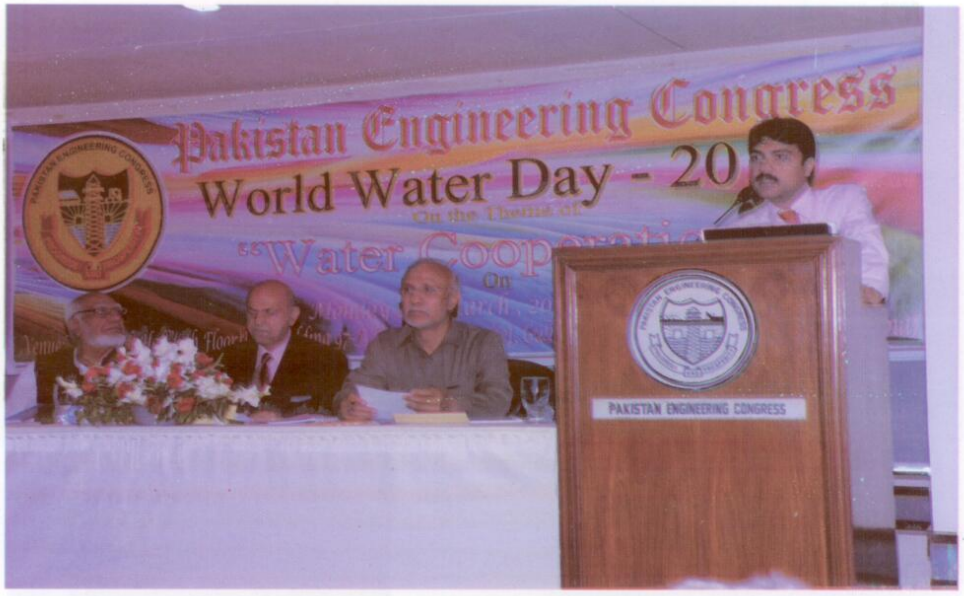


Engr. Abdul Khaliq Khan presenting his paper on the topic "**Environmental Degradation around River Ravi – Caused by the Division of Indus Basin Rivers**"

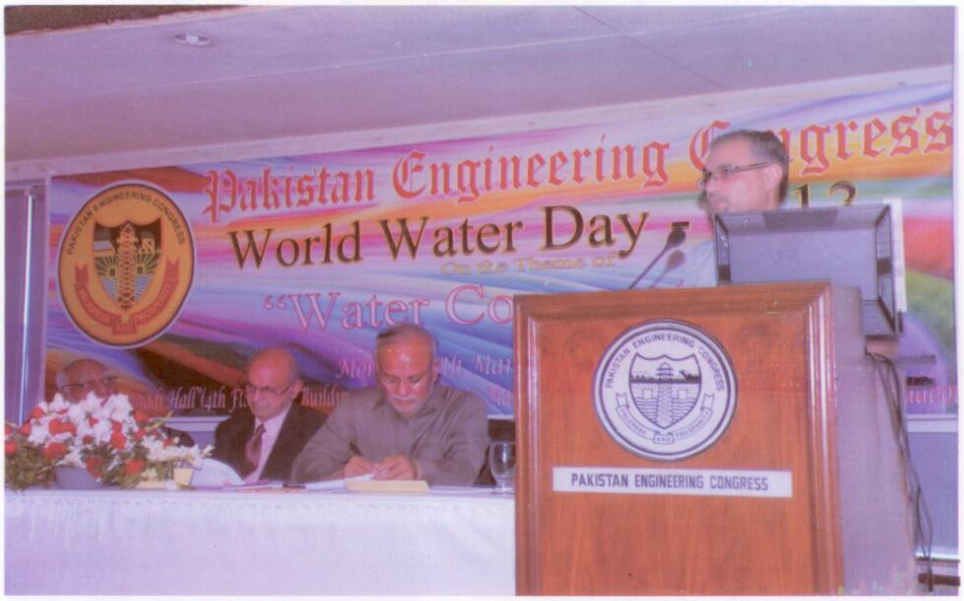


Engr. Dr. Asad Sarwar Qureshi presenting his paper on the topic **"Water Cooperation : Concepts, Benefits and Applications"**

Glimpses of World Water Day-2013

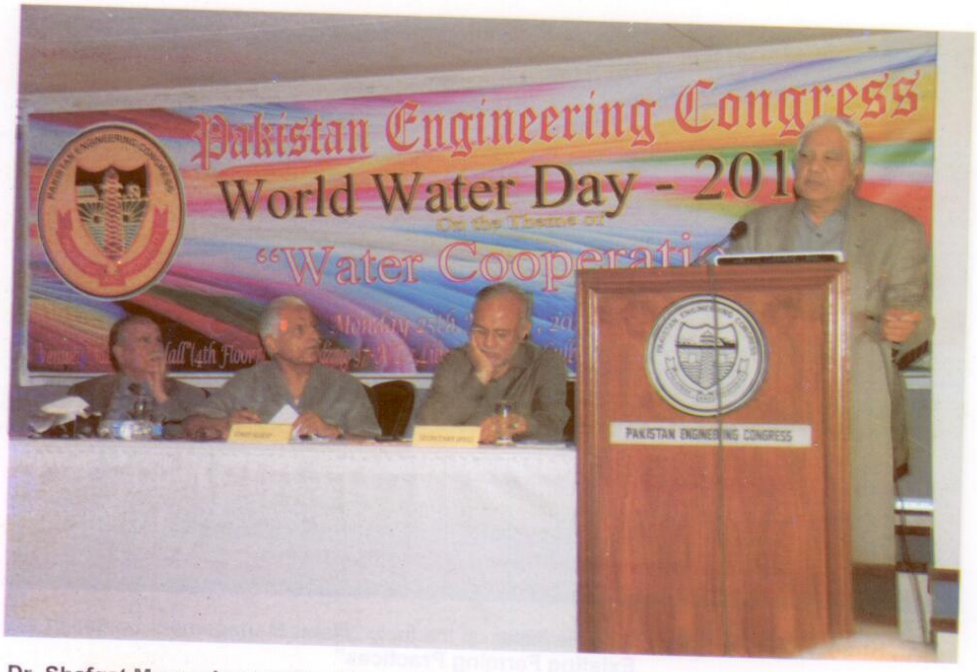


Mr. Khurram Dilshad presenting his paper on the topic "**Water Management Issues in Existing Farming Practices**"

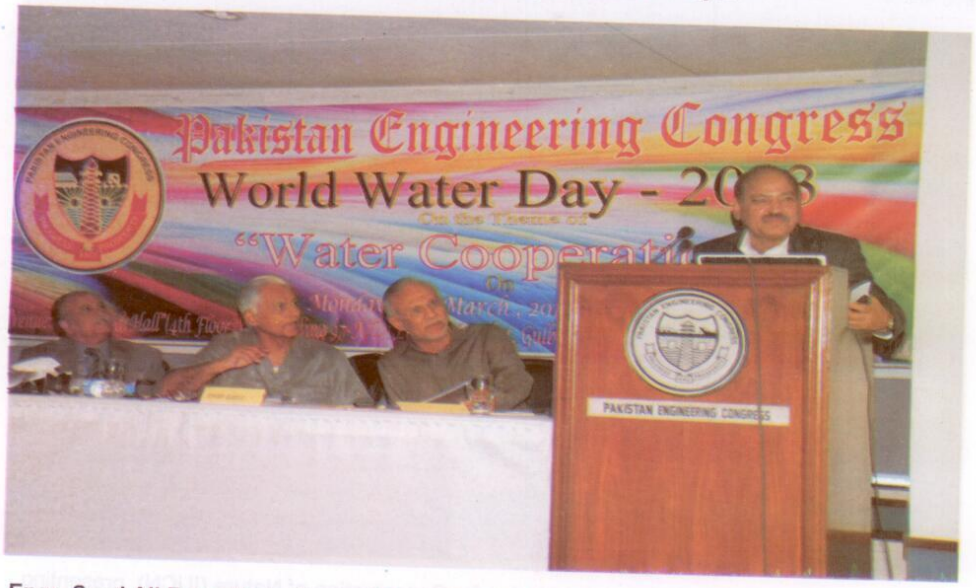


Mr. Saadullah Ayaz from International Union for Conservation of Nature (IUCN) presenting paper on the topic "Karez Rehabilitation : A Tool for Sustainable Livelihood and Climate Change Adaptation in Baluchistan"

Glimpses of World Water Day-2013



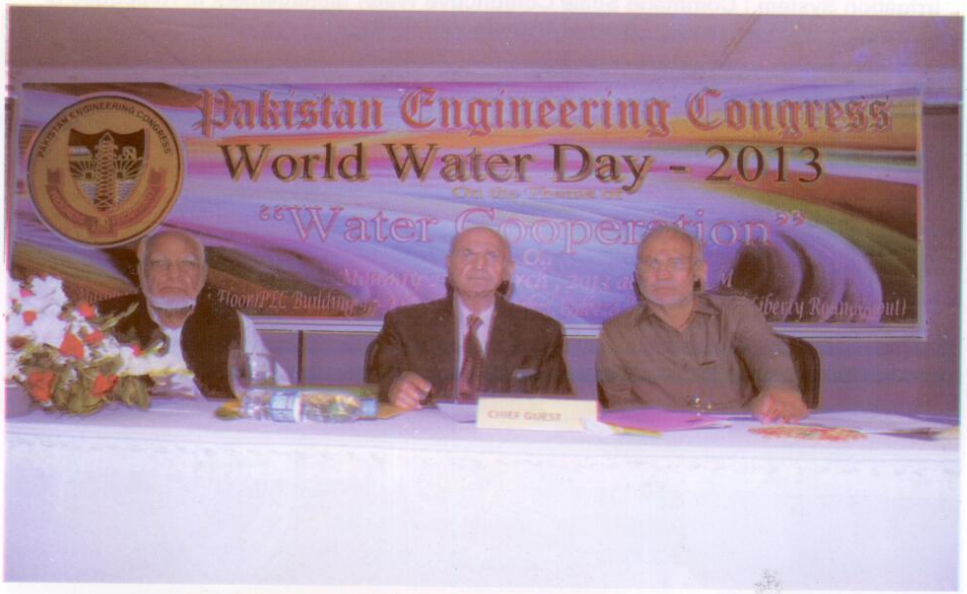
Dr. Shafqat Masood presenting his paper on **"Safeguarding Over Water Rights on Neelum Jehlum V/s Kishan Ganga Hydroelectric Project"**



Engr. Syed Ali Raza Shah, General Manager, Neelum Jehlum Hydro-Power project speaking at the Event

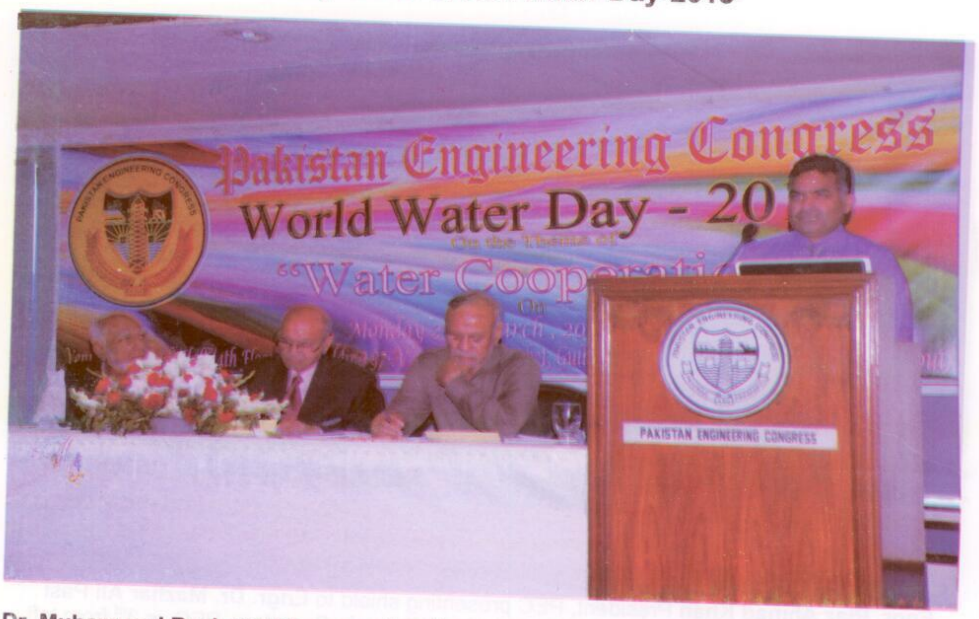
Glimpses of World Water Day-2013

Engr. Riaz Ahmad Khan President, PEC presenting shield to **Engr. Dr. Mazhar Ali** Past President, PEC / Chief Guest .**Engr. Akhtar Abbas Khawaja** Secretary, PEC is 3rd from left

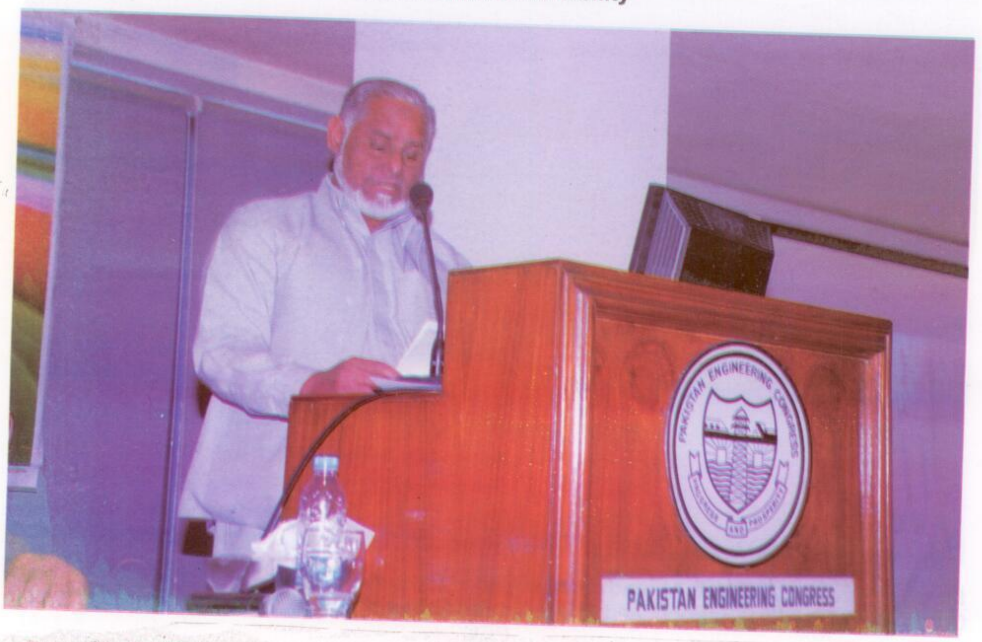


From Left: **Engr. Ch. Aftab Ahmad Khan** Member, Executive Council, **Engr. Riaz Nazir Tarar**, Chairing the Technical Session, and **Engr. Akhtar Abbas Khawaja,** Vice-President / Secretary, PEC

Glimpses of World Water Day-2013

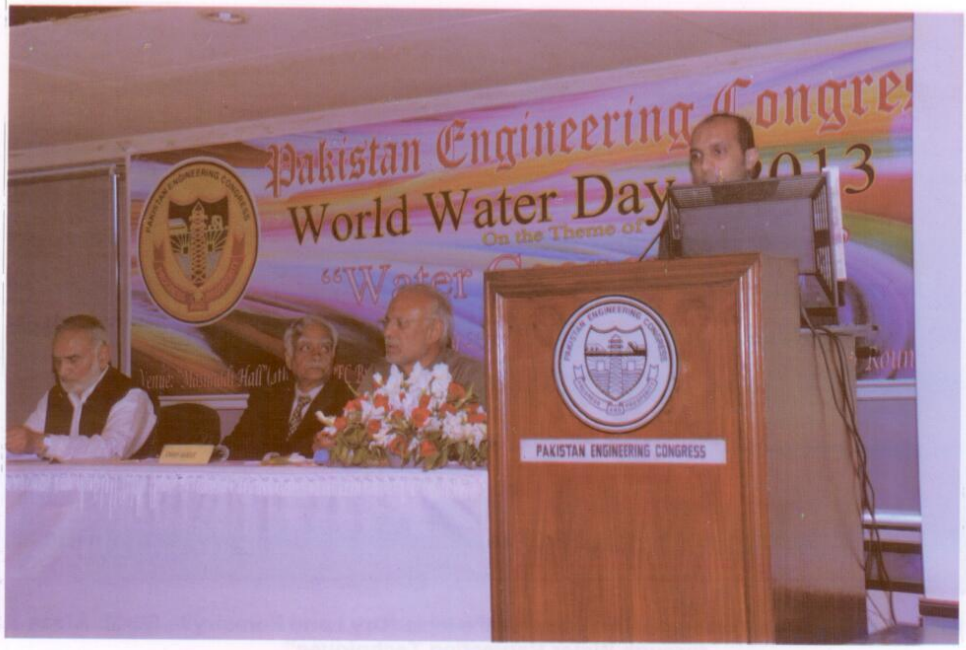


Dr. Muhammad Basharat Ch. presenting his paper on the topic **"Water Cooperation in LBDC Irrigation System : Command Scale Conjunctive Water Management in Response to Spatial Climate Variability"**



Engr. Khalid Mahmood Subhani presenting his paper on the topic **"Changing Trends of Agricultural Economy of Pakistan"**

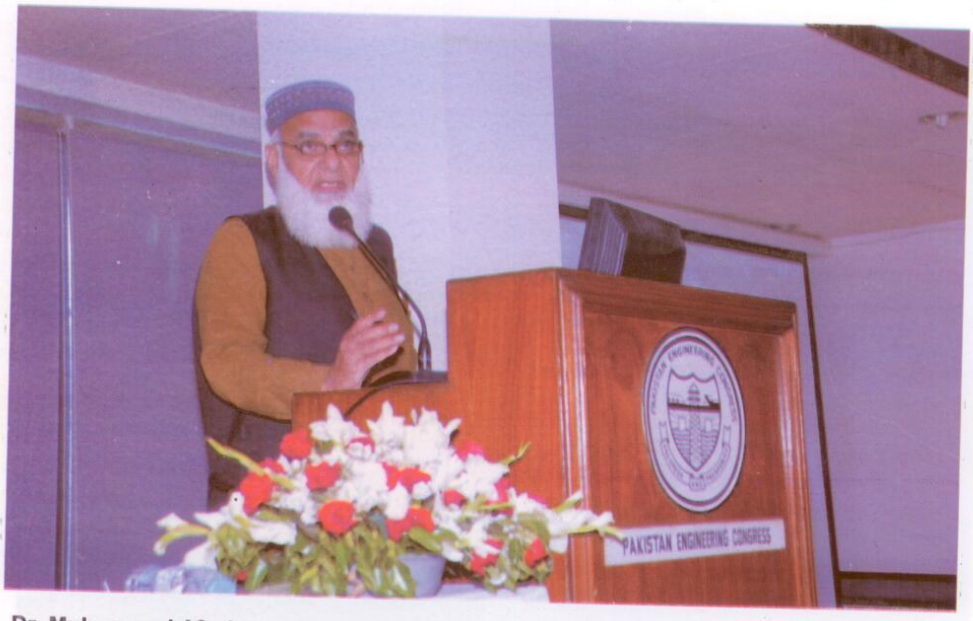
Glimpses of World Water Day-2013



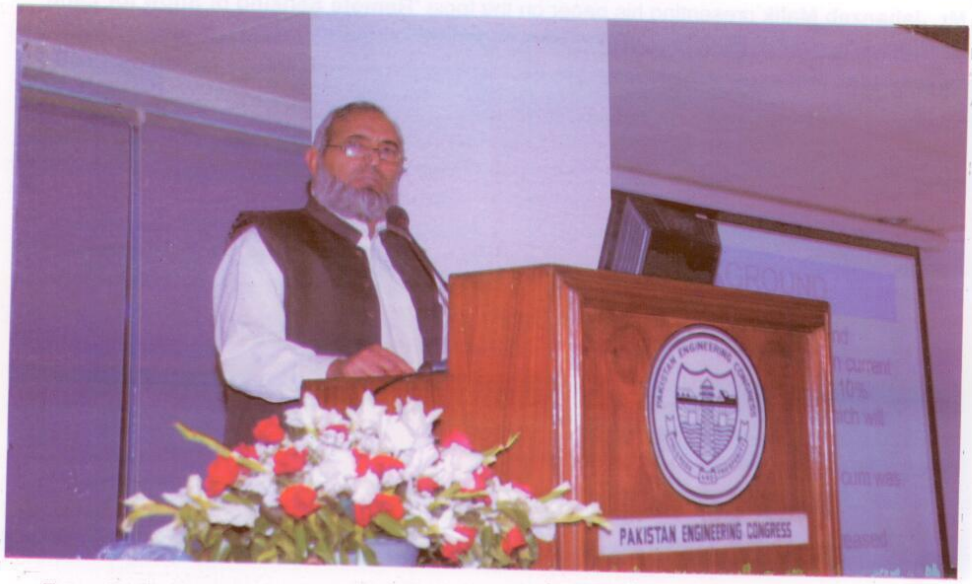
Mr. Jahanzeb Malik presenting his paper on the topic "**Remote Sensing of Snow for Land Surface Modeling**"

Engr. Abdul Qadeer Khan presenting his paper on the topic "**Sustainability of Water Operators and Water Cooperation with Special Emphasis on Lahore**"

Glimpses of World Water Day-2013



Dr. Muhammad Afzal presenting his paper on the topic **"Dry Land Forestry in Scrub Areas through Water Harvesting Techniques"**



Engr. Muhammad Saeed presenting his paper on the topic **"Ground Water Recharge Potential in Irrigated Areas of Indus Basin – Pakistan"**

Glimpses of World Water Day-2013

A view of the audience

A view of the audience

Glimpses of World Water Day-2013

A view of the audience

A view of the audience

Glimpses of World Water Day-2013

A view of the audience

A view of the audience

COMMEMORATION OF WORLD WATER DAY 2013 BY PAKISTAN ENGINEERING CONGRESS ON 25th MARCH 2013 KEY RECOMMENDATIONS

1 COMMEMORATION

As part of its professional activities, Pakistan Engineering Congress (PEC) commemorates World Water Day each year. For the year 2013, it was celebrated at the Headquarter of PEC at Lahore on 25 March 2013. Internationally proposed Theme for this year was:-

'Water Cooperation'

2 CONDUCTION

The moot was conducted as per programme in Annex-01. Sixteen (16) papers had been contributed by the professionals for this moot under the following related topics (refer Annex-02):-

i. Impact of Climate Change	4
ii. Surface Water Including Management	4
iii. Groundwater	4
iv. Agronomy	2
v. Environment	2

Most of the papers were presented by the authors / co-authors and discussed.

3 KEY RECOMMENDATIONS

Topic-wise key recommendations emerging from the above presentations are summarized in the following.

3.1 CLIMATE CHANGE

Impact of Climate Change on Pakistan is going to be very severe, particularly in the areas of hydrology and agronomy. Therefore, there is need for properly assessing these impacts to evolve timely management / mitigation measures.

3.1.1 Impact of Climate Change on Pakistan Rivers – A Case for Cooperative Research

i. There is a serious lack of current knowledge and convergence of preliminary research findings regarding climate change impacts on glaciers in Himalayan Karakoram Hindukush (HKH) region, and resultant projection of river flows to Upper Indus Basin (UIB). This requires understanding and modelling capability about the patterns of snow / glacier melt and precipitation contributing to water supply of Indus River System (IRS). These aspects need to be adequately addressed under an integrated programme of cooperative research through participation of the concerned national agencies and interested international entities.

ii. As a starting point, it is recommended that the Planning Commission may set-up a Special Task Force (STF) in Global Change Impact Studies Cell (GCISC) at Islamabad with representation from all concerned national agencies with mandate to :-

   a. Define the scope of study along with timeline and mode of implementation.

   b. Assess the needed hard / software inputs (both national and international).

   c. Identify the national institution(s) needing specific capacity building.

   d. Identify needed international cooperation / collaboration including financial assistance.

iii. Most of the international financing institutions (IFIs) and concerned UN entities are now actively involved in the pursuit of 'Meeting the Water and Climate Change Challenge' and may come forward to assist Pakistan.

iv. As part of Regional, National and Project Level Technical Assistance, since 2008 ADB is sponsoring in Pakistan 'Climate Proofing Water and Energy Projects in Indus'. Reduction in Indus river basin's winter snowpack formation and retreat of alpine glaciers threaten the reliability of downstream water supplies and the production of hydro-electric power. ADB's program on 'Glacial Melt and Downstream Impacts on Indus-Dependent Water Resources and Energy Project' will support this activity. The recommended cooperative research study could be conveniently dovetailed into this programme of ADB to secure the needed technical assistance, collaboration, cooperation and foreign funding.

3.1.2 Water Cooperation – Resilience to Climate Change

i. Placement of a resilient flexible and adaptive water resource infrastructure and management system driven by enhanced knowledge (limited not only to hydrology).

ii. Increase in water storage capacity through already engineered mega dams to: compensate for sedimentation of on-line reservoirs; and ensure storage during the high water periods/ floods.

iii. Adoption of sustainable development to reduce vulnerability to climate change by enhancing adaptive capacity and increasing resilience.

iv. Salvage of water losses due to seepages from canals and water channels etc. to enhance limited availability of irrigation water.

v. Promotion of efficient irrigation techniques like laser leveling of lands, sprinkler, and drip irrigation instead of prevailing flood irrigation.

vi. Adoption of rainwater harvesting techniques on catchment areas, terraces, contour farming, and roof-tops.

vii. Artificial recharging of ground water through delay action dams, percolation basins, modified stream beds, diversion structures, ditches and furrows besides injection wells.

3.1.3 Karez Rehabilitation : A Tool for Sustainable Livelihood and Climate Change Adaption in Balochistan

i. Karez, being an indigenous system of water management has all the characteristics required for sustaining livelihood of farming communities. Karez irrigation systems, on the other hand, have found to be resilient to changing climatic conditions and can thus be beneficially utilized as an effective management tool in arid areas.

ii. All Governmental / Non-Governmental Organizations working in water sector should focus on reviving the abandoned karezes on priority specially in Balochistan. Revival of this system would ensure continued supplies of water to the communities in the expected water scarcity era, yet to come.

3.1.4 Remote Sensing of Snow for Land Surface Modeling

i. Results of an analytical study carried out by one of the co-authors show that :
   a. Multi-temporal observations of snow cover in Near Infra-Red (NIR) and Thermal Infra-Red (TIR) regions of Electro Magnetism (EM) demonstrate good potential to discriminate dry and wet snow zones during the melt season.

   b. Assessment of mapped dry and wet snow areas shows significant correlation.

ii. Assimilation of snow albedo estimates in land surface models (LSM) are to-date still largely under-utilized which could significantly improve the predicted results of climate, weather and hydrology under the Climate Change Scenario.

3.2 SURFACE WATER INCLUDING MANAGEMENT

3.2.1 Water Cooperation: Concepts, Benefits and Application

i. Transboundary water issues should be managed through extended mutual operation. With the improvements in overall knowledge-base, technology, social norms and aspirations, water institutions and legal frameworks (both national and international), it should be possible to substantially enhance operation of water bodies in future.

ii. Many complex transboundary water issues have been resolved through mutual cooperation. These include : famous Israel-Jordan water allocation accord for sharing of Jordan River water and agreement on water allocation of different states of the Murray-Darling basin of Australia. Most relevant sub-continental example is Indus Waters Treaty (IWT) between India and Pakistan which has survived for the last 50 years despite complex geo-political circumstances.

iii. With passage of time, there is a need to revisit IWT so that realities of today can be incorporated. This will be in favour of both countries as they heavily rely on Indus Waters for their food and energy needs.

iv. Global experiences indicate that if a constructive and positive approach is adopted by the co-basin countries, it invariably contributes to the creation of a virtuous cycle where people of both countries become winners.

3.2.2 Governance of Hydropower in Transboundary River Basin – Role of International Organizations in Facilitating Bilateral Treaties in Developing Hydropower

i. International organizations can play a vital role in resolving major transboundary issues pertaining to shared basins. In case of India and Pakistan, the World Bank played an exemplary role in resolving the most contentious issue on water sharing between India and Pakistan through Indus Waters Treaty.

ii. Prior to the Treaty, both countries were extremely short in their food and energy production as well as victims of endemic poverty. With water share determined, both countries resorted to accelerated development of irrigated agriculture and hydropower.

iii. A similar approach through good offices of World Bank may lead to evolving a mechanism not only for coping with adverse impacts of climate change but boost particularly the hydropower development to the benefit of both the countries through the spirit of mutual cooperation.

3.2.3 Rational Surface Water Management: A Pre-Requisite for Ground Water Management in Pakistan

i. Groundwater is getting out of reach of small farmers and it is particularly so in lower parts of Bari Doab. To avoid incurring extra ordinarily high costs on groundwater pumping and other irreversible impacts e.g. quality deterioration in lower parts of Bari Doab, there is need to change the usual approach towards management of canal water in isolation of groundwater. The later being at par with canal supplies in meeting crop water requirement deserves intervention by the government through appropriate groundwater management measures.

ii. Rationalizing canal water allocations can further support and help in implementation of conjunctive water use and integrated water resources management (IWRM) at: IBIS level; provincial level; and at least canal command level. However, implementation of IWRM at

Basin level may involve difficulty due to legal bindings for water distribution under Water Apportionment Accord of 1991.

iii. Recommendations for sustainable groundwater management are:
   a. Priority construction of mega reservoirs.

   b. Gearing of surface water allocation towards recharge management, especially rehabilitation of Sukh-Beas channel for groundwater recharge in central and lower parts of Bari Doab during flood season.

   c. Formulation of groundwater management policy for various levels of irrigation system.

   d. Fresh assessment of crop water requirement, cropping patterns and intensities including reallocation of canal water for equity in the related irrigation demand.

   e. Ensuring equity of surface water availability at the farm gate by allocating less water (time allocation) at watercourse head and more towards tail reach.

   f. Capacity building of groundwater related institutions to perform key functions of planning, research and providing information/technical support at regional as well as grass-root levels.

3.2.4 Dry Land Forestry in Scrub Areas Through Water Harvesting Techniques

i. Water harvesting techniques combined with identified tree species can result in successful afforestation/reforestation programme to improve extremely low forest cover in Pakistan as compared to prescribed international standards.

ii. If the rainwater is harvested in scrub areas, the quantity of water may become sufficient for development of forestry thus improving socio-economic status of the local inhabitants.

3.3 GROUNDWATER

3.3.1 Water Cooperation in LBDC Irrigation System: Command Scale Conjunctive Water Management in Response to Spatial Climate Variability

An ADB funded project is under implementation to improve the irrigation system under command of Lower Bari Doab Canal (LBDC). Conjunctive water management is being studied as a key tool for improvement of irrigated agriculture. Recommendations resulting from this study are as below:-

i. Canal Water Allowance may be established in consideration of spatial variability of climatic parameters (rainfall and evapotranspiration) within and amongst the canal commands in the region.

ii. Available Irrigation water may be reallocated in the LBDC command to the extent of 25% from head to tail end of the command (with linear variation in between, however, with due consideration for saline areas). This would help in managing salinity issue as wells as social acceptance of the proposed re-allocation from more rainfall areas in head end to less rainfall areas in tail end of the command.

iii. For proper routing of the reallocated water, any modifications in channel hydraulics and design of control structures may be studied.

3.3.2 Quality of Potable Water in Circulation Within Different Cities of Pakistan and Removal of Arsenic Through Indigenous Source

Physio-chemical analyses of drinking water collected from various cities of Pakistan indicate significant variation. Arsenic has been also found in a few water samples that can be effectively removed with indigenously prepared activated carbon.

3.3.3 Ground Water Recharge Potential in Irrigated Areas of Indus Basin – Pakistan

In a recent study groundwater recharge potentials were determined for various irrigated areas in the Indus Basin on the basis of June 2012 data. The results are summarized below :

i. Overall groundwater recharge potential in Punjab, and KPK Provinces was 131.164 MAF.

ii. Water table depth above 12 m was found in 20% of irrigated areas of Indus Basin.

iii. On the average, 32% of irrigated area in KPK was in the range of water table depth above 12m.

iv. In Sindh and Balochistan, 54% area was in the range of 0-15 m.

v. It was observed from the data that severe water table depletion problem existed in the provinces of Punjab and KPK. Therefore it is strongly recommended that groundwater depleted areas should be recharged artificially when water is surplus, especially in flood season.

vi. In the shallow groundwater areas irrigation water allowance may be decreased to compensate the highly depleted areas.

3.4 AGRONOMY

3.4.1 Water Management Issues in Existing Farming Practices

i. Management of Land Resources: Presently, about 40% of the land holdings fall in the farm size category of 0-5 hectares and are getting further fragmented into uneconomical units. Therefore, to increase crop production from the cultivable land resources, a major policy change is required through land reforms.

ii. Improvement of Agronomic Practices: Role of proper cropping patterns keeping in view the agro-climatic zones and availability of water should be brought to the notice of farmers through active participation of agricultural extension staff.

iii. Improvement of On-Farm Water Use: With progressively reducing per capita water availability in Pakistan (from 5600 m^3 to 1200 m^3) there is need to efficiently manage the available water at the farm level. Similarly proper farm layout and adoption of short duration crops and cropping pattern is recommended. This can be achieved by proper layout, construction and keeping the water courses free from vegetation and sediment. Upto 50% of water is wasted in conveying the water from Mogha to farmer's field. Similar is the situation of wastage of water at the field level. In most of the cases farmers do not know the water availability status in the soil profile at the time of irrigation. To facilitate this, easy to operate tensiometer developed by the PCRWR is recommended.

3.4.2 Changing Trends of Agricultural Economy of Pakistan

i. Climate change is now emerging as the most severe problem for Pakistan. To cope with this situation prior planning is required for a new set of technological changes in the field of agronomy, farming practices, research, etc.

ii. In Pakistan, further horizontal expansion (increase in cultivated area) looks difficult due to decrease in water availability and continuous depletion of land resources. Mega storages require very large investment and long implementation periods. In these circumstances, the option left is vertical expansion through increased crop yields. The major constraints in this regard are: non/inadequate availability of irrigation water; high prices of farm inputs and energy; low market prices for farm produce especially during crop harvest; paucity of agricultural credit; and non-availability of suitable infrastructure.

iii. For improving crop yields investment is required in: improvement and development of production technologies including accelerated research; building rural institutions; and reinforcing extension services.

iv. Bio-technology is a low cost environment friendly technique and should be adapted to improve and enhance farm productivity.

3.5 ENVIRONMENT

3.5.1 Environmental Degradation Around River Ravi – Caused By the Division of Indus Basin Rivers

As a consequence of Indus Waters Treaty 1960, India was allowed exclusive use of Eastern Rivers. However, the requirement of environmental flows for the affected downstream river reaches in Pakistan was overlooked. These river reaches have started experiencing severe ecological degradation which may further aggravate. To halt this process, it is recommended that:-

i. Environmental water requirement of rivers Ravi and Sutlej must be assessed immediately.

ii. India should be persuaded to release these environmental flows into rivers Sutlej and Ravi.

iii. Pakistan should build retention reservoirs on the Eastern Rivers for recharge of aquifer.

iv. Legislation for regulating the groundwater abstraction, particularly in vicinity of impacted reaches of Eastern Rivers should be enacted.

v. Related arrangements for monitoring the water table in these areas be made on priority basis.

3.5.2 Use of Hairdin Drain Effluent for Growing of Salt Tolerant Crops on Saline Sodic Gypsiferous Soil – Strategies to Reduce Risk

Hairdin Drain receives effluent of varying salinity during floods and low flow period. A study was conducted to assess utilization of this effluent for growing salt tolerant crops. The findings / recommendations of this study are as below:-

i. There are spatial and temporal changes in quality of drainage water. Therefore the quality of Hairdin drain water may be monitored regularly and its use avoided during the days when its quality is highly hazardous.

ii. Pressmud followed by Farm Yard Manure (FYM) is better soil amendment to increase its permeability and to evade deterioration especially in clayey soils.

iii. Drainage water of Hairdin drain should not be used without adopting the remedial measures. Pressmud @ 10 tons ha-1 FYM @ 25 tons per hectare must be applied to control the adverse effect of drainage water on physical and chemical properties of soil and crop yields.

iv. Salt tolerant crops should be planted under drained water application.

v. For gypsiferous and saline sodic soils, leaching irrigations should be applied after improving the permeability to maintain soil productivity.

PAKISTAN ENGINEERING CONGRESS
World Water Day-2013
Held on
25th March, 2013
On the theme of
"WATER COOPERATION"

Recommendations made by Experts

Paper: **Impact of Climate Change on Pakistan Rivers - A Case for Cooperative Research**

Author: **Engr. Riaz Nazir Tarar**

Recommendations

Basic strategies and recommendations were contained in the 'Final Report of Task Force on Climate Change' submitted to Planning Commission in February 2010. Among the main recommendations, emphasis was placed on: Enhancement of Institutional Capacity for addressing Climate Change; and need for International Cooperation.

In particular, there is an urgent need to enhance the 'Institutional Capacity for assessing the Impact of Climate Change on Pakistan Rivers.

There is a serious lack of current knowledge and convergence of preliminary research findings regarding climate change impacts on glaciers in HKH region, and resultant projection of river flows to Upper Indus Basin (UIB). This requires understanding and modelling capability about the patterns of snow / glacier melt and precipitation contributing to water supply of Indus River System (IRS). These aspects need to be adequately addressed under an integrated programme of cooperative research through participation of the concerned national agencies; and interested international entities. Basic focus of this research effort should be on :

i. Understanding and modelling of the climate change trends in UIB.

ii. Variations in inter-season and intra – season precipitation.

iii. Spatial / temporal variations in the extent of snow / glacier cover through use of latest technologies (satellite imagery / GIS) for projecting future trends.

iv. Projecting the overall long term impact of hydro-meteorological changes on the flows of IRS.

As a starting point, it is recommended that the Planning Commission may set-up a Special Task Force (STF) in Global Change Impact Studies Cell (GCISC) at Islamabad with representation from :-

i. Pakistan Meteorological Department (PMD).

ii. Pakistan Water and Power Development Authority (WAPDA).

iii. Pakistan Council for Research in Water Resources (PCRWR).

iv. Indus River System Authority (IRSA).

v. Pakistan Agricultural Research Council (PARC).

vi. SUPARCO.

vii. National University of Science and Technology (NUST), to involve also the national academia

The mandate of this STF should be to:

i. Define the scope of study along with timeline and mode of implementation.

ii. Assess the needed hard / software inputs (both national and international).

iii. Identify the national institution(s) needing specific capacity building.

iv. Identify needed international cooperation / collaboration including financial assistance.

Most of the international financing institutions (IFIs) and concerned UN entities are now actively involved in the pursuit of 'Meeting the Water and Climate Change Challenge'. In this respect, Asian Development Bank has taken a number of initiatives covering: -

i. Climate change adaptation

ii. Knowledge products and Risk Management Tools

iii. Regional knowledge networking

iv. Specifying mechanism through: -
   a. Climate Change Fund.
   b. Water Financing Partnership Facility.
   c. Provoking Climate Change Adaptation in Asia and South Pacific.
   d. Climate Investment Fund.
   e. Adaptation Fund.

As part of Regional, National and Project Level Technical Assistance, since 2008 ADB is sponsoring in Pakistan 'Climate Proofing Water and Energy Projects in Indus'. Reduction in Indus river basin's winter snowpack formation and retreat of alpine glaciers threaten the reliability of downstream water supplies and the production of hydro-electric power. ADB's 'Glacial Melt and Downstream Impacts on Indus-Dependent Water Resources and Energy Project' will support this activity. The recommended study in the paper could be conveniently dovetailed into this programme of ADB to secure the needed technical assistance, collaboration and foreign funding.

Paper: **Environmental Degradation around River Ravi – Caused By the Division of Indus Basin Rivers**

Author: **Dr. Izhar ul Haq, Mr. Abdul Khaliq Khan**

Recommendations

In 1960, when the IWT was signed there was no cognizance of the environmental flows of rivers. Due to the stoppage of entire flows of river Ravi, Beas and Sutlej, the population of historic city of Lahore and several other Bari Doab cities, Cholistan and Bahawalnagar districts are worst affected. Because of no recharge the groundwater in these areas has gone deep. For sustainability of the civilization recharge of aquifer with fresh water is a must. The untreated domestic and industrial waste water flows of this area have polluted the aquifer and affecting the health of the people. The Sewerage and Industrial water must be treated. Freshwater must be ensured to flow in these rivers to flush the salts and bacteria and keep these rivers alive.

1. Environmental water requirement of rivers Ravi and Sutlej must be assessed and provided at the earliest.

2. India should be persuaded to leave at least environmental flows into rivers Sutlej and Ravi.

3. Rain water harvesting should be practiced for optimum utilization and groundwater recharge.

4. Pakistan should build retention reservoirs on rivers for recharge of aquifer.

5. Legislation for regulating the groundwater abstraction should be enacted. Institutional arrangement for monitoring the water table should be made on most urgent basis.

Paper: **Water Cooperation: Concepts, Benefits and Applications**

Author: **Dr. Asad Sarwar Qureshi**

Recommendations

Water management, like the management of any other natural resource, has been a gradually evolving process. Transboundary water issues can be managed through extended mutual cooperation. With the improvements in overall knowledge-base, technology, social norms and aspiration, water institutions and legal frameworks (both national and international) evolve, it should be possible to enhance cooperation on water bodies more and more in future. This will be much needed if we are serious in mitigating poverty, improving livelihoods and sustain environment and ecosystems.

History has proved that many complex transboundary issues have been resolved through mutual cooperation. These include famous Israel-Jordan water allocation accord for sharing of Jordan River water. Agreement on water allocation of different states of the Murray-Darling basin of Australia is another example where inter-provincial water issues have been resolved through cooperation. Indus Basin Treaty has also survived for the last 50 years despite complex geo-political circumstances. However, with the passage of time, there is a need to revisit this agreement so that realities of today can be included. This will be in favour of both countries as they rely tremendously on Indus water for their food and energy needs. A peaceful settlement of IWT will be a step forward in resolving other outstanding issues which are of vital importance for peace and prosperity in this region. Global experiences indicate that if a constructive and positive approach is adopted by the co-basin countries, it invariably contributes to the creation of a virtuous cycle where people of both countries become winners. The reverse of this approach equally brings into play a vicious cycle, where there are no winners. Potential benefits are simply lost both to the countries and to the people of the region concerned. With properly conceived frameworks, management and use of the transboundary water bodies in developing countries should result in 'win-win' situation for all the parties concerned. Contrary to popular belief, these are not necessarily zero-sum games.

Paper: **Water Cooperation – Resilience to Climate Change**

Author: **Mr. Ahmad Kamal**

Recommendations

- Placement of a resilient water resource infrastructure and management system which is driven to a much greater degree by knowledge (including but not limited to hydrologic knowledge), and which is designed and operated to be much more flexible and adaptive.

- Increase in water storage capacity to ensure storing water during the high water periods/floods so that the same could be utilized not only during the low flow periods of the same years but in subsequent drought years.

- Specific coping mechanism against GLOFs (Glacial Lake Outburst of Floods). Early warning system for GLOFs in the Northern Areas is all the more important because WAPDA has most of its future hydropower projects in these areas.

- A series of large dams needs top most priority for early implementation. In addition construction of Small Dams to augment local flood water supplies also require attention to solve water supply and irrigation water needs at local level

- Reduction in water losses due to seepages from canals and water channels etc. and use of limited available water in a highly efficient manner. The most efficient irrigation techniques like, laser leveling of lands, sprinkler, and drip irrigation are the most effective adaptive measures and should therefore be promoted on mass scale.

- Provision of environmental flows in the Indus river system especially in the winter season needs a serious consideration to address healthy river life, conservation of flora and fauna, mangroves growth etc.

- The surplus water in Indus River System is only available for 70 – 100 days during flood season. The average outflows below Kotri Barrage is reported to be between 32 - 35 MAF whereas recent past studies show that only 8.6 MAF of regulated round-the-year water discharge is required for the sustainable ecology of Indus Delta. In line with a recent study by an Independent International Panel of Experts following is recommended:
    - An escapage at Kotri Barrage of 5000 cfs throughout the year to check seawater intrusion, accommodate the needs for fisheries, environmental sustainability, and to maintain the river channel.
    - The sediment supply is required to maintain a stable coastline, sustain mangrove vegetation and preserve river ecology and morphology.

- The rate of loss of reservoir capacity is projected to increase in future. This risk can be mitigated by adopting appropriate preservation methods delaying the process of silting up of reservoirs to some extent. The most economical method may be construction of a series of dams on the river upstream of the existing reservoirs to trap the sediment in upstream reservoirs and store almost sediment free water in the lower reservoirs;

- Adoption of rainwater harvesting techniques like: Land alteration, Modified catchment area, Terraces, Contour farming, Micro-catchment farming, Inter-dunal water harvesting, Hill torrent water harvesting, Roof- top water harvesting is recommended to benefit from the rain waters;

- Artificial recharging of ground water through delay action dams, percolation basins, modified stream beds, diversion structures, ditches and furrows besides recharge through injection wells should be promoted.

- Regulatory framework for Ground Water use be put in place as a priority action;

- Water resource users should be persuaded to reduce the negative effects of water shortages due to climate change by adopting a number of strategies broadly include the following:
    - Use of limited water supplies towards higher value uses, such shifts could be from lower to high value crops, from agricultural or industrial to environmental and municipal uses;
    - Revising water storage and release criterion for reservoirs;

- Adopting crops and cropping practices that are robust over a wider spectrum of water availability;
- Expanding and adjusting crop insurance programs;
- Adjusting water prices to encourage water conservation and expansion of water supply infrastructure;
- Supporting water transfer opportunities;
- Adopting modern techniques of irrigation like sprinkler, trickle and drip irrigation instead of using only flood irrigation;
- Afforestation in the Pothohar area where it is predicted that monsoon activity will be increased due to climate change;
- Artificial ground water recharge in the sweet water zone;
- Adoption of sustainable development to reduce vulnerability to climate change by enhancing adaptive capacity and increasing resilience;
- Drainage and reclamation of soil may be given due consideration;
- Irrigation efficiency should be improved by minimizing water losses from channel to farm;
- In water scarce areas, less water consuming crops should be introduced.

Paper: **Governance of Hydropower in Transboundary River Basins – Role of International Organizations in Facilitating Bilateral Treaties in Developing Hydropower**

Author: **Sardar Muhammad Tariq**

Recommendations

International organizations can play vital role in resolving major transboundary issues pertaining to shared basins. In case of India and Pakistan, the World Bank played an exemplary role in resolving the most contentious issue on water sharing between India and Pakistan. Once the water shares were determined, it opened up flood gate of opportunities for both the countries. Prior to the treaty, both countries were extremely short in their food and energy production and were victims of endemic poverty. With water share determined, both countries resorted to addressing irrigated agriculture and renewable hydropower energy and within a short period, the extended irrigation network provided boost to their agricultural production and became self-sufficient in food and to great extent reduced the rural poverty. Hydropower development provides boost to the expansion of industrial base in both the countries. Treaty also helped to avoid major war over water.

Paper: **Quality of Potable Water in Circulation within Different Cities of Pakistan**

Author: **Dr. S. E. Benjamin and Fozia Sardar**

Recommendations

The Physico-chemical analyses of drinking water collected from various cities of Pakistan indicate significant variation. Arsenic was also found present only in a few water samples that can be effectively removed with indigenously prepared activated carbon.

Paper: **Changing Trends in Agriculture Economy of Pakistan**

Author: **Talib Hussain, Khalid Mahmood Subhani and Khalid Javed**

Recommendations

1. In Pakistan, further horizontal expansion (increase in cultivated area) looks difficult due to decrease in water availability and continuous depletion of land resources. The new storage dams require huge investment. In these circumstances, the option left is vertical expansion i.e., increase in per acre yield which is already very low as compared to international yield levels. The major production constraints are to be removed which include non/inadequate availability of irrigation water, high prices of farm inputs and energy, low market prices for farm produce especially during crop harvest, agriculture credit, establishment of infrastructures

2. The progress for improving crop yields should include investment in the improvement and development of production technologies, building rural institutions, improving and enhancing related research activities, creating and reinforcing extension services. In short, there should be changes in the whole chain of agents of production which shift the production function upward.

3. Bio-technology is a low cost technology and environment friendly. It is imperative to focus on this technology to improve and enhance farm productivity. .

4. Creativity and strengthening of agricultural research is need of the hour. Presently, the fund allocated to research hardly meets administrative expenses. Raising the funds for research is pre-requisite for sustainability and development of agriculture sector on scientific basis.

5. Climatic change is now emerging as the most obvious problem for Pakistan. It may become the most serious one in the near future. Prior planning is required for a new set of technological changes in the field of agronomy, farming practices, research etc.

Paper: **Remote Sensing of Snow for Land Surface Modeling**

Author: **M. Jahanzeb Malik, Rogier van der Velde, Zoltan Vekerdy and Zhongbo Su**

Recommendations

The results of this study and the study by Malik et al. (In review) show that:

1. Multi-temporal observations of snow cover in near Infra-Red (NIR) and Thermal Infra-Red (TIR) regions of Electro Magnetic (EM) demonstrate good potential to discriminate dry and wet snow surfaces. This combination of multi-temporal NIR and TIR observations has been used to map dry and wet snow zones during the melt season. Assessment of mapped dry and wet snow areas shows weak but significant correlation (R^2 = 0.458, t stats = -3.05 and p value = 0.011 at 95% confidence level) with the differential passive microwaves TB in 19 and 37 GHz (H - Polarization).

2. Assimilation of RS retrieved snow albedo estimates in land surface models (LSM) are to-date still strongly under-utilized in climate/weather and hydrological studies. Retrieved albedo estimates from two approaches (i.e., empirical approach MOD10A1 product and recently published pattern-based semi-empirical approach) were recently tested to update snow albedo via the direct insertion (DI) technique by Malik et al. (In review). Both the assimilated estimates of snow albedo improve simulations in comparison to the open-loop simulations.

Paper: **Dry Land Forestry in Scrub Areas through Water Harvesting Techniques**

Author: **Major (Rtd.) Shahnawaz Badar, Dr. Muhammad Afzal and Amjad Ali Ch**

Recommendations

Water harvesting techniques combined with identified tree species can result in successful afforestation / reforestation programme. Water is the main constraint in the development of natural resources in the dry areas. In some areas there is hardly any rain however if the rainwater is collected from large areas, the quantity of water may become enough to develop natural resources. Water harvesting is a useful technology for development of dry land areas and tool for elevating socio economic status of the local inhabitants.

Paper: **Ground Water Recharge Potential in Irrigated Areas of Indus Basin-Pakistan**

Author: **Muhammad Saeed, Syed Javed Sultan and Dilbar Hassan**

(i) **Recommendations**

1. Maximum depletion (18-25 m) is in lower part of Bari Doab, recharge potential is 45.61 MAF during Oct. 2010 and it increased by 2 MAF and became 47 MAF during Jun-2012.
2. In Rechna Doab 42% area falls in the range of 3-6 m and 30% area falls in the range of 6-9 m. The recharge potential in the Rechna Doab was 15.80 and 16.381 MAF during Oct- 2010 and June-2012 respectively.
3. Maximum water table depth area was 41% in the range of 3-6 m of Chaj Doab during Oct-2010 and groundwater recharge potential was 4.32 and 4.675 MAF during Oct-2010 and Jun-2012 respectively.
4. Maximum area was 23.72% in the range of 3-6 m water table depth in Bahawalpur Zone and groundwater recharge potential was 7.79 MAF during Jun-2012.
5. Maximum area was 59.32% in the range of 3-6 m water table depth in Thal Doab and groundwater recharge potential was 7.36 MAF during Jun-2012.
6. Maximum area was 28.70% in the range of > 18 m water table depth in Bannu and groundwater recharge potential was 2.57 MAF during Jun-2012.
7. Maximum area was 20.27% in the range of 13-18 m water table depth in Dera Ismail Khan and groundwater recharge potential was 32.46 MAF during Jun-2012.
8. Maximum area was 33.33% in the range of 1.5-3.0 m water table depth in Peshawar and groundwater recharge potential was 3.49 MAF during Jun-2012.
9. Maximum area was 38.38% in the range of 3-6 m water table depth in Mardan and groundwater recharge potential was 9.44 MAF during Jun-2012.
10. Overall Groundwater recharge potential in Punjab, and KPK Provinces was 131.164 MAF during Jun-2012.
11. Water table depth in the range of > 12 m is 20% of irrigated areas of Indus Basin during Jun-2012.
12. Area with water table depth in the range of > 12 m in Bannu, Dera Ismail Khan, Mardan is 52.3%, 27.6% and 6.1% respectively in KPK province during Jun-2012. Overall in KPK 32% irrigated area falls in the range > 12 m during June-2012; and

13. In Sindh and Balochistan 54% area falls in the range of 0-150 cm during Jun-2012.

(ii) Recommendations

1. It is observed from the data that severe water table depletion problem exists in province of Punjab and KPK. Therefore it is strongly recommended that groundwater depleted areas should be recharged artificially when water is surplus, especially in flood season.

2. In the Shallow groundwater areas surface irrigation water allowance may be decreased to compensate the highly depleted areas by increasing surface water allowance.

Paper: **Use of Hairdin Drain Effluent for Growing Of Salt Tolerant Crops on Saline Sodic and Gypsiferous Soil -Strategies to Reduce Risk**

Author: **Mr. Khalid Mahmood Subhani, Talib Hussain and Munawar Ali**

Recommendations

1. There are spatial and temporal changes in quality of drainage water. Therefore the quality of Hairdin drain water may be monitored regularly and its use may be avoided during the days when its quality is highly hazardous.

2. Drainage water of Hairdin drain should not be used without exercising remedial measures. Pressmud @ 10 tons ha^{-1} or Farm Yard Manure (FYM) @ 25 tons ha^{-1} must be applied to control the adverse effect of drainage water on physical and chemical properties of soil and crops yield.

3. Pressmud followed by FYM is better soil amendment to increase soil permeability and to evade soil deterioration especially in clayey soils.

4. Salt tolerant crop cultivar(i.e. varieties) should be planted under drainage water application.

5. For gypsiferous and saline sodic soils leaching fraction irrigations should be applied after improving the permeability of the soil to maintain soil productivity.

Paper: **Surface Water Management in Pakistan**

Author: **Dr. Qazi Tallat Mahmood Siddiqui**

Recommendations

It appears appropriate to evaluate the vision and strategy being formulated to deal with challenges in the area of water resource conservation in general and in the area of flood management in particular because floods have not only created havoc in the country in terms of colossal damages of life, property and livestock but their recurrence is also expected in the years to come. While it is understood that efforts are already afoot for improvements in water management, some areas where an evaluation/appraisal may suggest further improvements are identified in the following.

- Approval and Implementation of National Water Policy
- Preparation and implementation of Fourth National Flood protection Plan
- Strengthening of Flood control Mechanisms and Flood protection infrastructure
- Formulation of enabling strategy for water conservation i.e. development of infrastructure specially for small dams and reservoirs
- Safety / Maintenance standards for physical infrastructures of barrages

- Coordination among various stakeholders related to water management – setting up a National Water Commission (NWC)
- Measures for prohibition of habitation in river catchments and flood plains
- Measures for removing existing inadequacies of water discharges during high floods
- Tapping of surplus water during monsoon season through development of infrastructure specially large reservoirs

Paper: **Water Management Issues in Existing Farming Practices**

Author: **Zamir Ahmed Soomro, Khuram Ejaz and Muhammad Dilshad**

Recommendations

Management of Land Resources

Small land holding which is further fragmented into small pieces at different locations is a major constraint in achieving higher crop yields. About 40% of the land holdings fall in the farm size category of 0-5 hectares and average farm size the study area is 8 hectares and 40% of the land holding in fragmented into more than 2 parcels. About 49% of the cultivators are either tenants or tenants-cum owners. Similarly 92% of the landowners are illiterate or under matric. The present situation of land resources requires major policy change to make land resources more favorable for crop production.

Improvement of Agronomic Practices

Since farmer responsible for agronomic practices are not very educated therefore they are not in touch with the advances in the field of advanced agronomic practices. Seed rate, sowing time and crop varieties play major role in crop production, farmers need to be educated about their importance and availability of essential input need to be ensured. Similarly role of proper cropping patterns keeping in view the agro-climatic zones and availability of water should be brought to the notice of farmers by the active participation of agricultural extension staff. Availability of un-adulterated fertilizers, seeds and LASER leveling equipments should be provided to the farmers on cheaper rates by the provincial agricultural departments.

Improvement of On-Farm Water Use

As the per capita water availability in Pakistan has reduced from 5600 m^3 to 1200 m^3 need to efficiently manage the available water at the farm Level has become pre-requisite for any level of crop production. This can only be achieved by proper layout, construction and keeping the water courses free from vegetation and sediment. Upto 50% of water is wasted in conveying the water from the mogha to farmer's fields. Similar is the situation of wastage of water at the fields. In most of the cases farmers do not know the water availability status in the soil profile at the time of irrigation. Easy to operate tensiometer such as the one made by the PCRWR is recommended for assessing the soil moisture. Proper farm layout and adoption of short duration crops and cropping pattern is recommended.

Paper: **Rational Surface Water Management : A Pre-Requisite For Groundwater Management in Pakistan**

Author: **Dr. Muhammad Basharat, Talib Hussain and Syed Javed Sultan**

Recommendations

Indus Basin Irrigation System (IBIS) is more than a century old and its performance have never been evaluated regarding equity of meeting irrigation demands and/or canal supplies, especially amongst various irrigation units. Both supply and demand side management need to work together: i.e. rationalizing water allowance and groundwater recharge. Maintaining groundwater balance over wet-drought cycle is the net requirement for groundwater resource sustainability.

Very sensible management of groundwater resources is needed, because drainage of waterlogged lands is feasible but a very costly option. On the other hand efficient irrigation water management according to demand and supply principle can avoid both waterlogging and depletion. At present, existing water allocation amongst different canal commands has no rationale.

The whole of lower part of Bari Doab has never been waterlogged. This also shows relatively less water allocation as compared to water demand when compared with other areas in Punjab. In the last decade, Rabi canal supplies in Punjab were about 30% less than Water Apportionment Accord-1991 (WAA) allocations. This was due to low river flows and online storage loss, causing shortage of Rabi supplies which is the major contributor to groundwater depletion. Following are the major factors contributing to unprecedented groundwater depletion in lower part of the Bari Doab:

- Almost zero river flows, particularly in Sutlej river;
- Non-perennial allocations along rivers, particularly along Sutlej river;
- Comparatively low canal supplies and annual normal rainfalls in the area; and
- High crop water requirements, particularly in Kharif season due to severe climate of the area.

Groundwater has become out of reach of small farmers in lower parts of Bari Doab. To avoid incurring extra ordinarily high costs on groundwater pumping and other irreversible impacts e.g. quality deterioration in lower parts of Bari Doab, there is need to change chronic and as usual approach towards management of canal water in isolation to groundwater resources. The later being at par to canal supplies in meeting crop water requirement now a days, therefore, deserves intervention by the governments. That is prior to any steps towards proper groundwater management, there is an urgent need to rationalize canal water allocations and enhanced groundwater recharge particularly by utilizing flood flows. Thus it is concluded that "Rational Surface Water Management is pre-requisite for Groundwater Management in Pakistan".

Rationalizing canal water allocations can further support and help in implementation of conjunctive water use and integrated water resources management (IWRM) at IBIS system level, or at least it can be implemented at provincial level and also at canal command level. However, implementation of IWRM approach at its interprovincial implementation may still be doubtful due to legal bindings for water distribution such as Water Apportionment Accord of 1991, as pointed out by Biswas (2008) for Canada, India and Pakistan. Following are the recommendations for sustainable groundwater management in the country:

- Construction of mega reservoirs should be the first priority;
- Fresh assessment of crop water requirement, cropping patterns and intensities, and existing allocations is urgently needed and recommended. Re-allocating canal water for equity in relative irrigation demand rather than supply at IBIS, provincial and canal command levels is crucial;
- Before moving towards groundwater management, equity of surface water availability needs to be ensured, especially at farm gate.On watercourse basis, allocating less water (time allocation) at watercourse head and more towards tail reach, thus creating a sense of equal delivery of irrigation water at farm gate;
- The capacity of groundwater institutions be developed to perform key functions of planning, research and providing information/technical support at regional level as well as local level;

- Frame a national water law for regulation of surface and groundwater at various levels; and

- Surface water allocation should be geared towards recharge management, especially Sukh-Beas channel be rehabilitated for groundwater recharge in central and lower parts of Bari Doab during flood season.

Paper: **Water Cooperation IN LBDC Irrigation System : Command Scale Conjunctive Water Management in-response to Spatial Climate Variability**

Author: **Dr. Muhammad Basharat, Talib Hussain and Ata-ur-Rehman Tariq**

Recommendations

1. Canal Water Allowance may be established in consideration of spatial variability of climatic parameters (Rainfall and Evapotranspiration) within and amongst the canal commands in the region;

2. Irrigation water may be reallocated in the LBDC command to the extent of 25% from head to tail end of the command (with linear variation in between, however, with due consideration for saline areas). No change in cropping pattern and intensities was considered for the reallocation towards the tail end. Therefore, it is proposed to re-evaluate the recommended reallocation percentages in response to any groundwater depletion, expected in the wake of increasing cropping intensities and changing cropping patterns towards the tail end;

3. Canal water reallocation for existing irrigation systems may be undertaken after critical analysis of socio-political ramifications, including efficient irrigation technologies especially for saline areas in head end of the command. This would help in managing salinity issue as wells as social acceptance of the proposed re-allocation from more rainfall areas in head end to less rainfall areas in tail end of the commands; and:

4. For present study it was assumed that reallocated canal water could be supplied by changing the canal closure days at distributary levels and channel hydraulics was not studied. It is therefore recommended to study in detail any modifications in channel hydraulics and design of control structures.

Paper: **Karez Rehabilitation : A Tool for Sustainable Livelihood and Climate Change Adaption in Balochistan.**

Author: **Mehmood Akhtar Cheema and Irfan Ali Bakhtiari**

Conclusions and Recommendations

The successful implementation of the innovative approach of karez rehabilitation and the consequent benefits gained by the communities from rehabilitated karezes; it is pragmatically concluded that Karez, being an indigenous system of Water Management, has all the characteristics which are required for ensuring sustainable livelihood of farming communities. Karez irrigation systems on the other hand have found to be resilient to changing climatic conditions; therefore, they can be used as a water resource and management system in climate change conditions.

It is therefore, highly recommended that all the humanitarian organizations working in water sector and the governments should focus on reviving the abandoned karezes on priority. The revival of these systems would ensure continued supplies of water to the communities in the expected water scarcity era, yet to come.

VISIT TO HEAVY MECHANICAL COMPLEX

A 14-members' delegation of very senior / young professional engineers of Pakistan Engineering Congress led by Engr. Akhtar Abbas Khawaja, Vice-President / Secretary, PEC paid a technical visit to Heavy Mechanical Complex of Ministry of Production (Government of Pakistan) on 17th April, 2013. Heavy Mechanical Complex is immensely contributing to economic development of the Country. It is the largest. Engineering and Manufacturing Company in Pakistan. Product Mix includes complete plants, equipment and spares for various industries. The Company commenced commercial production in 1971. The facilities include:

- Design Centre
- Steel Foundry
- Cast Iron and Non-Ferrous Foundry
- Fabrication Shops
- Machine Shops
- Heat Treatment Shops
- Forge Shops
- Galvanizing Shop
- Assembly Shop
- Tool Room

HMC possesses state-of-the-art technologies, acquired through technical collaboration with international companies of repute.

A team of highly qualified and skilled engineers, technicians and workers specializing in Design, Planning, Project Management, Manufacturing, Installation and Commissioning provide tailor made Products / Services to both public / private sector organizations.

The organization is engaged in the production of the following.

- Cement Plants and Equipment
- Sugar Plants and Equipment
- Oil and Gas Processing Plants and Equipment
- Chemical and Petrochemical Plants and Equipment
- Packaged Type Industrial Steam Boilers
- Utility Boilers Equipment
- Hydel and Thermal Power Plants Equipment
- Overhead Traveling Cranes and Portal Cranes
- Road Construction Machinery

- Railway Axles, Screw Jacks, Screw Couplings, Surface Traverses
- Industrial Steel Structures and S. S. / Guy Towers
- Die Forgings for Auto Industry
- Sophisticated and Heavy Castings and Forgings
- Spares for Engineering Industry

Upon arrival, the team was received by Mr. Abdul Aleem, OIC – Protocol. Briefing / presentation session ensued at Management Training Center for about one and half hour. After that the delegation was taken round of Steel Foundry, Fabrication and Machine Shops-1. In the evening, the delegation visited the Historical Taxila Museum which was highly informative and gave a deep insight of the national heritage.

Glimpses of the Visit of Pakistan Engineering Congress Delegation to Heavy Mechanical Complex, Taxila on 17th April, 2013

The Delegation of Pakistan Engineering Congress at Heavy Mechanical Complex, Taxila on 17th April, 2013. Engr. Pir M. Jamil Shah is 1st from right, Engr. Akhtar Abbas Khawaja, Vice-President / Secretary, PEC 4th from Right.

The Congress Delegation in Heavy Mechanical Complex in Briefing Session

Glimpses of the Visit of Pakistan Engineering Congress Delegation to Heavy Mechanical Complex, Taxila on 17th April, 2013

Engr. Akhtar Abbas Khawaja, Vice-President / Secretary addressing at the briefing session

Pakistan Engineering Congress Delegation visiting Hydraulic Press Shop of Heavy Mechanical Complex. Engr. Shabir Ahmad Qureshi, Engr. Akhtar Abbas Khawaja, Engr. Pir M. Jamil Shah (Vice-Presidents PEC) can be seen in the Picture

Glimpses of the Visit of Pakistan Engineering Congress Delegation to Heavy Mechanical Complex, Taxila on 17th April, 2013

Pakistan Engineering Congress Delegation visiting Fabrication Shop of Heavy Mechanical Complex

Delegation at Machine Assy and Auxiliary Shop

Glimpses of the Visit of Pakistan Engineering Congress Delegation to Heavy Mechanical Complex, Taxila on 17th April, 2013

Pakistan Engineering Congress Delegation at Heavy Mechanical Complex

Engr. Akhtar Abbas Khawaja, Vice-President / Secretary, PEC in intense discussion at Nondestructive Testing Laboratory

Glimpses of the Visit of Pakistan Engineering Congress Delegation to Heavy Mechanical Complex, Taxila on 17th April, 2013

Pakistan Engineering Congress Delegation visiting Steel Foundry of Heavy Mechanical Complex

Pakistan Engineering Congress Delegation visiting "Steel Foundry" of Heavy Mechanical Complex

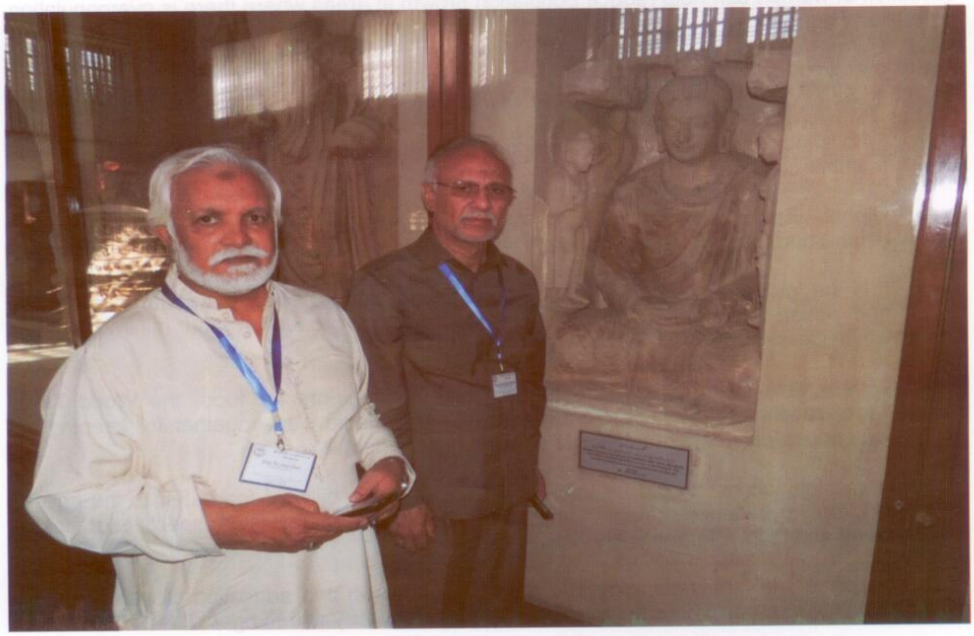
Glimpses of the Visit of Pakistan Engineering Congress Delegation to Heavy Mechanical Complex, Taxila on 17th April, 2013

Pakistan Engineering Congress Delegation getting Briefing on Steel Foundry

Briefing at Fabrication Shop of Heavy Mechanical Complex

Glimpses of the Visit of Congress Delegation to Taxila Museum

Pakistan Engineering Congress Delegation at Taxila Museum



From Left : Engr. Pir. M. Jamil Shah, Vice-President, PEC, Engr. Akhtar Abbas Khawaja, Vice-President / Secretary, PEC at Taxila Museum

RECOMMENDATIONS MADE BY EXPERTS ON THE EVE OF WORLD ENVIRONMENT DAY HELD ON 5TH JUNE, 2013

World Environment Day-2013 was commemorated on the Theme of *"Think – Eat – Save"* at the Pakistan Engineering Congress Headquarter, on 5th June, 2013. Presentations were made by the experts in the relevant fields. All the presentations generated lively discussions. The following recommendations were made:

Global Food Security : Production, Wastage, Shortage and Solutions

Around one third of food produced for human consumption is lost or wasted globally within food supply chain. Immediate measures are required to be taken to control food loss and waste at each stage of food supply chain.

Food security is a three dimensional subject including adequacy of food supply, access to food, and equity of food distribution. All these dimensions require special interventions and enabling environment for ensuring household food security.

Post-harvest losses are mainly at storage stage for non-perishable food stuff. Time lag in transportation and improper handling of fruits and vegetables reduces the quantity and quality of perishable food items.

Food loss of both perishable and non-perishable food can be controlled by improving transportation facilities, marketing and storage facilities (i.e., cold storage at whole sale and retail outlets) in order to preserve fresh fruits and vegetables.

Most of the problems being faced by the world today, including food shortage, are due to the rapid increase in population. Investment in family planning and reproductive health and education of women can help reduce population growth in areas where there is overpopulation, poverty and hunger.

The following suggestions are made:

Global

- FAO should regulate the food production and ensuing losses with the assistance of member countries.
- Global, Regional and National Research and Development Centres should be established for carrying out research about food production and losses.
- It is the 'global, national and sub-regional' moral duty of every individual, organization and nation to contribute towards increasing food production and minimizing food wastes/losses.
- With a view to protecting the fundamental human right for food, the World Trade Organization and other relevant market players should work together for keeping the food prices within affordable limits of world hungry people.
- Divine injunctions should be followed to ensure availability of food stuff to the poverty stricken, and undernourished and malnourished communities irrespective of colour, creed and faith differences.
- Investment in family planning and reproductive health and education of women should be made in areas where there is overpopulation, poverty and hunger.
- Mass awareness programmes should be launched at all levels for minimizing/controlling food wastages / losses.

- Consumer behavior should be oriented towards food security through formulation of Consumer Societies.
- Best food waste management practices should be studied, tested and advocated.

National

The following interventions are suggested to make the country 'food secure':

- Sustainable and efficient utilization of the natural resources (like Land and Water).
- Productivity enhancement of major food crops (i.e. Wheat, Rice, Maize, Oil Seed).
- Distribution of land and access to the resources and inputs.
- Improving harvest techniques, storage facilities and farmers' education.
- Improving the application of physical inputs.
- Diversification of on-farm and off-farm income generation activities.
- Stabilization of input and output prices.
- Addressing the gender inequity.
- Skill development and exposure to the development opportunities.
- Improving the nutritional aspects of food.
- Taking measures to employ "Precision Agriculture in Pakistan" by sharing the investment cost by the Government, providing enabling environment, strengthening research and development, and by building the capacity.
- A substantial share of the increasing food demand could also be met by introducing food energy efficiency, such as recycling of waste. With new technology, waste along the food supply chain could be used as a substitute for cereals in animal feed.
- Rain fed agriculture should be given due consideration for productivity enhancement by adopting the following measures:
  - Employ rain-water harvesting techniques to fully utilize the rainfall potential.
  - Employ soil moisture conservation techniques like improved tillage practices and add gypsum to increase crop production.
  - The crop calendar should be changed according to rainfall availability e.g., the first and second week of November and first week of December are considered optimal for sowing of wheat crop.
  - Detailed hydrological analysis should be done using long term hydrological data.
  - Water conservation treatments should be employed during critical periods.
  - High efficiency irrigation system should be installed.

Addressing the Water Pollution of the River Ravi

- Wastewater, including sewage and industrial affluent, must be treated before discharging into the River. The wastewater treatment should be simple, indigenous and

cost effective as suggested by the River Ravi Commission i.e. construction of bio-remediation treatment plant with the concept of constructed wetlands.

- The industries may develop primary or secondary treatments before the affluent leaves the industry OR Industries establish a common treatment plant.
- All housing colonies must establish sewage treatment plants at least to reduce major portion of the organic loading.
- The organic waste (after plant harvesting) from the bio-remediation treatment can be used as a resource for biogas production.
- Phyto-remediation techniques may be applied to reduce the pollution and for metal adsorption.
- Ground water abstraction policy should be framed in the Punjab Province on emergency basis. Lahore's water drawdown curve is going down because of over abstraction. Strategy for regulating water abstraction should be developed to help maintain the ground water table.
- There should be restriction on the use of industrial effluents for irrigation purposes.
- Measures should be taken to conserve and enhance fish production in the river Ravi.

WELCOME TO NEW MEMBERS

The Executive Council of the Pakistan Engineering Congress approved Membership of the following new members into the Congress fold. The Engineering News congratulates all of them and welcomes them to Pakistan Engineering Congress

Members admitted on 11th March 2013

1 Engr. Adil Sohail Mushtaq
2 Engr. Javed Akhtar
3 Engr. Arshad Chughtai
4 Engr. Syed Raheel Jamil
5 Engr. Rajendar Kumar
6 Engr. Muhammad Anees ur Rahman
7 Engr. Muhammad Umar Farooq
8 Engr. Barkat Ali Qureshi
9 Engr. Kalim Ahmad
10 Engr. Muhammad Usman
11 Engr. Nazer Muhammad Bilawal
12 Engr. Noman Ghulamullah
13. Engr. Rehan Masood
14 Engr. Muhammad Haseeb
15 Engr. Saeed Rashid
16 Engr. M. Fahad Amin
17 Engr. Bilal Shafiq
18 Engr. Auranzeb
19 Engr. Waqas Javed
20 Engr. Ata ur Rehman Khan
21 Engr. Syed Imad ud Din
22 Engr. Muhammad Fayaz
23 Engr. Awais Iqbal
24 Engr. Muhammad Talha
25 Engr. Muhammad Yasir Siddique Anjum
26 Engr. Muhammad ali Raza Anjum
27 Engr. Tajammal Hussain Malik
28 Engr. Qmar Iqbal
29 Engr. Muhammad Ahsan Tahir
30 Engr. Waqar Mahmood
31 Engr. Muhammad Asif
32 Engr. Taskeen Ahmad
33 Engr. Aamir Hussain
34 Engr. Sarfraz Saleem
35 Engr. Shoaib Ahmad
36 Engr. Muhammad Yousaf Mugsi
37 Engr. Gulzar Ahmad Memon
38 Engr. Shahryar Khan Niazi
39 Engr. Rizwan Khan
40 Engr. Muhammad Faisal Javed
41 Engr. Zohaib Nisar
42 Engr. Muhammad Sher Zaman Khan
43 Engr. Muhammad Aamir Yasin
44 Engr. Ahmad Yar Baig
45 Engr. Muhammad Qasim
46 Engr. Syed Riaz ul Hassnain
47 Engr. Muhammad Zeeshan Safdar
48 Engr. Muhammad Kamran
49 Engr. Saba Iklaq
50 Engr. Bashir Ahmad Memon
51 Engr. Ali Hasnain Syed
52 Engr. Ussama Javed Rai
53 Engr. Nauman Ijaz
54 Engr. Syed Faraz Jafri
55 Engr. Sarfraz Khan
56 Engr. Khurram Waheed Bhatti
57 Engr. Usman Zahid
58 Engr. Zubair Iqbal Rao
59 Engr. Mansoor ul Hassan
60 Engr. Syed Muhammad Ali Raza Zaidi
61 Engr. Muhammad Rohan
62 Engr. Waseem Sarwar
63 Engr. Muhammad Shahid Hassan
64 Engr. Abid Ali
65 Engr. Akhtar Abbas
66 Engr. Marzooq Ahmad
67 Engr. Muhammad Munawwar Akhtar
68 Engr. Umair Shakir
69 Engr. Hamza Ahmad
70 Engr. Rahmat Ullah
71 Engr. Muhammad Faisal Watto
72 Engr. Muhammad Mubashir Qureshi
73 Engr. Muhammad Nadeem
74 Engr. Muhammad Bashir
75 Engr. Shaheen Sabir
76 Engr. Munir Ahmad
77 Engr. Asif Anwar
78 Engr. Abu Bakar
79 Engr. Rehman Maqbool
80 Engr. Haji Ahmad
81 Engr. Abdullah Khalid Parvez
82 Engr. Haroon Abid
83 Engr. Haseeb Haider
84 Engr. Abdul Waheed Khan
85 Engr. Hammad Waheed Sheikh
86 Engr. M. Fahad Naveed Khan
87 Engr. Haroon Aftab
88 Engr. Muhammad Akif
89 Engr. Ans Mushtaq
90 Engr. Faisal Iftikhar Ahmed Mirza
91 Engr. Izfar Ahmad Chaughtai
92 Engr. Muhammad Ghazanfar Mubin
93 Engr. Sajid Ali Bhutto
94 Engr. Ammad Ahmad Khan
95 Engr. Ali Saleem Kazi
96 Engr. Salman Amjad
97 Engr. Muhammad Asghar
98 Engr. Major (R) M. Asif Kamal
99 Engr. Ajmal Nadeem Bhutta
100. Engr. Iftikhar Khan
101 Engr. Bilal Ahmad
102 Engr. Shakeel Ahmed Khan
103 Engr. Imran Kareem
104 Engr. Fahad Faraz

105 Engr. Bhagwan Das
106 Engr. Muhammad Danish Farooq
107 Engr. Muhammad Shabir Hussain Kamboh
108 Engr. Ikhlaq Ahmad Khan
109 Engr. Irtiza Mansoor
110 Engr. Yasir Khalid
111 Engr. Faisal Dilshad Siddiqui
112 Engr. Mohammad Adnan Ch.
113 Engr. Muhammad Ali Manzoor
114 Engr. Ch. Mahboob Ali
115 Engr. Usama Javid
116 Engr. Noraiz Ahmad Rao
117 Engr. Muhammad Ghazanfar
118 Engr. Muhammad Shahid Amin
119 Engr. Muhammad Irfan-ul-Hassan

Members admitted on 5th August 2013

1 Engr. Murad Ahmad Khan
2 Engr. Hafiz Muneeb Ahmad Qureshi
3 Engr. Muhammad Sadiq
4 Engr. Arshad Majeed Bhatti
5 Engr. Muhammad Khalid
6 Engr. Muhammad Saeed
7 Engr. Fahad Ali Soomro
8 Engr. Naeem Ahmad
9 Engr. Naveed Ahmed
10 Engr. Atif Iqbal
11 Engr. Tariq Altaf
12 Engr. Mohammad Ajmal Ahmadani
13 Engr. Abdul Waheed
14 Engr. Akhtar Ayaz
15 Engr. Naveed Akhtar
16 Engr. Fawad
17 Engr. Faisal ur Rahman Awan
18 Engr. Shahzad Hassan
19 Engr. Aneela Sabir
20 Engr. Lt. Col. Nadeem Ahad
21 Engr. Muhammad Moghees Arshad
22 Engr. Asmat Ullah Nasir
23 Engr. Zeeshan Ahmad
24 Engr. Dilshad Ahmad
25 Engr. Muhammad Rauf
26 Engr. Dr. Noor Mohammad Khan
27 Engr. Haider Ali
28 Engr. Majid Jamil
29 Engr. Muhammad Yousaf
30 Engr. Mohammad Arif
31 Engr. Amer Hassan Khateeb
32 Engr. Asad Ali
33 Engr. Imran Babar

Members admitted on July – September 2013

1 Engr. Usman Pervaiz
2 Engr. Dr. Muhammad Afzal
3 Engr. Habib Ahmad Iftikhar
4 Engr. Saleem Raza
5 Engr. Shoaib Zia
6 Engr. Haseeb Afzal
7 Engr. Yasir Khan
8 Engr. Rizwan Aslam
9 Engr. Rizwan Khurram
10 Engr. Asma Iftikhar
11 Engr. Muhammad Farooq Khattak
12 Engr. Muhammad Ahsan
13 Engr. Asad Hussain Jatoi
14 Engr. Majid Hussain Jatoi
15 Engr. Adeel Haider Razi
16 Engr. Faisal Shahid
17 Engr. Zia ul Islam Tariq
18 Engr. Muhammad Umar Nawaz
19 Engr. Haris Qayyum
20 Engr. Muhammad Imran
21 Engr. Shah Jahan
22 Engr. Noor Muhammad
23 Engr. Fazeel Mehmood
24 Engr. Akmal Hafeez
25 Engr. Syed Wasif Azim Rizvi
26 Engr. Raja Waqas Ahmed Azad
27 Engr. Farhan Mirza
28 Engr. Shahzad Arif Sheikh
29 Engr. Ghulam Dastigir
30 Engr. Hassan Faraz
31 Engr. Zohaib Hassan
32 Engr. Kamran Taufiq Khan
33 Engr. Haider Ali Shah
34 Engr. Muhammad Usman Haider
35 Engr. Muhammad Shoaib
36 Engr. Abid Hameed
37 Engr. Muhammad Azam Sarwar
38 Engr. Usman Mir
39 Engr. Rizwan Qadir
40 Engr. Malik Mateen Ahmed
41 Engr. Humera Ahmed
42 Engr. Khurram Rashid
43 Engr. Amber Rana
44 Engr. Nemat Ullah
45 Engr. Muhammad Umer Siddiqui
46 Engr. Adeel Elahi
47 Engr. Muhammad Zafar Iqbal
48 Engr. Ahmad Ali
49 Engr. Abdul Khaliq
50 Engr. Muhammad Imran ul Haq
51 Engr. Muhammad Zafar Iqbal
52 Engr. Muhammad Nauman Bin Ejaz
53 Engr. Muhammad Akbar Sheikh
54 Engr. Muhammad Saeed
55 Engr. Muhammad Shoaib
56 Engr. Lt. Col. (Rtd.) Irfan Ali
57 Engr. Altaf Ali
58 Engr. Muhammad Muzam Hayat
59 Engr. Muhammad Arsalan Anwer
60 Engr. Yaqoob Khalid

61 Engr. Ali Raza
62 Engr. Sabir Hussain
63 Engr. Hafiz Muhammad Faisal
64 Engr. Usman Zaman Khan
65 Engr. Waqas Mahmood
66 Engr. Sana Jaweed
67 Engr. Sahar Jaweed

OBITUARIES

May their souls rest in Peace

1. Mother of Engr. Najam Waheed, passed away on February 24, 2013.
2. Mother of Engr. Amjad Raza Khan, passed away on March 6, 2013.
3. Engr. Z. A. Nizami, passed away on April 7, 2013.
4. Engr. Muhammad Saeed an eminent Engr. Former Chief Engineer (PWD B&R), Director General Highways (West Pakistan) and Adviser to the Late King Faisal of Saudi Arabia, passed away on April 23, 2013.
5. Engr. Muhammad Rafique Goheer, Founder Chairman of Saira Memorial Trust Hospital and Ex-Chief Engineer ATCO Saudi Arabia passed away on April 28, 2013.
6. Engr. Abdul Rauf Consulting Engineer Associated with M/s, ACE, passed away on May 18, 2013.
7. Mother in Law of Engr. Capt. (R) Muhammad Qadir Khan Member Executive Council of Pakistan Engineering Congress passed away on May 24, 2013.
8. Engr. Akhtar Ali Chohan Chief Engineer (R) Communication and Works Department and Father of Mrs. Laila Khalid Soofi passed away on May 29, 2013.
10. Sister of Engr. Syed Abdul Qadir Shah, Chairman, Pakistan Engineering Council / Member Executive Council of Pakistan Engineering Congress passed away on July 28, 2013.
11. Engr. Shamim Ahmad Khan Chief Engineer (R) WAPDA passed away on July 22, 2013.
12. Engr. Muhammad Anwar (R) S. E. Mechanical Irrigation Department Punjab passed away on August 19, 2013.

STATUS OF HIGH EFFICIENCY IRRIGATION SYSTEM (HEIS) UNDER PUNJAB IRRIGATED-AGRICULTURE PRODUCTIVITY IMPROVEMENT PROJECT (PIPIP)

By

Ahmad Ali Zafar*

PROJECT RATIONALE

Irrigated agriculture is the lifeline of Pakistan's economy contributing 90 percent of the total agriculture share (over 21 percent) in GDP. The sector is so intimately interwoven with almost all other major sectors that it acts as engine of growth for rest of the economy. Punjab is the agricultural and economic heartland of the country contributing over 80 percent towards agriculture sector and about 90 percent of it comes from irrigated areas. Water is the most critical and precious input for crop production under irrigated agriculture. Growing physical scarcity of freshwater resources, shortage of economically accessible water, changing climate uncertainties, growing population and increasing competition for water threatened food security of the future generations. The situation has further aggravated due to low crop water productivity because of ineffective and inefficient utilization of water resources besides environmental degradation. The water shortages registered during the last few years were as high as 40-50 percent. Improving water productivity through capitalizing modern water resource conservation technologies and practices is the most viable option for maintaining the long term integrity of agriculture irrigated.

On the basis of current water shortages and rapidly competing future demands, the foreseen situation would simply be unsustainable for agriculture on which national economy is based. Improving water productivity through capitalizing modern water resource conservation technologies and practices is the most viable option for maintaining the long term integrity of agriculture resources in particular water. An integrated development approach based on promoting as well as adopting the most efficient modern technology-aided resource conservation technologies aiming at improving crop water productivity as well as research backup support is direly needed to sustain crop production under irrigated agriculture in Punjab.

The PIPIP has been designed to maximize productivity of available water by providing a complete package of OFWM (On-Farm Water Management) interventions to minimize water losses at various levels and improve water productivity through ensuring its adequacy, equity, and reliability at the farm level. It envisages developing/upgrading tertiary conveyance system, promotion of high efficiency water conserving technologies like sprinkler/drip irrigation systems, LASER land leveling, capacity building of all stakeholders, and undertaking action research for acquisition, indigenization, and pilot testing of improved water management interventions to suit the local conditions. The combined effect of these advancements would lead to enhanced output of available land and water resources.

PROJECT OBJECTIVES

The overall Project Development Objective (PDO) is to improve water productivity i.e. producing more crops per drop. It will be achieved through increasing delivery efficiency, adopting improved irrigation practices, promoting crop diversification, and effective application of non-water inputs. The PDO would contribute to increased agricultural production, more employment opportunities in rural areas, higher incomes from the farming, better living standards of the farmers, and improved environment.

The proposed project will have following key objectives.

I. Improving productivity of irrigation water by efficient conveyance and its effective farm level use by adopting conservation agricultural practices.

II. Production of more profitable crops through high efficiency irrigation systems (HEISs) for meeting increasing domestic demand and enhancing exports.

III. Strengthening the private sector service delivery capacity and sustainability for supporting irrigated agriculture.

IV. Capacity building of stakeholders in better managing irrigation water for attaining higher crop yields with less production costs.

PROJECT COMPONENTS

The major activities to be carried out under the proposed project would include, interalia, the followings.

A. Improving Water Productivity

A-1 Installation of High Efficiency Irrigation Systems (HEISs) on **120,000** acres

A-2 Strengthening of Precision Land Leveling Services in Private Sector through provision of **3,000** Laser units to farmers / service providers

B. Upgrading Farm Level Irrigation Conveyance System

B-1 Improvement of **5,500** Unimproved Canal Irrigated Water courses

B-2 Completion of **1,500** Partially Improved Watercourses

B-3 Rehabilitation of **2,000** Irrigation Conveyance Systems in Non-Canal Commanded Areas

C. Adoption and Promotion of Modern Irrigation Technologies & Practices and Monitoring & Evaluation

C-1 Adoption and Promotion of Modern Irrigation Technologies and Practices

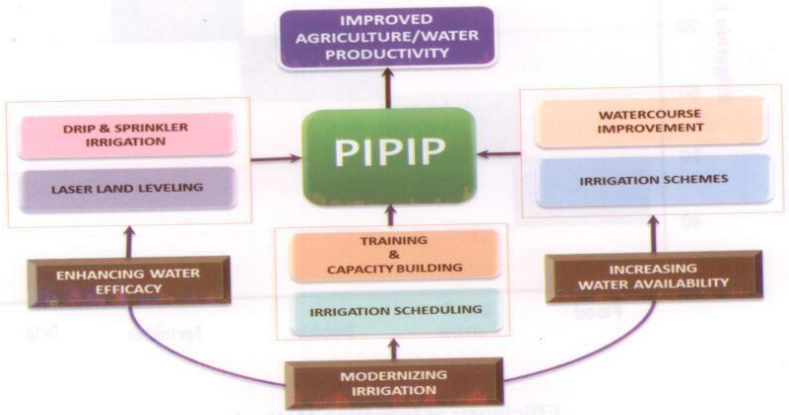
C-2 Monitoring and Evaluation of Project Impacts

D. Project Management, Supervision, Technical Assistance, Training and Strategic Studies

D-1 Project Implementation and Management Support

D-2 Implementation Supervision and Third Party Validation Consultancies

D-3 Strategic Studies, Technical Assistance, Training etc.



PIPIP Conceptual Framework

HIGH EFFICIENCY IRRIGATION SYSTEMS

Drip, bubbler, conventional sprinkler, rain-gun, center pivot etc. are together referred to as high efficiency irrigation systems (HEISs) which use pipes for conveyance of water from the source to points of use. In drip or trickle irrigation, water is provided to individual plants by means of small emitters in the form of droplets. Bubbler irrigation is very similar to trickle irrigation except that the water is delivered to the plants through micro sprinklers mounted on small spikes. In rain-gun irrigation systems, water is pumped at high pressure through a piped system and sprayed over the field.

i) Drip Irrigation System

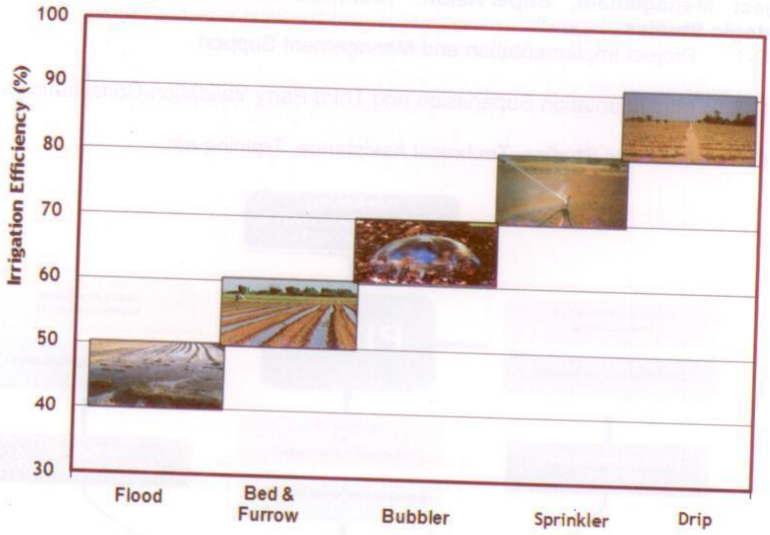
Drip irrigation also called as trickle / micro irrigation is the most efficient technology that makes highly effective use of water, fertilizers, and nutrients. Its main principle is to apply water and other inputs slowly, regularly, and frequently as close to the plant roots as possible through emitters installed on plastic pipes laid out in the field. Regular and timely availability of nutrients throughout the plant growth period as per exact requirements and maintenance of favorable soil moisture conditions to facilitate maximize crop productivity. Drip irrigation technology is best suited for orchards and high value row crops such as cotton, maize, sugarcane, vegetables etc. It has become the most valued innovation, which optimizes use of water and fertilizers by enhancing the irrigation efficiency as much as 95 percent.

ii) Sprinkler Irrigation System

The sprinkler system is the overhead irrigation whereby water is sprayed on the soil/crop somewhat like rain. A typical sprinkling unit comprises of an electric or diesel pumping unit, a portable or buried main pipeline with hydrants at predetermined intervals, and one or more sprinklers units attached to hydrants or hose.

iii) Impacts of High Efficiency Irrigation Systems

Flood irrigation is the traditional irrigation practice at the farm level adopted by majority of the farmers in Pakistan. The efficiency of traditional irrigation methods ranges from 40-70 percent, while the drip and sprinkler irrigation systems are the most efficient having efficiency upto 95 percent as illustrated in Figure below.



Efficiency of Irrigation Methods

The high efficiency irrigation systems (HEISs) have been developed and successfully adopted in various countries of the world including USA, Australia, China, India etc. Major constraint in adoption of these technologies is their high installation and operational costs. The issue has, however, been resolved through research on development, particularly in China where cost effective systems have been developed for orchards and all field crops including vegetables. The experience of other countries and studies conducted in the recent past recommend that introduction of high efficiency irrigation systems is highly effective in conserving water resources.

The impact assessment studies for performance evaluation of drip/sprinkler irrigation on sugarcane, citrus, potato, wheat, and gram have been undertaken by technical committees headed by Director (Research) of particular crops, with representatives from Punjab Economic Research Institute (PERI), Crop Reporting System (CRS), and Planning and Evaluation (P & E) Cell of Agriculture Department. These technologies have exhibited following impacts against conventional irrigation methods.

Sugarcane

- Increase in yield — 39%
- Additional land brought under sugarcane — 72%
- Water saving — 57%
- Saving in irrigation cost — Rs. 8,500 per acre
- Reduction in labour for irrigation management — 60%
- Saving of Nitrogen and Phosphorous — 53% and 28%
- Sugar recovery against conventional flooding — 11.2% against 9.18%
- Easy, precise, efficient and uniform fertilizer application

Citrus

- Additional plants planted per acre — 47 Nos.
- Reduction in mortality rate — 100%
- Saving in irrigation cost — 72%
- Increase in yield — 105%
- Enhancement in sale price — 76%
- Juicy contents — 30% more
- Bigger fruit size — 67 mm against 45 mm
- Uniform size & shape and better color fruit
- Adoption of high density orchard plantation for higher yields

Potato

- Increase in yield — 34%
- Water saving — 50%
- Savings in fertilizer used — 30-40%

- Tuber cleanliness
- Better weed control
- Higher ratio of larger tubers

Wheat

- Increase in yield 230%
- Water saving 50%
- Enhancement in cropping intensity 100%
- Efficient nutrient uptake
- Uniform and better seed germination

Gram

- Water saving 50%
- Increase in cropping intensity 100%
- Better utilization of inputs
- Positive impact on socio-economic status of farmer

In addition, Nuclear Institute for Agriculture and Biology (NIAB) Faisalabad has evaluated drip irrigation for cotton and flaunted the following impacts.

- Water saving 49%
- Increase in yield 52%
- Input productivity improvement
- Fertilizer 69%
- Water 67%

STATUS OF HEIS TECHNOLOGY IN PUNJAB

In view of the expected benefits of High Efficiency Irrigation Systems (HEISs) and increasing water shortage in the country, federal government launched "Water Conservation and Productivity Enhancement through High Efficiency (Pressurized) Irrigation Systems" project during 2007-08 throughout the country at a cost of Rs. 18.00 billion. Its execution and implementation was approved through OFWM wings / Directorates of the provincial Agriculture Departments and federally administered areas. Main objective of the project is to promote drip and sprinkler irrigation through demonstration of these technologies on about 291,000 acres.

The Punjab component of the project was started in December 2008 after its approval by the PDWP to install drip and sprinkler irrigation on about 140,000 acres during four years (2008-09 to 2011-12) at a total cost of Rs. 6.917 million in the entire province. At onset of the project implementation in the Punjab, it was realized that its execution arrangements were not correctly conceived. Despite administrative, technical, and financial constraints, OFWM wing of the Punjab Agriculture Department has got installed drip and sprinkler irrigation systems on more than 9,000 acres at 350 sites in the province during three years. The project administration in the federal government was shifted from Water Management Cell of MINFA to Pakistan Agricultural Research Council (PARC), Islamabad on 29-07-2009. Its PC-I revision was started by the PARC and provincial governments were asked to stop further work from 31-12- 2009 onwards till restructuring of the project. The project was abandoned by the federal government

due to financial crunch and shifting of agricultural functions to provinces under 18th constitutional amendment.

Meanwhile, Government of Punjab has implemented an inventive undertaking for promotion of cotton cultivation under desert environment with drip irrigation on 2,000 acres. The "Pilot Project for Promotion of Cotton Cultivation in Thal Region with Drip Irrigation" project has been designed to provide integrated support and assistance to the farmers that have been proved highly efficacious. It is reported that cotton yielded upto 50 maunds (1.86 tons) per acre with an average of 30 maunds (1.12 tons) per acre against 15 maunds (0.60 tons) per acre average in the area. This intervention also made it possible to grow cash crops first time on sand dunes without land leveling in the project area including oil seeds, onion, vegetables in tunnels, maize, water melon etc.

The crop production under high efficiency irrigation requires fundamental change in the irrigated agriculture. Accordingly, under PIPIP, the successful promotion and adoption of these technologies has been well addressed through awareness, demonstration, service provision, backup support, training and capacity building as well as research and indigenization. As the role of Service Supply Companies (SSCs), being the major stakeholder in project implementation is very crucial. So, strenuous efforts have been made to encourage private sector for involvement in provision of various services related to high efficiency irrigation. The prime objective of PIPIP in this regard is to:

- Build confidence of service providers for assured sizeable market / clientage
- Create enabling environment for existing pipe and plastic industry to start local manufacturing of drip/sprinkler components for technology indigenization
- Encourage the firms for establishment of service provision network / backup support centers at regional/district level

Under PIPIP, installations have been completed on 2,356 acres on 210 sites.

PROMOTION OF INDIGENOUS AND ENDANGERED TREE SPECIES TO MITIGATE WATER SHORTAGE IN PUNJAB

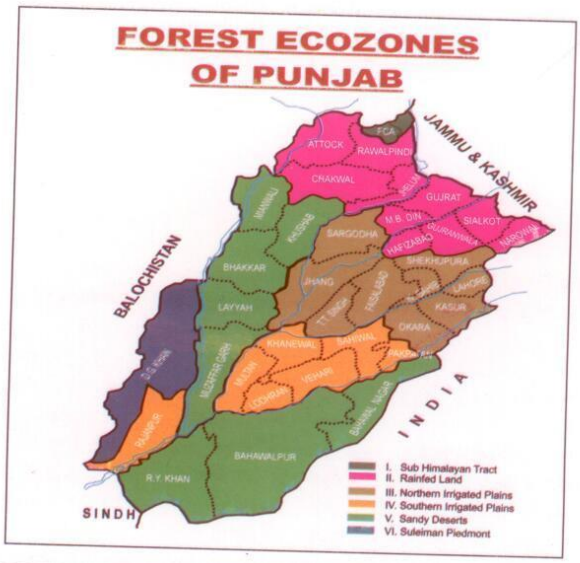
By

Dr. Muhammad Afzal*, Aqeela Mobeen Akhter and M. Mahboob-Ur-Rahman*****

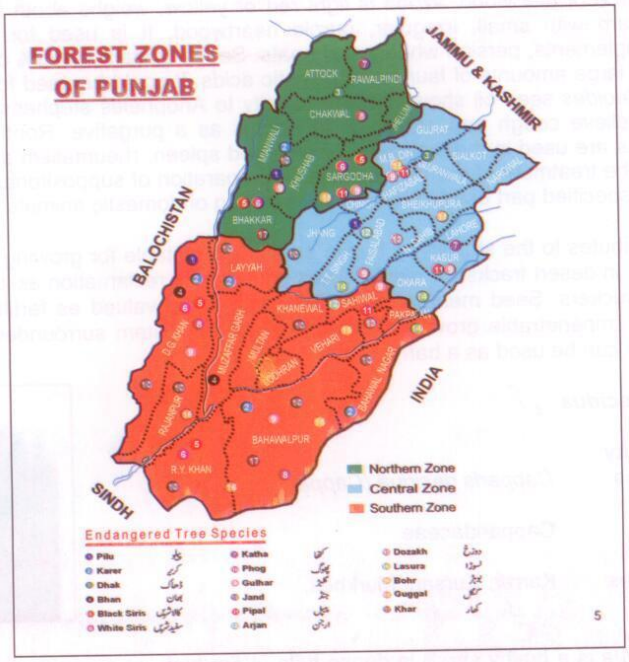
Introduction

We live in a time characterized by some experts as the *"last great land grab"*. In order to sustain the rapidly growing population of the world in the coming years, millions of acres of forest will need to be converted to other uses – unless we come up with smarter solutions. With global warming on the rise, forests are more valuable than ever as vital carbon sinks. The twin threats of global warming and deforestation threaten many geographically distinct and ecologically important trees. An endangered species is a population of pie which is at risk of becoming extinct because it is either few in numbers, or threatened by changing environmental or predation parameters. A study conducted by the Royal Botanic Gardens during September, 2010 found that 22% of the approximately 380,000 known plant species i.e. about 83,600 plant species are endangered.

Have you ever wondered why are plants endangered? There are many causes of endangered species of plants. The main cause for a plant to become endangered is loss of its natural habitat. This is mainly due to the expansion of mankind. As urban development increases, plants lose more and more of their natural habitat. Clearing land for pastures and agricultural purposes also cause plants to lose their habitat. Grazing animals are a large contributor to causing endangered species of plants. Natural disasters like droughts and floods also cause a plant to become endangered. Wild fires are a large natural cause for a plant to lose its natural habitat. Certain weeds and pests can deplete the land needed for rare and endangered plants to survive as well. The multiple causes of endangered species of plants often occur over time. When a plant species is discovered to be endangered the situation is extremely critical and fast action must be taken because often it is not known that a plant has become endangered until after it has become extinct.



*Director. **RO and ARO***. Puniab Forestry Research Institute. Faisalabad.



1. Salvadora oleoides پیلو

Species Identity

Technical Name: *Salvadora oleoides*

Family: Salvadoraceae

Common Names: Pilu,Vann,Jar

Description

Salvadora oleoides is a shrub or small tree attaining 6-9 m height under favourable conditions. Seed is greenish-yellow about 3mm in diameter. The tree generally flowers in March-April and fruits in June. The seed matures in summer.

An intolerant tree that grows as scattered individuals or groups in the desert. It occurs with *Prosopis cineraria* and *Capparis aphylla* on a variety of well drained sandy soils. It is adapted to a precipitation zone of 100 to 250 mm / yr, in a temperature range of 10 to 50 °C at altitude up to 1000 m. It prefers an arid, dry, sub-tropical, tropical thorn type climate and is very susceptible to frost. In its natural range it is disease and insect free. It grows about 6cm/yr in height. Its calorific value is 5100 Kcal / Kg. The tree regenerates freely by seed and root-suckers and to some extent by natural layers. Poly bag raised 1 year old seedling can be successfully planted out.

Distribution

The tree is found in the arid regions of Western India and Pakistan.

Importance

Fruits are sweet and edible. The pulp contains glucose, fructose and sucrose. It is a rich source of calcium containing about 15 times the amount of calcium present in wheat. The tree is often lopped for camel fodder. Fruits fed to cattle are said to increase milk production. Seed cake is suitable as livestock fodder and contains 12% protein. Sheep and goats graze the tree. It is an

important source of fuel wood. Wood is light red or yellow, weighs about 608-865 kg / m^3, is moderately hard with small, irregular, purple heartwood. It is used for building purposes, agricultural implements, persian wheels and boats. Seeds contain 40-50% of a greenish-yellow fat containing large amounts of lauric and myristic acids. It could be used for making soap and candles. *S. oleoides* seed oil showed 100% toxicity to Anopheles stephensi at 0.01%. Leaves are used to relieve cough and are given to horses as a purgative. Root bark is used as a vesicant. Fruits are used in the treatment of enlarged spleen, rheumatism and fever. The seed fat is used in the treatment of rheumatic pains, in preparation of suppositories and as a base for ointments. Unspecified part used to treat throat swelling of domestic animals.

The tree contributes to the stability of fragile areas. It is suitable for growing in shelterbelts and as windbreaks in desert tracks. *S. oleoides* has potential for reclamation as it regenerates freely through root suckers. Seed meal left after fat extraction is valued as fertilizer for tobacco. A dense, almost impenetrable growth is formed by a parent stem surrounded by a ring of root suckers, which can be used as a barrier.

2. *Capparis decidua*

Species Identity

Technical Name: *Capparis decidua (Capparis aphylla)*

Family: Capparidaceae

Common Names: Karrer, Kursan, Murkheit,

Description

Capparis decidua is a bushy shrub in dense tufts, 4-5m high, or occasionally a small tree with many green vine-like apparently leafless branches hanging in bundles. Flowering occurs at the beginning of the dry season. It is tolerant to prolonged drought and an interesting plant by reason of its excellent adaptation to arid conditions. It is adapted to a precipitation zone of 100 to 750mm/yr, in a temperature range of 25 to 31 °C at elevation range 300-1200 m. It prefers alkaline, sandy and gravelly soils, thriving on shallow, hard soils and rocky outcrops. Vegetative propagation is carried out through cuttings or tissue culture. Direct sowing and planting stock have also been used.

Distribution

This species is common in dry tropical Africa, especially in the Sahel, where it sometimes constitutes lines of small trees in Wadi beds, as in Mauritania for instance. In West Africa, the area of distribution is identical to that of *Cadaba farinosa*, its southern limit corresponds to the northern loop of the Senegal River. In the Republic of Niger it reaches the Konadougou. Its area includes Tibesti (West Chad), much of the Sudan (except the extreme South), the Arabian Peninsula, Jordan, India, Pakistan, Iran, the Mascarene Islands and Natal.

Importance

The fruit is relished by camels and also wherever within their reach by goats. The fruits are also consumed by man in the Sudan. Its browse value is probably most important asset, despite being low in nutritional value. In Sudan for instance, it is a major source of camel food as it can be eaten when little else is available. It is used for charcoal and firewood in its native range. The wood is very hard and used to make water pipes and water troughs. The very bitter roots are used in the Indian and Farsi pharmacopoeia and the root bark is used to cure swollen joints. *C. decidua* has been found to be one of the best species for shelter belts to check the movement of sand in the Thar Desert. One of its preferred uses in the Sudan is as a shade and shelterbelt. As it is drought resistant and withstands neglect this species could be particularly useful in arid areas as a live hedge providing edible fruits.

3. *Butea monosperma* ڈھاک

Species Identity

Technical Name:	*Butea monosperma (B. frondosa)*
Family:	Leguminosae
Common Names:	Bastard teak, Dhak, Palans,

Description

Butea monosperma is a small to medium-size deciduous tree, 5-15 (max. 20)m tall, up to 43cm dbh, trunk usually crooked and tortuous. Seed ellipsoid, flattened, about 3cm long. The pods mature in May. Each Pod contains only one seed. It is a characteristic tree of the plains, often forming pure patches in grazing grounds and other open places. The tree is very drought resistant and frost hardy, although the leaves turn white and fall off. Altitude: up to 1500m, Mean annual temperature: -4 to 49°C, Mean annual rainfall: 450-4500 mm. It grows on a wide variety of soils including shallow, gravelly sites, black cotton soil, clay loams and even saline or waterlogged soils. Seedlings thrive best on a rich loamy soil with pH 6-7 under high temperature and relative humidity. The wood is susceptible to boring insects. A moderately fast growing tree. Growth of 5m in height and 20cm in diameter has been recorded for an 8 year period.

It can reproduce from seed or by vegetative means. Natural regeneration by both seed and root suckers is profuse. Artificial propagation is chiefly from direct-sown seeds, sown 25-30 cm apart in lines 3-5 m apart. The taungya system is often used, as weeding during the 1st 1-2 years is essential to the proper development of the plants. Root suckers and nursery seedlings can also be used for propagation. Because of the good coppicing power of this species it is also a reliable method of natural propagation. Germination, which starts in about 10-12 days, is completed in 4 weeks. Fresh seeds have a good germination capacity (about 63%) at optimum germination temperature of about 30 °C.

Distribution

Butea monosperma is a tree of Tropical and Subtropical climate of the Subcontinent. Found throughout the drier parts of India, often gregarious in forests, open grasslands and wastelands. The tree is not found in arid regions but is found on the plains and in the foothills of Jhelum valley and Sialkot districts.

Importance

Young leaves are good fodder, eaten mainly by buffaloes. Though the leaves are fairly rich in nutrients, digestibility values are low, comparable only to those of straws. Wood makes a fuel of moderate quality. Leaves are sometimes used as a fuel. The wood is burnt for gunpowder charcoal. A coarse fibrous material obtained from the inner bark is used for cordage, caulking the seams of boats and making paper. The soft wood is light, about 570kg/m³ air dry, white or yellowish-brown when fresh but often turning greyish because of susceptibility to sap stain. It is not of great value due to non durability but is sometimes used for utensils. A red exudates is obtained from the bark, hardening into a gum known as 'Butea gum' or 'Bengal kino'. It can be used as a dye and as tannin. A bright yellow to deep orange-red dye, known as Butein, prepared from the flowers is used especially for dyeing silk and sometimes for cotton. This dye is used by Hindus to mark the forehead. The bark is used for tanning. The seeds yield clear oil. Seeds show bactericidal and fungicidal activities. The flowers are useful in the treatment of liver disorders and seeds act as an anthelmintic. An astringent gum oozing from the cut stem has medicinal properties as a powerful astringent and is applied in cases of diarrhea. In India, the tree is an important host for the lac insect (*Laccifer lacca*), which produces shellac. From all the lac trees, it yields the most lac stick per hectare.

In India, farmers frequently use *B. monosperma* to stabilize field bunds. *B. monosperma* is planted as an ornamental because it flowers with a profusion of bright orange, rarely sulphur-coloured flowers.

4. *Populus euphratica* بھان

Species Identity

Technical Name: *Populus euphratica*

Family: Salicaceae

Common Names: Bahan, Bhan, Gharab, Indian poplar

Description

Populus euphratica is a medium-size to large deciduous tree with rarely a straight stem often bushy but attaining a height of about 15m and a girth of 2.5m under favourable conditions. Seed minute, enveloped in silky hairs. Flowering and seed production occurs between January and June.

It requires a lot of light for normal development. A tolerant tree that grows on a variety of sites including waterlogged and saline soils. It is found on rocky and hilly soils. The tree tolerates a high degree of salinity and brackish water. The soil pH best suited for the poplar is 5.0-6.5. Soils with impeded drainage and little aeration are not suitable. This is the only poplar that will grow on saline soils. It also grows on land that is seasonally flooded and that on which no other form of cultivation appears possible. It prefers an arid, semi arid, sub tropical climate. It is adapted to a precipitation zone of 750 to 1250 mm / yr or more, in a temperature range of -10 to 45 °C. It has an altitude range from below sea level to the tree line at 4000m. It is frost hardy, can withstand drought and periodical inundation. It does coppice. It has no significant disease or insect problem in Pakistan. It is relatively fast growing. Yield of 8 to 15m^3/ha/yr have been recorded.

It is reproduced both from seed and by vegetative means. Natural reproduction is through root suckers or seed. The seedlings spring up on fresh alluvial soil after the floods recede. Three sizes of cuttings are used for rooting in the nursery for subsequent plantings. Seed pretreatment is not required.

Distribution

In its natural habitat, *P. euphratica* is found in subtropical, broad leaved, hill forests, wet temperate, moist temperate deciduous forests and dry temperate forests. The tree is native to the Middle East, Southern Russia, the Subcontinent and east to China. In Pakistan it is found in hot arid areas along rivers courses or where there is sub surface water.

Importance

The leaves afford good fodder for sheep, goats and camels. Its wood is moderately hard and light. The lops, tops, rejects, wastes and material derived through pruning are used as fuel wood. The calorific value is reported to be 5019 kcal / kg for sapwood and 5008 kcal / kg for the heartwood. *P. euphratica* holds excellent promise as a source of fiber for various grades of paper, fine paper, packing paper and newsprint. The wood is easy to saw and works to a good finish. It is good for turnery and can be peeled off with a rotary cutter. Used for planking, lacquer work, artificial limbs, matchboxes and splints. It is also suitable for plywood, cricket bats, shoe heels and bobbins. The bark is reportedly a vermifuge. The twigs are chewed and used for cleaning teeth.

P. euphratica comes up well in burnt areas and acts as a colonizer on exposed soils, eroded hill slopes and land slips. The main branches are simple and spread fairly wide, resulting in a dense, conical crown with abundant foliage. It acts as a windbreak and shelters for crops. Due to its salt tolerance, it is the main specie for afforestation of saline soils in sandy desert regions, for example in Mongolia, China. The tree crown intercepts rain and checks soil erosion, thereby improving soil physical properties. *P. euphratica* is largely used for roadside planting and lends decor to avenues.

A single line of *P. euphratica* plants along field boundaries, roads, around orchards and in parks improves the landscape and additionally serves as a windbreak, benefiting the fruits and agricultural crops. *P. euphratica* is one of the forest species considered ideal for intercropping with agricultural crops due to its characteristics such as leaflessness during winter, multiple uses, soil-enriching properties and compatibility with agricultural crops. Crops tried with this species include maize, wheat, cowpea, potatoes and sugarcane.

5. Albizzia lebbek کالاشریں

Species Identity

Technical Name: *Albizzia lebbek*

Family: Leguminosae

Common Names: Black siris, Kala sirin

Description

Albizzia lebbek can attain a height of 30m and a diameter of 1m; more often it is 15-20m tall with a diameter of 50cm. Seeds brown, flat, orbicular or elliptic, 8-10 x 6-7 mm transversely placed with 6-12 in each pod. The pods mature between June to September.

Altitude: 0-1800m, Mean annual temperature: 19-35°C, Mean annual rainfall: 500-2500mm Soil type: Establishes well on fertile, well-drained loamy soils but poorly on heavy clays. Tolerates acidity, alkalinity, heavy and eroded soils and waterlogged soils. *A. lebbek* is a dominant species in semi-evergreen vine forests (monsoon forest). It can withstand long, hot, dry periods and cold winters. It is also found on the banks of riverine sites, on stabilized dunes or low lateritic ledges above the beach. After the 1st year it can tolerate droughts and some frost. Relatively fast growing. Yield of $5m^3$/ha/yr depending on the site.

It is best established using potted seedlings, although bare-rooted seedlings, direct seeding and stump cuttings have all been used successfully. Seed pretreatment involves scarification and immersion in boiling hot water then cooling and soaking for 24 hours or acid treatment to break seed-coat dormancy. Germination improves after storage for 2-4 years but satisfactory germination (50-60%) has been obtained from fresh seeds. Freshly collected seed has about 70% germination capacity after 1-2 months. About 880 pods weigh 1kg and will yield about 300g of seed.

Importance

A. lebbek is grown in some areas primarily as fodder for camels, water buffalos and cattle. The leaves are reported to be good fodder with 17-26% crude protein; 100kg of leaves yield 11-12 kg of digestible protein, and 37kg of digestible carbohydrates. The pods contain saponin and are not eaten in large amounts by sheep, although cattle eat them readily. Its whitish flowers are fragrant, attracting bees. Highly regarded by bee-keepers for the light-coloured honey its nectar provides. An excellent fuel wood specie with a calorific value of 5200 kcal / g. *A. lebbek* fruits can yield 10 barrels of ethanol per hectare.

It is moderately heavy and hard, strong and fairly durable, with a specific gravity of 0.5-0.6kg/m^3. The wood seasons well, works and polishes easily, can be used for interior moulding, parquet, furniture, paneling, turnery and general construction. It is also used for making agricultural implements and mine props. The trunk yields a reddish gum that is used as an adulterant of gum arabic. The bark is used for tanning fishing nets (tannin content of 7-11%). Leaves and seeds are used for eye problems and to treat soils. Saponin from pods and roots has spermicidal activity. When dried and pounded, the bark can be used for soap.

Due to its extensive, fairly shallow root system, *A. lebbek* is a good soil binder and is recommended for eroded lands and erosion control, for example along river embankments. The species is commonly grown as a shade tree in pastures, tea, coffee and cardamom plantations and along avenues. It can be planted in exposed coastal situations and as quick-growing shelter

for less hardy plants. *A. lebbek* is not rhizobium specific and native strains are nearly always capable of producing an abundance of nodules. The nitrogen-rich leaves are valuable as mulch and green manure. *A.lebbek* is also often planted along roads and in home gardens.

6. Albizzia procera سفید شریں

Species Identity

Technical Name: *Albizzia procera*

Family: Leguminosae

Common Names: Sufed sirin, White siris

Description

A fast growing deciduous tree 12 to 30m tall. Diameters to 1m have been recorded. The pods mature in September. An intolerant tree that grows on a variety of moist sites. It does well in low lying, moist savannas and tolerates saline and sodic conditions. It requires a summer precipitation zone 500 to 1000 mm / yr. It prefers a sub – humid, warm, sub – tropical climate with a temperature range of 1 to 45 °C and an elevation range of 0 to 1200 m. Grazing can be a problem with this tree. Seedlings are susceptible to forest damage. The tree is light demander and becomes suppressed under heavy shade. It is moisture loving. It is ideally suited for planting in low lying moist area. Young plants are apt to be injured by frost. Its capacity to coppice is very well. In Pakistan it has no known pests or diseases. It is relatively fast growing. Yields of 10 m^3 / ha / yr, depending on the site, have been recorded for rotations of 30 years. Growth in irrigated plantations has remained excellent. It can be reproduced both from seed and by vegetative means.

Distribution

This tree is native to Central and Southern India, Bangla Desh and Burma. In Pakistan it has been planted in the Punjab and Khyber Pakhtunkhwa.

Importance

Branches of trees are utilized as fuel wood. Its charcoal is considered very hard. The *A. procera* wood is excellent for high class furniture, poles and construction and agricultural implements It weighs about 640 kg / m^3. The bark is used for tanning. Its fodder is valuable supplement to sheep and goat. It is also used for shade and apiculture. The foliage is good green manure. This tree is one of the important nitrogen fixing tree species.

7. Acacia catechu کتھا

Species Identity

Technical Name: *Acacia catechu*

Family: Leguminosae

Common Names: Khair, Katha, Cutch tree

Description

Acacia catechu is a small or medium-sized, thorny tree up to 15m tall. The small pods are 5 to 9cm long. The pods mature between December and January. Seed storage behaviour is orthodox. According to different authors, viability is lost within 1 year in hermetic storage at room temperature at 11-15% moisture content and can be maintained for at least 2 years at ambient temperature, 9 months in open storage at room temperature for several years in hermetic storage at 10 °C. There are 15000-40000 seeds/kg. Altitude : 0-1500 m, Mean annual temperature: -5 to 40 °C, Mean annual rainfall: 500-2000mm. Soil type: The species grows in a wide range of soils. An intolerant, drought hardy tree which grows best on rocky, stony, gravelly, sandy alluvium, loamy, clayey, well drained soils. It can grow on acid soils and can grow on wet or swampy sites. It shows some frost hardiness. Young plants can be damaged by frost. No

disease or insects have been identified. *A. catechu* occurs naturally in mixed deciduous forests and savannas of lower mountains and hills. It is especially common in the drier regions on sandy soils of riverbanks and watersheds.

It is easily reproduced both from seed and by vegetative means. *A. catechu* can be raised from direct sowing, coppice, planting out nursery-raised seedlings or by stump planting. It is recommended, but not necessary, to put the seeds in boiling water and then leave for 24 hours to cool.

Distribution
The tree is native to the Subcontinent in the western regions of the Himalayas. Specifically it is found in Malakand, Hazara and Rawalpindi districts. It is also planted in the Punjab and Sindh.

Importance
Seeds contain water-soluble mucilage (6.8%), a good protein source but nutritionally incomplete with respect to essential amino acids. It is considered to be a good fodder tree and is extensively lopped to feed goats and at times cattle. For leaf fodder, finger-thick branches are lopped usually before main leaf fall occurs. The wood is excellent firewood. The calorific value of sapwood is estimated at 5142 kcal/kg, heartwood 5244kcal/kg. Dry wood on destruction gives 38.1% charcoal of very good quality. Comparatively heavy with a density of 880-1000 kg/m^3 at 15% moisture content. It is recommended to saw the comparatively heavy wood of *A. catechu* when green. The wood is also very strong, durable and resistant to white ants. Timber is used for house posts, agricultural implements and wheels. Spent chips left over after extraction of katha and cutch can be used for the manufacture of hardboards. A substance called cutch, which is marketed as a solid extract, can be isolated from the heartwood. Depending on the way of processing, several products can be obtained from crude cutch. The dark catechu or Pegu cutch is used to tan heavy hides into sole leather, often in a mixture of tan stuffs. Catechu extract is also used for dyeing silk, cotton, canvas, paper and leather to a dark-brownish colour. The bark exudes a light gum of very good quality and is one of the best substitutes for gum arabic. The bark is said to be toxic and contains an alkaloid and both fruit and stem are used in Myanmar to poison fish. Khersal, a crystalline form of cutch sometimes found deposited in cavities of the wood is used medicinally for the treatment of coughs and sore throat. The bark is said to be effective against dysentery, diarrhea and in healing of wounds. The seeds have been reported to have an antibacterial action. The powdered bark, mixed with sulphate of copper and egg yolk, is applied to cancerous growths. The tree is a host for the lac insects. Catechu extract is also used for preserving fishing nets, ropes and a viscosity modifier in on-shore oil wells. The tree is thought to have a powerfully protective mucilaginous juice. One of the most remarkable properties of which is its power of retaining water. It is well known that fire and even hot metal can come in contact with bare skin without injury provided the skin is covered with the mucilage. The spiny branches serve as brushwood fence for the fields.

8. Calligonum polygonoides پھوگ

Species Identity

Technical Name:	*Calligonum polygonoides*
Family:	Polygonaceae
Common Name:	Phog

Description
Calligonum polygonoides, locally known as *Phog*, is a small shrub found in Thar Desert areas usually 1.2 to 1.8 m high but occasionally may reach even 3 m in height with a girth of 30.5 to 61cm. This tree is also named orta in old Arabic poems. So much people agree the arabic origin of Aorta for the great human artery. It commonly grows on dry sandy soils and on sand dunes.

It is very hardy and being capable of growing under adverse conditions of soil and moisture. It is frost hardy and is vulnerable / threatened in the habitat. It has already been wiped out from most of the sandy districts. It produces root suckers and is easily propagated by cutting and layering.

Distribution
It is found from arid and semi-arid areas of Rajasthan state in India at the east to the Goravan Sands State Reservation in Armenia, Azerbaijan (Nakhichevan), Turkey (Aralykh, Igdir) at the North-West. In Pakistan it is found in desert area of Cholistan, Tharparkar and Southern Balochistan.

Importance
Its roots are used to prepare charcoal to melt iron. Its flowers, known as *Phogalo* in Rajasthani language, are used to prepare rayata. Also it is a good food plant for cattle and important habitat element for a number of species of semi desert wildlife. It provides energy rich fuel. This plant is over exploited and as a result has become vulnerable in its habitat. The coal prepared from the wood of this plant is used by the iron- and gold- smiths. The phog plants provide valuable fodder during scarcity. It stabilizes the sand dunes and prevents soil erosion. The flower buds are valuable vegetable (phogla) for making delicious heat relieving Raiyta. The wood of the plant is used in building huts/shelters and scaffolding of wells and other structures.

9. Ficus racemosa

Species Identity
Technical Name: *Ficus racemosa (F. glomerata)*

Family: Moraceae

Common Names: Cluster fig, Cluster tree,Redwood fig

Description
Ficus racemosa can grow over 12m tall and 6 to 12m wide. It is called sung. Plant *Ficus racemosa* in a location that receives full sun to part shade. Cluster fig is a tropical plant.

Ficus can be rooted from tip cuttings with rooting hormone. Use only non-woody stems as cuttings. For larger plants, air layering is the preferred method.

Distribution
This is native to Austral-Asia, South-East Asia and Pakistan, India.

Importance
It is sometimes used as a bonsai. This tree has edible fruit and works well as a shade tree. The bark of this tree is said to have healing power. In countries like India, the bark is rubbed on a stone with water to make a paste and the paste is applied over the skin which is having boils or mosquito bytes. Allow the paste to dry on the skin and reapply after a few hours.

10. Prosopis cineraria

Species Identity
Technical Name: *Prosopis cineraria*

Family: Leguminosae

Common Names: Jand, Kandi

Description
An almost evergreen, thorny, large shrub, small size tree 12m tall. The pods are flat, 12 to 25mm long and contain on the average 10 to 15 seeds, maturing between April and August.

An aggressive tolerant tree that grows on a variety of dry sites including soils from clays to sands. It also does well on highly alkaline sites (pH 9.8). It requires a summer precipitation zone of 75 to 650 mm / yr and is considered very drought hardy. It prefers a hot arid, semi-arid to sub-tropical climate with a temperature range of -6 to 45 °C at elevations up to 450m. Seedlings can be damaged by frost and grazing but once it is established it is very difficult to eradicate. A number of insects attack it but they are of little significance. It is fast growing with reported yields of 3 to $5m^3$ / ha / yr. On favorable sites it will reach heights of 7m in 11 years.

It is reproduced both from seed and by vegetative means. The seed can be stored for long periods. Pretreatment of seed by nicking the seed coat or a water or acid soak will speed germination.

Distribution
The tree is native to Pakistan, India, Afghanistan and other parts of the Middle East. In Pakistan it is found in the dry plains and hills of the Sindh, Punjab, Balochistan and Khyber Pakhtunkhwa.

Importance
Fodder, fuel, nitrogen fixing, poles and construction, agriculture implements, apiculture, furniture and soil stabilization.

11. Ficus religiosa پیپل

Species Identity

Technical Name:	*Ficus religiosa*
Family:	oraceae
Common Name:	Pipal

Description
A large deciduous tree that is leafless or nearly so far a short period during hot seasons. Seeds are very small. Fruit matures from October to November.

A very intolerant tree that is cultivated on a large variety of sites but does best on sandy clay soils. It is adapted to an altitude zone of 0 to 200m with a precipitation range of 800 to 1000mm/yr. It grows well within a temperature range of 0 to 40°C in a semi-arid, warm, sub-tropical climate. The growth rate of this tree is fast. Height growth of 1m/yr has been reported.

It is reproduced both from seed and by vegetative means. It coppice well. Seeds are very small and are sometimes spread in bird droppings.

Distribution
The tree is common in the Sub-Himalayas but probably is not native. It is cultivated throughout the plains of the Punjab.

Importance
Ornamental, fodder, food, small timber, and medicinal.

12. Terminalia arjuna ارجن

Species Identity

Technical Name:	*Terminalia arjuna*
Family:	Combretaceae
Common Name:	Ariun

Description
A large ever green tree 21 to 30m tall with a diameter of 1 to 2.5m. The fruit is a wood capsule 2.5 to 5cm long. The cones mature in May and June.

A shade tolerant tree that grows on variety of moist sites if they are well drained. It will grow on saline, sodic and water logged sites. It requires a precipitation zone of 750 to 3800mm/yr. It prefers a humid, hot tropical, sub-tropical monsoon climate with a temperature range of 0 to 45°C on an elevation up to 600m. The tree is not frost hardy. It is moderately hardy. The seedlings are susceptible to drought condition. It has no known insect or disease problems. It is a fast growing tree that can produce yields between 10 to 12m^3/ha/yr. Heights of 5 to 8m have been recorded in a 5 year period. It can be reproduced both from seed and by vegetative means.

Distribution
The tree is native to the Subcontinent. In Pakistan it has been planted throughout the plains, in gardens and as a roadside tree.

Importance
The wood is hard strong and moderately heavy. It is used for Implements, wheels, spokes and axles, Its Specific gravity ranges from 0.74 to 0.82. Wood is considered good for construction and furniture. The calorific value ranges from 5030-5128Kcal/kg. It is a good fuel wood species. Bark is an astringent and cardiac stimulant. It is used as tonic and astringent and is said to be useful in hypertension, fractures and ulcers. The fruit is used as tonic and deobstruent. It is fodder and ornamental tree.

In the inter space of plants of Arjun, the cultivation of brinjal, tomato, ladys finger, ginger, gora paddy are very common. It is a good soil binder.

13. Gleditsia triacanthos دوزخ

Species Identity
Technical Name: *Gleditsia triacanthos*

Family: Leguminosae

Common Names: Dozakh, Honey locust

Description
A large deciduous tree with a spreading crown. Heights of 25m are not uncommon and diameter will range from 0.6 to 1m. The fruit is a large pod, 50cm in length and 3.7cm in width. The pod is pulpy and encases the seed. Seed ripens in September and October.

An intolerant, deep rooted tree that is adapted to semiarid, warm to hot sub-tropical climates that are characterized by winter monsoons. Under cultivation the tree can survive on varied sites including both alkaline and acid soils. It grows best on deep alluvial soils of limestone origin and in precipitation regimes of 500 to 1500mm/yr. It is frost hardy and occurs in a temperature range of -2 to 35 °C. Height growth is approximately 0.5m/yr.

It is reproduced both from seed and by vegetation means. Under cold storage seed will remain viable for 2 years. Hot water or acid treatment is needed to overcome seed coat dormancy.

Distribution
The tree is native to the United States of America but has been successfully planted in Africa, Australia, New Zealand, South America, Pakistan and other countries of the world. In Pakistan, it is found as a roadside tree and in gardens as well as in the plains of Punjab and Khyber Pakhtunkhwa

Importance
Posts and supports, Furniture, Shade, Apiculture and fodder.

14. Cordia dichotoma لسوڑا

Species Identity

Current Name:	*Cordia dichotoma* (*Cordia myxa*)
Family:	Boraginaceae
Common Names:	Bhokar, Borla, Lasura

Description
Cordia dichotoma is a small to moderate size deciduous tree with a short bole and spreading crown. Fruits are formed soon after flowering, develop quickly and ripen from June to August in north India and normally before May in south India. Seed dispersal is aided by birds and monkeys which feed on the ripe fruit.

Young seedlings are frost tender and also suffer from exposure to hot sun. They are susceptible to browsing and fire but recover appreciably from these injuries. The tree coppices and pollards well. On good sites the trees reach a height of 4 m in 4 years and a diameter of over 20cm in 8-9 years. From pole stage it prefers complete overhead light but seedlings and saplings can withstand a fair amount of shade. Altitude: 200-1500 m. Mean annual rainfall : 250-3000 mm. Soil type : The tree prefers deep moist sandy loam soils.

Propagation is through seed which should be sown direct into containers, beds or trays and pricked out when the first pair of true leaves have formed. Sowing is done in June-July at a depth of 2cm in lines spaced about 20cm apart. A seed rate of 80g/sq. m of nursery area is adopted. Germination starts in about 3-4 weeks and is completed in 6 weeks. At lower altitudes, plantable seedlings can be obtained after 3-4 months in the nursery but at higher altitudes, 9-12 months are needed. In India raising plants from stumps has been carried out successfully. The stumps should be 8-13mm thick at the root collar, with about 4cm stem and 20-25cm root. Such plants should be raised in beds for 12-15 months before stumping. Shading should be for only 1 week after seedlings have been pricked out otherwise seedlings should have full light. Frequent weeding and root pruning is necessary. Seedlings should be ready for planting in the field in about 1 year at the commencement of monsoon rains. Frequent weeding and root pruning is necessary. Ripe fruits are collected from the trees and rubbed to remove the flesh. The healthy stones are dried in the shade and kept in tin containers. The stones can be stored for 1 year in airtight containers kept in a dry place to avoid insect attack. There are 4000-7000 stones / kg.

Distribution
C. dichotoma is a tree of tropical and subtropical regions. It grows in the Sub-Himalayan tract and outer ranges, ascending up to about 1500 m elevation. It is found in a variety of forests ranging from the dry deciduous forests of Rajasthan to the moist deciduous forests of Western Ghats and tidal forests in Myanmar. In Maharashtra, it grows in moist monsoon forest also. It does not grow gregariously but is found growing singly in moist shady ravines and valleys. In areas with annual rainfall less than 500 mm, it thrives along streams or depressions where moisture is available. The tree is found in Pakistan, India, Myanmar, Nepal.

Importance
The immature fruits are pickled and are also used as a vegetable. The leaves yield good fodder and are lopped for this purpose. They contain 12-15 % crude protein, 16-27 % crude fibre, 42-53 % nitrogen-free extract, 2-3 % ether extract, 13-17 % total ash, 2-4 % calcium and about 0.3 % phosphorus. The seed kernel of *C. dichotoma* contains a high proportion of fatty oils and proteins (46 and 31%, respectively) which has potential as cattle feed. The tree is used as a fuel wood. The wood is used to make agricultural implements. Fruit extract of *C. dichotoma* suppresses larval hatching of *Meloidogyne incognita*. Seeds of the species are anti-inflammatory. The bark is medicinal and several chemicals have been identified. The seed kernel has medicinal properties.

C. dichotoma is a quick growing fruit tree performing well under semi-arid conditions and suitable for planting along boundary and farm roads.

15. Ficus benghalensis بوہڑ

Species Identity

Technical Name: *Ficus benghalensis*

Family: Moraceae

Common Names: Bengal fig, Indian fig, Bohr

Description

It is a very large, fast growing, evergreen tree up to 3.0 meters with spreading branches and many aerial roots. It is hardy, drought resistance and withstands mild frost. Propagation through seed, transplanting and stem-cutting. *Ficus benghalensis* produces propagating roots which grow downwards as aerial roots. Once these roots reach the ground, they grow into woody trunks that can become indistinguishable from the main trunk. The figs are eaten by birds and mammals. Fig seeds are dispersed by birds such as the Mynas and studies have shown that seeds that pass through the digestive system of the bird are more likely to germinate as well as sprout earlier.

Distribution

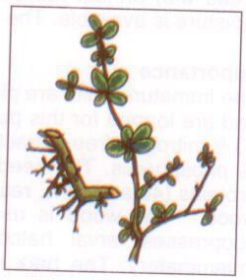
It is planted in Monsoon in rain forests. Often planted throughout Pakistan.

Importance

According to Ayurveda, it is astringent to bowels, useful in treatment of biliousness, ulcers, erysipelas, vomiting, vaginal complains, fever, inflammations, leprosy. According to Unani system of medicine its latex is aphrodisiac, tonic, vulernary, maturant, lessens inflammations and useful in piles, nose-diseases, gonorrhea etc. The aerial root is styptic, useful in syphilis, biliousness, dysentery and inflammation of liver etc. It is planted for soil conservation. Timber is used for well-curbs, furniture etc. Suitable for paper pulp. Leaf (Crude protein 9.63%) lopped for fodder. Fruits are used to prepare Shurbut traditionally.

This tree is considered sacred in India and often shelters a little or larger temple underneath but is offered worship on its own generally too and especially so on one particular full moon day in summer when the full moon occurs near the last star of the constellation Scorpio but definitely before beginning of Sagittarius. Even apart from the worship it is one of the most sheltering trees in the heat of the land, with a large and deep shade and is thus extremely useful for travelers of the old sort - on foot, bicycles or ox-carts or horse riders - traveling for hours or days. Traditionally it was found almost ubiquitously on roads and in village centres, the latter very useful for any formal or informal gathering to be conducted in a cool place or even for any poor person or a travelers to sleep under. The respect for this and other trees of this nature is thus linked both to the use and the worship as sacred. *F. benghalensis* is also the National tree of India also known as Indian Banyan.

16. Commiphora wightii گگل



Species Identity

Technical Name: *Commiphora wightii*

Family: Burseraceae

Common Names: Guggal, Mukul myrrh tree

Description
It is a shrub or small tree reaching a maximum height of 4m with thin papery bark. It is tolerant of poor soil. It can grow in those area having poor soil and rocky tracts. It is propagated through seed and cuttings.

Distribution
The guggal plant may be found from Northern Africa to Central Asia but is most common in northern India. It prefers arid and semi-arid climates of Pakistan. A small tree occurring in dry zones from the Deccan and West India to the north-west and Karachi, Sind and Balochistan in Pakistan.

Importance
Traditionally guggal has been used to treat arthritis, rheumatism, haemorrhids, urinary disorder, obesity, skin diseases and high cholesterol. Guggal (aka guggulu) ia s gum resin, historically used for its antiseptic and deep penetrating actions in the treatment of elevated blood cholesterol and arthritis. Guggal is effective as a weight – loss and fat burning agent. It increase white blood cell counts and possesses strong disinfecting properties. Often used as a carrier and combined with other herbs to treat specific conditions. Guggul is sought for its gummy resin which is harvested from the plant's bark through the process of tapping. In Pakistan and India guggul is cultivated commercially. The resin of the guggul plant, known as *gum guggulu*, has a fragrance similar to that of myrrh and is commonly used in incense and perfumes. It is the same product that was known in Hebrew, ancient Greek and Latin sources as bdellium. Guggul can be purchased in a loosely packed form called *dhoop*, an incense from India, which is burned over hot coals. This produces a fragrant dense smoke. The burning coals which let out the smoke are then carried around to different rooms and held in all corners for a few seconds. This is said to drive away evil spirits as well as remove the evil eye from the home and its family members.

17. Haloxylon recurvum کھار

Species Identity

Technical Name:	*Haloxylon recurvum*
Family:	Amaranthaceae
Common Name:	Khar

Description
It is a 25–69cm tall, pale, spread-out shrub with many branches almost leafless with woody stem. The seed is about 1.5mm in diameter. *Haloxylon recurvum* is a drought and salt tolerant plant found in Thar Desert. It is one of the dominant halophytic species around saline lakes of Thar Desert. It is propagated through seed.

Distribution
The genus *Haloxylon* is distributed in Southwest and Central Asia, from Egypt to China. It is also distributed in Middle East.

Importance
It is a source of crude salts with Sodium carbonate (Barilla or Sajji-khar). The Sajji-khar is added as an ingredient for unique taste of famous Bikaneri Papad. The ash of this plant is used as substitute of soap for cleaning clothes and is also taken with water for treatment of internal ulcers. It is an important economic plant for sand fixation, pasture and fuel.

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CONDITION MONITORING OCCUPATIONAL NOISE IMPACT, ON HUMAN HEALTH AT ZEAL PAK CEMENT FACTORY HYDERABAD SINDH (PAKISTAN)

By

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ABSTRACT / SYNOPSIS

Development of modern mechanized operation in industrial plants have been found considerably decreasing the physical burden of work. The most undesired and unavoidable by product to these operations is the generation of high level Noise, particularly in Industries that is potentially causing serious health problems.

Occupational Noise Pollution is one of the main sources of nuisance in our society. The operation of machinery in industrial workrooms / shops / yards generates excessive Noise. Workers exposed to undesirable Noise may suffer annoyance, reduction in work efficiency, reduced speech intelligibility, and permanent hearing loss. Noisy equipment in large untreated workrooms may also result in excessive reverberation. This results into the inability to recognize and localize other Noise and signals. It may become a serious safety issue when workers cannot recognize and respond appropriately to process warning signals, back-up alarms etc. It is, therefore, necessary to limit Noise levels and reverberation times to acceptable limits at work positions / places, as advised by ISO, EEC and other National Standards.

The Noise study was undertaken at Zeal Pak Cement Factory, Hyderabad. The prevailing Noise Level was found more Intensive i.e. **97.7 dB (A)** at Compressor House, **95.9 dB (A)** at Mill House and **93.8 dB (A)** at Kiln House, and Workshop that is much higher than the recommended Noise Level Limits of set by ISO, EEC and other National Standards at Zeal Pak Cement Factory (ZPCF).

Interviews about the physical health of workers / officials of various sections were conducted from workers / officials at Kiln House and the Workshop. Different sections of the Society. The poll results showed that 62% workers were suffering from different diseases whereas 33% were indirectly facing various diseases due to the prevailing noise.

During Survey, it was found that, precautionary measures were not being taken in the industry, hence the Noise pollution was resulting into negative impacts on the health of workers.

Suggestions made to provide safety Measures for workers include mandatory wearing of ear protectors at the time of work; also their audio metric tests should be carried out periodically, against high level Noise Health Hazards like Headache, Hearing problem, Irritation, Accidents at work, Tension, disturbance to work and other physiological and psychological effects,

Finally regular and proper maintenance of machines should be carried out, in order to minimize the breakdowns, improve the working efficiency of plant, save the time and wastages.

Key words: Occupational Noise, Occupational Health.

1. INTRODUCTION

Noise Pollution is one of the main sources of nuisance in our society. The operation of machinery in industrial workrooms / shops/yards generates excessive Noise. Workers exposed to undesirable Noise may suffer annoyance, reduction in work efficiency, reduced speech intelligibility, and permanent hearing loss. Noisy equipment in large untreated workrooms may also result in excessive reverberation. This results into inability to recognize and localize other

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Noise and signals. It may become a serious safety issue when workers cannot recognize and respond appropriately to process warning signals, back-up alarms etc. It is therefore necessary to limit Noise levels and reverberation times to acceptable limits at work positions / places, as advised by ISO, EEC and other National Standards.

Development of modern mechanized operations in industrial plants have been found considerably decreasing the physical burden of work. But the most undesired and unavoidable by product to these operations is generation of high level Noise, particularly in Industries that is causing potentially serious health problem.

2. OBJECTIVES

a) Assess the Noise Level in every section of Zeal Pak Cement Factory (ZPCF) Hyderabad, and to Analyze the same in the light of ISO, EEC and other National Standards.

b) Detect the impact of Noise on human health, by investigating the workers/staff of ZPCF Hyderabad, through a Questionnaire.

c) Suggest ways and means to overcome the Noise, and to improve the efficiency of plant, along with machine parts maintenance etc.

3. MATERIALS AND METHODS

a) NOISE MEASUREMENT TECHNIQUES

The Measuring Instrument used in ZPCF was Digital Noise Level Meter TES 3150. The Meter was regularly calibrated and checked prior to and after each set of measurements, as the measurements were taken by keeping Microphone 1.5 meters above the ground level at a distance of 1-3 meters from the source depending upon survey site / close to workers position. Noise level data was recorded in dB (A), with Meter at "Fast" response and the measurements made in Lmax at five different points, in every section of ZPCF Hyderabad. At each measuring point ten readings were taken in a period of two minutes.

b) STAFF OPINION

Staff Opinion obtained through prescribed questionnaire in different sections of the plant i.e. ZPCF right from lower to higher ones.

4. HEALTH EFFECTS

Noise is one of the deadliest pollutants in the urban areas of Pakistan. Depending upon the level, quality and exposure duration of Noise, it may result in adverse effects such as physiological and psychological effects on human system[12]. These can be categorized as:

i) Auditory Effects

ii) Non-Auditory Effects

i) AUDITORY EFFECTS

Noise can deafen or damage ears instantaneously; it can severely reduce the ear's sensitivity to sounds of certain frequencies over a period of time; it can numb the ears for a limited period of time, and return to near normal within a matter of minutes, weeks or months long.

ii) NON-AUDITORY EFFECTS

A large number of people work in factories and workshops where the Noise levels are consistently high, and when the exposure takes place regularly for about 8 hours a day, year after year, the effects cease to be temporary and permanent hearing loss, ultimately leading to chronic disability. Noise has direct and specific effects on Cochlea and indirect effects on various physiological and psychological systems of human health[8] such as:

REDUCTION IN OUTPUT OF WORK,

LACK OF EFFICIENCY,

IMPAIRMENT OF HEARING,

VAGUE FEELING OF ANNOYANCE,

INCREASED INCIDENCE OF HEART DISEASE PROBLEMS,

ACCIDENTS AT WORK,

IRRITATION,

SPEECH INTERFERENCE,

SLEEP DISTURBANCE,

WORK INTERFERENCE,

CANCER,

HEADACHE,

TENSION,

CARDIO VASCULAR EFFECTS

DIGESTIVE SYSTEM EFFECTS

RESPIRATORY SYSTEM EFFECTS

CENTRAL NERVOUS SYSTEM EFFECTS

PSYCHOLOGICAL EFFECTS

SHORT TERM EFFECTS

LONG TERM EFFECTS

5 RESULTS AND DISCUSSION

Noise study was undertaken in ZPCF Hyderabad. The prevailing Noise was recorded in detail, at all the sections of ZPCF and found b/w **72.5 dB (A)** to **97.7 dB (A)** given in table-1, fig.1 almost being above the permissible Noise level criteria, as compared to maximum permissible Noise exposure limit of,

- 85-90 dB (A) for 40 hours / per week, as recommended by ISO[1]
- 90 dB (A) for 40 hours / week allowed in United Kingdom[2], Belgium[3], Denmark[4,7], France[5], Irish Republic[6], Italy[7], Canada[7], and Australia[7].
- 85 dB (A) for 40 hours / week allowed by Occupational Safety and Health Act USA[8], Japan[9], Germany[10], Sweden[7] and Norway[7].

According to Webster's[11] relationship face to face communication between workers at the distance of 1 meter is very difficult even at a high pitch almost in all the sections, except that of Control Room.

There is a fairly consistent evidence that prolonged exposure to Noise[9,12] level at or above 90 dB (A) causes deafness. The amount of deafness depends upon the degree of exposure; the plant works 8-10 hours / day and 7 days a week, without taking any Noise control measures (the workers do not wear ear protectors during the work) that would cause deafness problems.

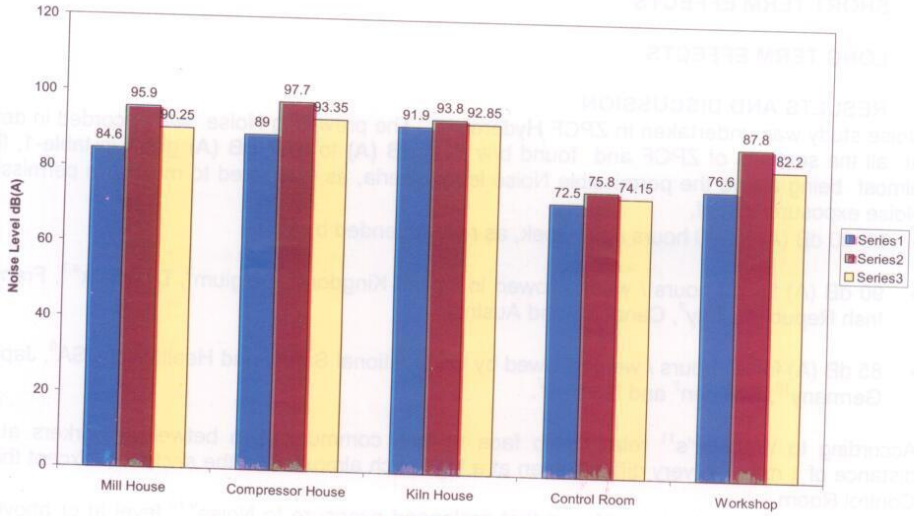
Table-1 **OCCUPATIONAL NOISE RECORDED AT ZEAL PAK CEMENT FACTORY HYDERABAD SINDH**

METER	**Digital Noise Level Meter TES 3150**
METER RESPONSE	**Fast**
HEIGHT	**1.5 Meters above ground**
DISTANCE	**1-2 Meters from Source**
DIRECTION / POINTS	N/E, N/W, S/E, S/W, North, Centre and South

Lmax. dB (A)

Time	a Mill House			b Compressor House			c Kiln House			d Control Room			e Workshop		
	Min	Max	Avrg	Min	Max	Avrg	Min	Max	Avrg	Min	Max	Avrg	Min	Max	Avrg
10:00 to 11:00	95.2	95.9	95.56	92	97.7	93.5	91.9	92.7	92.47	72.5	75.8	74.15	76.6	87.8	82.31
11:00 to 12:00	86.8	87.7	87.29	89	93.5	92.7	92.3	93.6	92.82	72.7	75.5	74.1	79.9	86.2	82.4
12:00 to 1:00	84.6	86.3	85.34	95.2	96.9	95.56	92.3	93.8	92.98				82.3	87.4	84.85
1.00 to 2.00	94.7	95.6	95.15	92.3	93.6	92.82	92.1	92.9	92.5				85.6	87.7	86.65

Occupational Noise at ZPCF Hyderabad Sindh



Bar Graph

TABLE: 2 PERMISSIBLE SOUND LEVEL EXPOSURE UNDER THE OCCUPATIONAL SAFETYAND HEALTH ACT -16

Sound Level dB(A)	Permissible Daily Exposure
91	8 hours
91	6
95	4
97	3
100	2
102	1.5
105	1
10	0.5
116	0.25 OR Less

TABLE 3 MAXIMUM PERMISSIBLE NOISE EXPOSURE LIMITS FOR OCCUPATIONAL NOISE

ALLOWED BY U.K [2], U.S.A AND INTERNATIONAL STANDRADS ORGANIZATION (ISO)[1]

Noise Level dB (A)	Maximum Daily Exposure U.K	U.S.A	I.S.O
88	12 hours / day		
90	8 hours / day	8 hours / day	40 hours / week
92		6	25
93	4	20	
95			15
95		4	
96	2	10	
98		3	
99	1	5	
100		2	
102	30 minutes	1.5	150 minutes/week
105	15 minutes	1.0	75
108	3.5		40
111		30 minutes	
111	3.75		20
118	30 seconds		
121	15 seconds	124	7.5
127	3.8		
130	1.9		
134	1.0		
135	0.6 seconds		

EEC countries; Belgium, Denmark, France, Irish Republic, Italy, Australia, also allow exposure of 90 dB(A) for 8 hours/day, whereas Germany, Sweden, Norway, allow exposure of 85 dB(A) for 8 hours/day.

6. PUBLIC OPINION

Staff opinion was obtained through prescribed questionnaire in different sections of ZPCF, as the staff was not satisfied because of facing different types of diseases/troubles like hearing problem, eye sore, headache, Irritation, blood pressure, disturbance at work etc. The detailed discussions made with them is given in Table-4.

Table-4 **QUESTIONNAIRE FROM ZPCF STAFF / EMPLOYEES**

S. No	Name	Age (years)	Designation	Service (total years)	Service in this section (years)	Satisfac tory	Unsat-isfactory	FEELINGS
1	Mir Aftab (Mill House)	40	Fitter	22	22		✓	Speaking loudly at home
2	Ghulam Ahmed (Mill House)	56	Gen. Fitter	32	4		✓	Hearing Problem
3	Sher Waheed (mill House)	48	Fitter	20	20		✓	Unhappiness, dust and coke smoke problem
4	Naveed Hussain (Mill House)	42	Fitter	26	26		✓	Throat, Liver, and Hearing Problem,
5	Umar Khitab (Compressor House)	58 42	Compressor Mechanic	35	21		✓	Headache and Heavy feeling
6	Ghulam Mustafa (Compressor Room)	42	Compressor Mechanic	22	22	✓		Normal
7	Ghullam Farooque (Kiln House)	27	Burner Opt.	18	18	✓		Normal
8	Ghulam Murtaza (kiln House)	50	Coal Opt.	7	7	✓		Normal
9	Muhammed Saleem (Kiln House)	45	Kiln In charge	20	20		✓	Throat, Liver and hearing Problems
10	Zafar Ali (Mech. W/Shop)	42	Fabricator	23	23		✓ ✓	Hearing and Coke Smoke Problem
11	Shahabdin (Mech.W/Shop)	35	Shaper Man	25	25		✓	Hearing and Dust smoke Problem
12	Ali Mohammed (Packer Machine)	38	Packer	15	15		✓	Heavy Feeling
13	Muhammed Jameel		Silo Attendant	12	12			Dust and Coke Smoke Problem

7. NOISE SOURCES

i) Violation of ISO and other Standards to limit high level Occupational Noise,

ii) Unawareness of workers about ill-effects of high level Noise and safety measures,

iii) Old machines / plants,

iv) Improper installation of machines,

v) Lack of Regular maintenance at the Plant.

8. MITIGATION MEASURES

Control of Noise at source by placing screens or deflectors along the transmission path, or at the receivers' end.

i) CONTROL OF NOISE THROUGH DESIGN[1]

a) REDUCE IMPACT FORCE

b) REDUCE SPEEDS AND PRESSURES.

c) REDUCE RADIATING AREA.

d) REDUCE NOISE LEAKAGE.

e) PROVIDE MUFFLERS/SILENCERS.

ii) **CONTROL OF NOISE BY REDRESS**
a) BALANCE ROTATING PARTS,

b) REDUCE FRICTIONAL RESISTANCE IN MOVING PARTS BY,
- ALIGNMENT
- POLISH
- BALANCE
- ECCENTRICITY

iii) **APPLY DAMPING MATERIALS,**
To redress vibration are,

- Liquid Mastics, which are applied with a spray gun and harden into relatively solid materials.
- Pads of rubber, felt, plastic foam, leaded vinyls, adhesive tapes of fibrous blankets, which are glued to the vibrating surface.
- Sheet metalviscoelastlc lamnates or composites, which are bonded to the vibrating surface.

IV] **PROTECT THE RECIEVER (when all else fails),**
a) ALTER WORK SCHEDULE

b) EAR PROTECTION

A lot of work has been done by different quarters in developed countries to assess the Noise effects on human system and to limit high level Environmental and Occupational Noise within the acceptable limits, but very little work is being done in Pakistan.

9. CONCLUSION

Occupational Noise recorded at ZPCF Hyderabad; shows that the level of Noise is high i.e.

97.7 dB (A) ranging between 72.5 dB(A) to 97.7dB(A), and at all the sections almost being above the permissible Noise level criteria as compared to E.E.C, I.S.O and other National Standards, except that of Control Room.

10. SUGGESTIONS

i) **Audio metric tests of staff** should be carried out periodically,

ii) **Routine Maintenance of Machines** should be carried out to limit high level Noise,

iii) **Ear Protectors should be worn** during work,

iv) **Appropriate Acoustical Treatment /** Use of Vibration isolators / Acoustic Absorbents in the foundations.

v) **Implementation of existing Rules** and National standards like U.K., U.S.A., E.E.C., and I.S.O forcefully.

Occupational Noise[1] exposure limit of 85 dB(A) for 40 hours a week is quite safe for the workers. But in developing countries like Pakistan it would be difficult to see Occupational Noise limit of 85 dB(A) in existing Old Plants; it can be set-up for new Plants as the limit 90 dB(A) for 40 hours a week may be recommended for Old Plants in Pakistan.

ACKNOWLEDGEMENT

Thanks to the Environmental Protection Agency Hyderabad and Authorities of ZPCF Hyderabad, for providing facility to conduct Noise survey at the plant.

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WATER QUALITY PROFILE AT DIFFERENT DEPTHS IN LAHORE AREA

By

Zamir Ahmed Soomro[1], Habib ur Rehman[1] and Munawar Hussain[1]

ABSTRACT

The availability and quality of drinking water is the major and alarming concern to the masses now a days. The availability of water is continuously decreasing due to increase in population and water usage but quality is being deteriorated due to anthropogenic and natural activities. Ground water quality is of more significance due to being source of drinking because it directly affects the human health. The ground water quality depends on aquifers and the quality of aquifer. The study deals with ground water quality assessment at different depth levels from drilled well. The analytical data reveals that ground water quality changes with different depth levels due to confined layers. Results indicate the correlation of total dissolved solids (TDS) and Arsenic concentration at different depth level from drilled well. Standard methods, Atomic Absorption Spectrometer Vario, 6 (Analytic Jena) and Digital Electrical Conductivity meter (Hanna) were used for the analysis of samples. The analytical data reveals that ground water quality changing with different depth level due to confined layers. The study indicated that at the lower level of total dissolved solids (TDS) Arsenic concentration is high but when total dissolved solids increases the Arsenic concentration decreases and it applies where source of arsenic is present in ground water.

KEYWORDS

Ground water quality, arsenic, TDS

INTRODUCTION

Water is a precious and finite commodity on the globe and is an essential natural resource for sustaining life and the environment. Safe drinking water is a basic need for all human beings on the earth, while millions of people worldwide are deprived of this necessity. Groundwater is the most appropriate and widely used source of drinking water which is increasingly threatened by pollution from industrial and agricultural activities (Prasad & Narayana, 2004). In Pakistan the major source of drinking water is ground water. It is being utilized through open wells, springs, tube wells, injector pumps, hand pumps and infiltration galleries. Groundwater studies carried out in various locations have revealed declining levels of water and lowering of water tables, brackish water that cannot be used for domestic purposes, poor soil health and decreased crop yield due to the pumping of sodic water.

A water quality study (Bennett, H.B. et al., 2010) in rural Cambodia showed that a shallow aquifer was chemically less of a health risk than a deep aquifer. However, microbial contamination was considerable for both open and rope-pump shallow wells. Nevertheless, contaminants present in shallow wells may readily be removed by simple household water treatment.

A study (Sampson, M., 2008) in Bangladesh revealed that the risk of childhood diarrhoea was 46% lower in the 179 households that used a deep tube well than in the 364 that used a shallow tube well (P=0.032). Neither socioeconomic status, latrine density, population density nor study year had a significant influence on disease risk. Another study (Wu, J. et al., 2011) in Bangladesh concluded that increased access to tubewells (greater tubewell density) was associated with a lower risk of childhood diarrhoea. Intermediate-depth wells (40-90 m) were associated with more childhood diarrhoea compared to shallower or deeper wells (90-300 m).

Access to clean drinking water is becoming a survival issue for Lahore with expanding population and thousands of industrial units. The Water and Sanitation Agency Lahore is

1. Pakistan Council of Research in Water Resources Regional Office, Lahore

managing water supply from the aquifer through its 467 tube wells having 2-4.0 cusecs capacity. However, there is no artificial recharge mechanism in operation and as a result the aquifer is depleting at about 2 ft / year. After the construction of Thein Dam in 2000 upstream of Madhopur Head Works in India, flow of Ravi River has drastically ceased which was a major source of recharge to the aquifer. There is also problem of rapid growth in industrial growth and population leading to dual sustainability threat for the aquifer in terms of increasing pumping rates and underground seepage from untreated waste disposal. It is reported that during last three decades aquifer of Lahore is quickly depleting by over 300 percent which poses serious threat about availability of clean water to the City in the future.

The ground water quality depends on aquifers which are the layers of underground water bearing permeable rocks or unconsolidated material sand, silt, gravel etc. Aquifer is typically saturated region that has feasible quantity of water. The quality of ground water depends on soil characteristics and its hydrology. Many chemicals and substances which are naturally occurring like calcium, magnesium, sodium, iron etc are the parts of natural water but it may also be affected due to specific contaminants that lead to pollution.

Ali et. al conducted a study to demonstrate the seasonal variations in physico-chemical parameters of mixed water of Rivers Ravi and Chenab, for a period of ten months from February to November 2000. Copper (Cu) toxicity of water and plankton in the river Ravi stretch from Lahore siphon to Baloki Head Works and related effluent discharging tributaries was studied by Rauf et. al in 2007. The study showed that there is serious arsenic issue and the studies about modes of contamination of ground water as well as surface water by arsenic, its metabolism, health impacts and factors influencing arsenic poisoning.

Water quality can be assessed by the measurement of physical, chemical and microbiological characteristics of water. The water quality is mostly used by reference to a set of standards against which permissible limits can be assessed. The purpose of the standard used is to assess the water quality related to drinking water safety of human beings and for the existence of healthy ecosystem. Therefore, the quality of water in Pakistan varies due to climatic, environmental changes and geological structure of the earth.

According to these facts finding a depthwise study was conducted in Lahore to identify the quality changes. The earlier studies show that the water quality of different areas especially big cities of Pakistan is deteriorating fast and indicates that quality of water in congested areas is very alarming. For saving life and providing pure drinking water different government and non-government organizations are installing water filtration plants in the access of people so that people could save their lives from water borne diseases.

To assess the water quality depth drilling bore water samples were collected from 50 feet to 400 feet with the interval of 50 feet each. A road running along the study area, consists of industries and there are almost **76** collecting drains which connect **eight** major drains namely Satukattla Drain, Mian Meer Drain, Lakshmi Drain, Sukh Nehar Drain, Upper Chotta Ravi Drain, Lower Chotta Ravi Drain, Sidique Pura Drain and Shahdara Drain. All these mentioned drains ultimately fall into river Ravi.

MATERIAL AND METHODS

Samples were analyzed for major parameters namely electrical conductivity, total dissolved solids (TDS) and arsenic. For the ground water quality analysis, Standard APHA methods were utilized in regional water quality laboratory, Pakistan Council of Research in Water Resources (PCRWR) Lahore.

The methodology of the study consists of:

- Specifying the method of drilling Well
- Identifying the points of Interval for sampling
- Recording data of water sampling points

- Types of samples to be collected,
- Method of sample collection,
- Water quality parameters and methods used for respective analysis.

STANDARD METHOD USED FOR WATER QUALITY ANALYSIS

The standard methods used for analysis were :

Conductivity, (μ S/cm), and TDS	EC meter, Hanna Instrument Model HI 991301, Italy
Arsenic (μ g/l)	Atomic Absorption Spectrometer,Vario 6 Analytikjena

Arsenic

For the determination of arsenic contamination in drinking water, Mercury Hydride System of Atomic Absorption Spectrophotometer (AAS) Vario 6, Analytikjena was used.

Water Quality Standard

The permissible limits or guideline values for the parameters under analysis are given in table;

Water Quality Parameter	Units	Max Permissible Limit (WHO)
Electrical conductivity	(μSm/cm)	NGVS
Total dissolved solids	(ppm)	1000
Arsenic	(ppb)	10

μ Sm / cm: Micro Siemens per centimeter; **ppm** : Parts per million, **ppb** : Parts per billion **WHO**: World Health Organization; **NGVS**: No Guide Line Value Set.

SAMPLING PROCEDURE

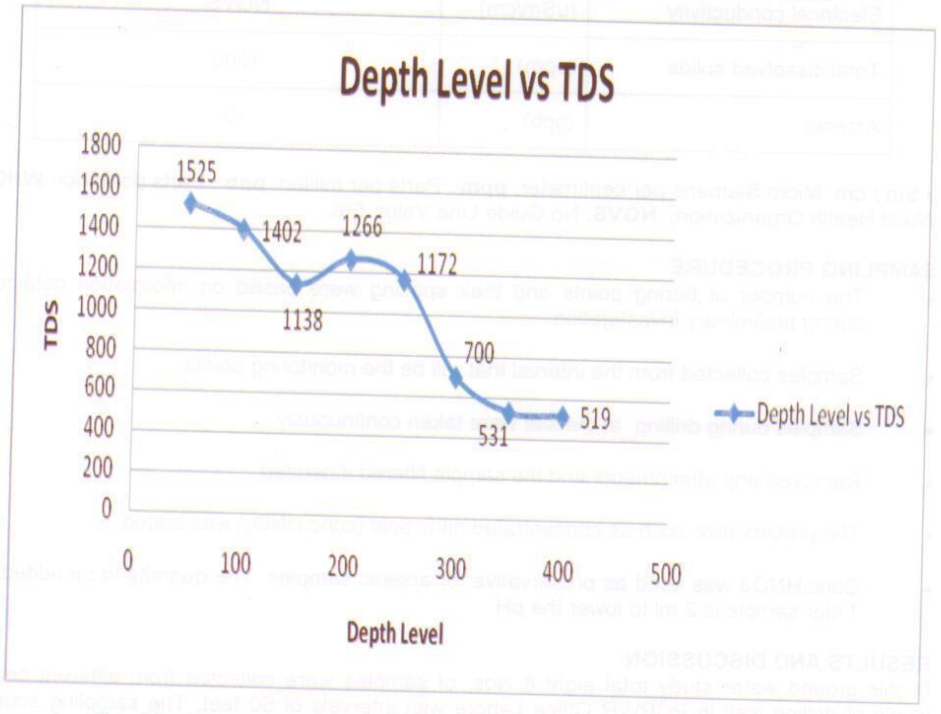
- The number of boring points and their spacing were based on information obtained during preliminary investigation
- Samples collected from the interval that will be the monitoring points.
- Samples during drilling at the site were taken continuously
- Removed any attachments and the sample filtered if needed.
- The preservative such as concentrated nitric acid (conc.HNO_3) was added.
- Conc.HNO3 was used as preservative for arsenic samples. The quantity to be added in 1 liter sample is 2 ml to lower the pH.

RESULTS AND DISCUSSION

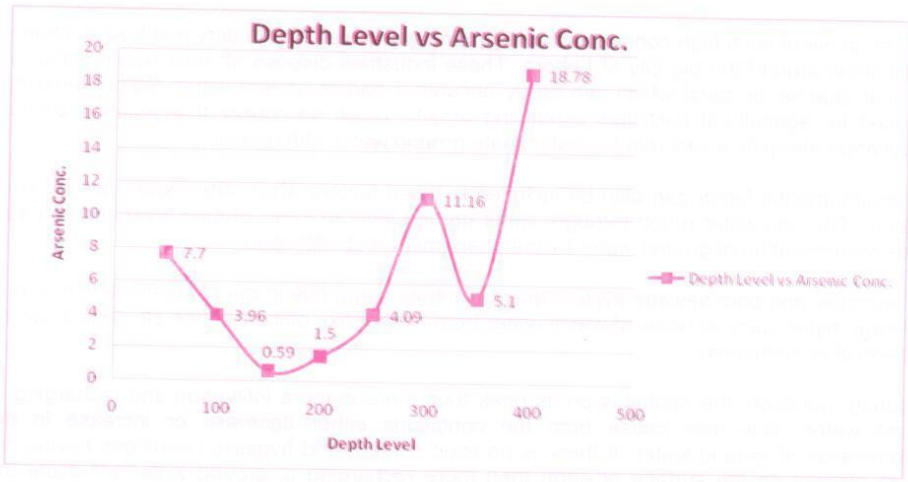
In this ground water study total eight 8 Nos. of samples were collected from different depth levels of drilling well in PCRWR Office Lahore with intervals of 50 feet. The sampling source containing shallow aquifers was marked clearly and protocol sampling was adopted during field. The results of the samples are given in table.

Sample Code	Depth (ft)	TDS (ppm)	As (ppb)
S-1	50	1525	7.70
S-2	100	1402	3.96
S-3	150	1138	0.59
S-4	200	1266	1.50
S-5	250	1172	4.09
S-6	300	700	11.16
S-7	350	531	5.1
S-8	400	519	18.78

Graphical Representation of Total Dissolved Solids with depth level



Graphical Representation of Arsenic Concentration with depth level



From the graphical representation (a) and (b) it comes out that TDS and Arsenic at different depth level with specific intervals shows different mode and behavior from each other.

The research study showed quality changes in water with different drilling depths. This is very important to overcome the problems and contamination specially the change of source locality in respect of upper level contamination and extra burden of expenses for the installation, filtration of water and its maintenance. In this study it was very interesting that water quality was seen changing with different depth level including with arsenic concentration. Total of eight samples were analyzed 6 were found unfit with respect to TDS. It means that 75% samples were exceeding permissible limits of WHO standards, so they are unfit and risky for drinking purposes while 25% samples were found safe.

In the study of Arsenic parameter 2-samples were found unfit while other 6 were under permissible limit. It means 75% samples were safe and remaining 25% were found unsafe but pH parameter in whole study was found within permissible limit.

The analytical data also shows that the quality of water changes depthwise from 50 feet to 250 feet with respect to TDS and TDS shows decreasing consistently from 50 feet to 200 feet but on 250 feet TDS increases noticeably and then decreases on 300 - 400 feet rapidly which shows that there are many confined layers present on drilling point. The quality of water changing depthwise due to these confined layers.

On the other hand heavy metal Arsenic varies randomly which shows it does not depend on water layers. It means other factors (Industrial and domestic waste, Geological material and Environmental contamination) are influencing the Arsenic concentration in different depth levels of water. For this purpose of Ground water quality, some research work is needed as there is no continuity in the concentration value of arsenic.

There may be many factors that can cause such variation. One of the factors can be Ravi River. Ravi is a trans-boundary river flowing through Northwestern India and Pakistan. It flows from India to Pakistan by passing in urban areas of Lahore. The pollution levels in the river discharge are reportedly very high, which is attributed to careless disposal of large amount of industrial and agricultural waste water and faulty drainage system in both countries. A 72-kilometer stretch of the Ravi River from Lahore Siphon to Balloki Head-Work indicates heavy contamination of water.

So during flow, water passes from different places and areas. It can be possible that water may dissolve arsenic contents from different sources (e.g. rocks, soil, contaminants etc). While passing, may be some of arsenic contaminated water is added to groundwater due to seepage and infiltration.

Another cause of such high contamination of ground water may be the dirty and toxicity channel of industries around the big city of Lahore. These industries dispose off their waste water into any near channel or canal which can easily become a part of ground water. Some herbicides are used for agricultural purposes containing arsenic (such as copper II arsenate, disodium methyl arsenate) play a vital role to contaminate ground water with arsenic.

The environmental factor can also be included in those factors which are responsible for such variation. The rain water runoff through higher ground level to lower ground level and can also cause contamination of ground water by the phenomenon of infiltration.

The improper and poor sewage system may contribute some role in the contamination in water. Sewerage pipes carry all types of waste water from household, offices, shops etc. thus it can be a reason of contamination.

As during monsoon, the rainfall is on its peak thus there is more infiltration and recharging of ground water. This may cause both the conditions either decrease or increase in the contamination of ground water. If there is no toxic content and hygienic conditions having the source present on the surface of earth then more recharging of ground water will dilute the already present contaminated ground water. Whatever is source of contamination, it will cause the increase in contamination within ground water. It is also depending on geology of that specific area. If the most common source of ground water contamination is the mobilization of naturally occurring sediments, soil Rocks, giving the chemical conditions in the subsurface which can dissolve into ground water used for drinking water.

RECOMMENDATIONS

- An institutional framework needs to be developed for regular water quality surveillance and control in the rural and urban areas.
- Intensive awareness-raising activities should be undertaken immediately with regard to the negative health effects of drinking arsenic-contaminated water in order to introduce preventive measures in cooperation with local bodies, NGOs and others.
- The activities recommended above should be undertaken in an integrated manner combining the medical and water supply interventions at the district level in order to make the entire district population free from arsenic risks.
- Low Cost Arsenic kits, Arsenic removal filter and other related technologies developed by PCRWR should be distributed among population for frequent testing of drinking water.
- A number of domestic and community water treatment methods have been developed to remove arsenic in drinking water. A review and evaluation of the arsenic removal treatment technologies and their efficiency should be undertaken.
- People should be given awareness for the health hygiene and to protect the passing canals and channels near to their houses. Because if the water bodies got contaminated they can badly affect the human health indirectly, sometimes directly.
- Development of sewage and waste disposal system is a better way to overcome this problem. An efficient sewage and waste disposal system should be developed to prevent the contamination of soil and water supplies.

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CHARACTERIZATION OF LEACHATE SAMPLES FROM DIFFERENT DUMPING SITES IN ISLAMABAD

By

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Abstract

The purpose of present study was to characterize leachate from I-14, NUST dumpsite H-12, Nallah Layee to compare their level of toxicity. Samples were collected as per methods stated in the methodology. Samples were analyzed for various physiochemical parameters these include pH, temperature, turbidity, conductivity, TDS (total dissolved solids), Cl (Chloride), COD (Chemical oxygen demand), TOC (total organic carbon) and TN (Total Nitrogen). XRF (X-ray fluorescence) was used for determination of heavy metals in the leachate samples collected from three different sites. The values of pH ranged from 6.70 to 8.24, temperature fluctuated from 26.3 to 28.4^{0}C and conductivity measured from 0.02 to 8.76 µm (micro meter). Mean value of TDS was 1.54 mg/L (milligram per litre) and value of turbidity was 30 to 354 mg/L. The measurement of COD ranged from 5333mg/L to 35,200 mg/L and TOC fluctuated from 403 to 452 mg/L. The value of TN varied from 148mg/L to 174 mg/L and chloride ranged from 2300mg/L to 3250 mg/L. Results of this study indicated that COD, TOC, TN and chloride is higher in the sample of active dumping site of Nallah Layee as compared to dormant dumping site I-14 and abandoned site of NUST H-12. The results of leachate analysis collected from different sites were compared with Nigerian Leachate Standards. COD was much higher as compared to Nigerian Standard values of Leachate. The measured samples of leachate need an appropriate and economical treatment prior to disposal in any water body.

Keywords: Leachate, COD, abandoned dump site, active dump site, dormant dump site

Introduction

Human cannot live without using chemicals and their products. They derive benefits from chemical products in different sectors of life. However, unsafe exposure to them can cause acute toxicity. There are almost 100,000 chemicals utilized by mankind in this ecosystem and most of them are highly toxic (Nowierski et al, 2006). Analysis of adverse environmental impacts of chemicals on human health and ecosystem is recently gaining momemtum (Fortner & Wittman, 1983). Disposing off these chemicals openly on dumpsite is causing havoc environmental hazards and related health problems. Combination of different types of chemicals on dumpsite and moisture present in the waste lead to generation of Leachate.

Leachate has been identified as one of major environmental hazard to ground water aquifers (Fatta et, 1999). Open dumped waste subjected to water bodies, percolates by precipitation or ground water underflow. The moisture present in solid waste is slowly released and by-products of decomposition enters in underground water. Areas near dump sites and landfill have more possibility to contaminate ground water aquifer of surrounding areas (Mor et al, 2006). There are a number of studies of leachate contamination done (Saarela, 2003) defining the standards of disposing off Leachate. In Pakistan, there are no limiting standard values designed for safe disposal of leachate. Therefore, it is presumed that sound scientific readings and data is required to define the specific limit for specific compounds which have adverse health impacts (Fortner & Wittman, 1983).

Leachate may contain large amount of BOD, COD, ammonia, halogenated hydrocarbons and heavy metals (Aziz et al, 2009). This study mainly focuses on leachate characterization of different dumping sites (active, dormant, abandoned) in Islamabad. The result of the present study would assist Environment Protection Agency of Pakistan to develop standard limiting values of leachate prior to safe disposal as well as for designing a treatment facility.

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Materials and Methods

Samples were collected from three different solid waste dumping sites in Islamabad from March to May 2013. These sites are Open Dumpsite in sector I-14, NUST H-12 Dumpsite and Nallah Layee. Sampling Site of I-14 was used by Capital Development Authority of Islamabad to dump municipal solid waste openly without proper management. Nust H-12 dumpsite has also been utilized by CDA Islamabad for dumping municipal waste but it was abandoned in 2003. Third site of Nallah Layee has been utilized as a dumping canal for industrial, municipal and commercial solid and liquid waste. The I-14 site has been dormant from last two years whereas Nust H-12 dumping site has been abandoned. The Nallah Layee is still an active site. Sampling type was Purposive to collect the concentrated leachate sample with acute toxicity from the above mentioned sites. Triplicate samples were collected from each site.

Samples were analyzed for physical parameters pH, temperature, turbidity, TDS and conductivity. COD was analyzed using titrimetric method by digesting sample for two hours on COD reactor and titrating it against Ferrous Ammonium Sulphate. Total organic carbon and total nitrogen was measured using TOC analyzer. Chloride was measured by flow injection analysis using a combined reagent (Mercurric thiocyanate and ferrous nitrate). Heavy metals were qualitatively checked by XRF (range from Sodium to Uranium).

The data was statistically analyzed by calculating Mean and Standard deviation. Pearson correlation was carried out to determine the positive and negative correlation among different parameters. Analysis of variance is applied to determine the level of significance among correlated variables using Statistical Package for social sciences software package (Norusis, 1997).

Results were compared with Environmental standards of Nigeria because Nigerian Government has developed Leachate standards for different types of solid waste dumping sites (Active, dormant)

Samples were collected, stored, transferred and analyzed according to Standard methods of examination of water and waste water (APHA, 2010)

Results and Discussion

The results of physicochemical properties are mentioned in Table-1. Values of Mean, Minimum, maximum and standard deviation are also shown in Table-1. The mean value of pH is 7.51 and it ranges from 7 to 8. The pH value of active site that is Nallah Layee has low pH value as compared to dormant and abandoned site samples (Keimowitz, 2005). Different types of chemicals, pharmaceutical medicines, toxicants from different industries are regularly dumped in Nallah Layee which decreases its pH value. As the breakdown and mixing of different chemicals and toxicants if going on the active site so it could be probable reason for increase in pH. Conductivity is high in sample of I-14 site because sample was collected in the rainy season and high number of ions is present. The TDS of this dormant site is also higher than active and abandoned site and it poses more environmental risk than other two sites. Dormant site is under process of biodegradation while active site is still fresh and leachate is under production. The COD value 36800 mg/L of active site (Nallah Layee) is higher than other two sites. This result of COD is in agreement with the observation of (Ogundiran & Afolabi, 2008). COD value 5333 mg/L of dormant site was lower because it is under the process of biodegradation.

This result strongly upholds the view that active site has comparatively less toxic compounds while dormant site is biodegrading and abandoned site (NUST Dumpsite) has more toxicity. COD is the oxygen demand for degradation of chemical complex compounds usually found on active or dormant dump sites which are assumed to be toxic. This is also proved by the results of (Xiaoli et al, 2007). Natural process of biodegradation generates more toxic compounds which have complex structure and cannot be further degraded. Analysis of heavy metal was done on X-ray Fluorescence. The value of TOC 542 mg/L is higher in dormant site because it was a dumpsite of only municipal waste. For this reason, value of TOC is higher than COD. TOC 403 mg/L of Nallah Layee sample was less because chemically degradable matter is higher due to untreated discharge of industrial effluent than organic content of sewage.

A comparison of COD and TOC with TDS showed significant relationship in Pearson correlation model in Table-1. COD has negative correlation with TDS which means that as value of COD is increasing, total dissolved solid is decreasing. Similarly, total organic carbon has negative correlation with COD. Organic carbon is more easily biodegradable than COD (Ogundiran & Afalabi, 2008). Classically, the toxic effect of non biodegradable organic content on the ecosystem is presented by (Renou et al, 2008). TOC has significant positive correlation with TDS which shows that increase in total organic carbon will increase in total dissolved solids. In Table-2 there is also significant correlation between Conductivity, TOC and COD

Table-1

Pearson correlation between TDS, COD and TOC

Pearson Correlation	TDS	COD	TOC
TDS		.029	.041
COD	.029		.012
TOC	.041	.012	

*. Correlation is significant at the 0.05 level (2-tailed)

Table-2

Pearson correlation between Conductivity, TOC and COD

Pearson Correlation	Conductivity	TOC	COD
Conductivity		.041	.029
TOC	.041		.012
COD	.029	.012	

*. Correlation is significant at the 0.05 level (2-tailed)

The analysis of variance model in Table-3 and Table-4 is applied on cumulative values of conductivity, COD, TN, Chloride and TOC. It showed significant relationship between COD, TOC and conductivity. There was no significant relationship between COD and chloride. The value of chloride 3250 mg/L is highest in the sample of active dumping site as compared to dormant site 2400 mg/L and abandoned site 2300 mg/L.

Table-3

One way Anova showing relationship between TOC, TN and COD

Anova	Degree of freedom	Frequency	Significance
TOC	1	489.82	.041
TN	1	239.41	.168
COD	1	.208	.029

Table-4

One way Anova showing relationship between COD, TOC and Chloride

Anova	Degree of Freedom	Frequency	Significance
COD	1	489.82	.029
TOC	1	11970.66	.041

Pakistan Environmental Protection Agency has not developed any limiting standards for Leachate generation and disposal. Therefore, readings were compared with Nigerian Federal Environment Protection Agency because they are developed for active and dormant dump site Leachate. The results of COD, TOC and chloride were higher than standard values of FEPA (Lagos Waste Disposal Board, 2006).

The results of heavy metal investigation by XRF revealed no heavy metal present because range of XRF model used for analysis is from sodium to uranium.

Conclusions

The physicochemical characterization of leachate from different sites revealed higher toxicity as compared to standards of FEPA and have potential to cause environmental hazard. Samples from dormant dumpsite of I-14 has more organic content as compared to the samples from

active and abandoned dumping sites. COD and chloride level was highest in the active dumpsite of Nallah Layee. All samples have complex chemical composition but toxicity was acute in the Nallah Layee samples because municipal, commercial and industrial waste is being dumped together in the Nallah Layee. Control measures should be launched immediately to protect human health and surrounding environment. These results would help to design a proper economical treatment facility for leachate generated from different sites as well as to introduce limiting standards for Leachate disposal.

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FOOD CONSUMPTION CHALLENGES AND ENVIRONMENTAL PRESERVATION STRATEGIES

By

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1. INTRODUCTION

1.1 Present global population is 7 billion. It will increase to 9 billion by the year 2050. It is noteworthy that most of the developing nations of Asia and Africa are suffering from hunger and malnourishment. About one billion people are hungry and 800 million people are deprived of balanced diet. 90% of these people belong to developing countries. 200 million children are seriously undernourished. Further, 20,000 children die annually prior to reaching age of 5 years. Ill managed land and water resources and orthodox agricultural technologies especially in the developing countries have led to situation of looming food crisis. Most of the Asian and African countries do not enjoy food security and food safety and are dependent on food exporting countries for meeting their food needs.

1.2 Despite the fact that the world at large is facing food shortage. Food losses are increasing with passage of every day 1.3 billion tons of food is wasted annually according to Food and Agriculture Organization (FAO) of the United Nations (UN). Certain countries destroy the stocks of surplus food with a view to keep their prices in the global market at specified level. Crunch of food losses is now being felt at national, regional, global and United Nations levels. That is why the theme of World Environment Day 2013 has been chosen as Think Eat Save. The present paper aims at ascertaining the causes of food losses, their adverse impacts and suggesting the way forward for realizing the goal of food security and food security for people of the world.

2. CAUSES OF FOOD LOSSES

Variety of causes can be attributed for the current ever growing food losses. Food is wasted in many ways commencing at individual, community and national levels. Significant causes are discussed in the following:

2.1 Imbalances in Food Production

Food production varies both in quality and quantity in countries, regions and continents. Similarly different demographic profiles demand different needs of foods. In turn health of people is also impacted. Certain countries produce more food than their respective needs whereas the case is opposite in others. Ensuing food losses depend on number of consumers and the commensurate rate of food productivity.

2.2 Improper Food Storage/Preservation

If the finished and raw food items are improperly stored/preserved these will face heavy losses. In many cases food is likely to be damaged since such facilities are not handy. This practice is frequently followed in hotels/restaurants where food stuff is thrown away rather than feeding the hungry persons.

2.3 Quality of Food Products

A number of international standards are applicable to food items which govern their local marketing, exports and shelf life. Poor quality product is determined throughout their lifecycle / supply / consumption chain. Production technologies, processing mechanisms,

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chemicals and catastrophes impact quality of agricultural produce. Poorly cooked foods in hotels / restaurants are thrown in the waste bins since these will loose customers.

2.4 Quantity of Food Production

Food items are important components of agriculture. Some undesirable chemicals are added for increasing crop yields. Resultantly more quantities of foods can be produced but their quality will suffer. This principle is applicable to poultry birds also. If quality of food is poor it is liable be wasted the earliest.

2.5 Food Consumption Habits

Different societies have their own peculiar eating habits. Certain people lay more stress on fast foods. Others like to eat organic foods. Similarly rates of eating, intervals between two meals, food ingredients etc. vary from people to people and place to place. Many people eat more and waste less whereas reverse is the case with others.

2.6 Varying Lifestyles

Rural and urban communities follow different lifestyles. People in villages lead comparatively simpler life. This equally applies to food habit. Meal timings also vary on the basis of lifestyle. Urban communities are in habit of late dining.

2.7 Available Technologies

Scores of technologies are utilized for production of food and other agricultural produce. Quality and quantity of food production will suffer if such technologies are neither environment friendly nor food grade. Under such negativities rate of waste generation will be higher.

2.8 Climate Change

Prevalent climate change has affected quality as well as quantity of food products. Because of this global phenomenon sowing, maturity, yield, resistance/adjustment with climate change etc have been affected. This in turn has caused variations in food consumption patterns.

3. ADVERSE IMPACTS OF FOOD LOSSES

Food losses in any size or form may generate multifarious negative impacts. These include environmental, socio-economic and health issues. Unscrupulous consumption of food creates huge losses. Significant negative impacts are summarized as under:

3.1 Environmental Impacts

3.1.1 Undesirable eating habits may lead to throwing the food wastes here and there. Unsightly conditions may arise with generation of bad odours. Aesthetics of the area will be jeopardised. Management of huge quantities of waste may create technological dilemma.

3.1.2 Overeating on part of the consumers will put pressure on growing more food. Thus there will be additional requirement of land and other agricultural inputs.

3.1.3 Generation of huge quantities of wastes will certainly pollute the atmospheric, aquatic and terrestrial resources. Ultimately environmental mitigation costs may rise without proportions with tremendous losses to national exchequers.

3.2 Socio-economic Damages

3.2.1 Production of food and subsequent generation of the wastes will entail colossal socio-economic repercussions. Certain social classes will have easy access to more and better foods whereas the marooned people will remain deprived of adequate food

supplies. The same applies among rich and poor countries. Rich countries will put political and social pressures on the food deficit countries. Similarly the rich countries may dump their food wastes in territories of the poor countries. The developing countries may make hue and cry but in vain.

3.2.2 Economic losses on account of food wastes are two-fold. On one side huge investments are needed in terms of capital and maintenance costs and inputs like energy. On the other hand management of surplus food and the wastes will be a big drain on the economy of relevant countries.

3.3 Health Concerns

If the consumers especially women and children do not eat balanced diet they will fall victim to food pollution and scores of allied diseases. Instead food rich countries and the individuals do not allow the surplus food reach the needy ones and waste it in variety of forms. Therefore, those playing with lives and health of human beings and other biodiversity are committing crime against living organisms and also against United Nations charter which considers food as the basic right of human beings. It is added that contaminated waste food is a source of many dreadful ailments hitherto unknown to humanity.

4. STRATEGIC AGENDA

For achieving food security/safety and environmental preservation at the same time and avoiding food losses is an uphill task. However, it is an achievable target if right actions are taken in right direction for the sake of humanity. Following strategic agenda is proposed:

4.1 Integrated Planning

Policy planning should be undertaken commencing at the global level down to individual unit. FAO of the UN should perform this task with the help of other components of the UN and relevant global stakeholders. In the light of directives of FAO the countries should formulate their respective policy plans and action strategies.

4.2 Establishment of Sustainable Food Infrastructure

For provision of optimum food supplies to peoples of the world suitable food infrastructure should be developed. All the facets of food production, conservation, processing and losses should be covered in comprehensive manner. Emphasis needs to be laid on institutional strengthening/capacity building rather than providing the grants/subsidiaries. This is especially applicable in case of public sector in the developing world.

4.3 Application of the Latest Technologies

The latest technologies should be introduced in agriculture and food production. Aim is to produce more food for meeting needs of ever growing population and permit minimum losses. Developing nations may learn from experiences of the advanced world rather than inventing the wheel again.

4.4 Development of Sustainable Society

For realizing the objective of sustainable development it is imperative that the societies at all levels are self reliant. These need to utilize the natural and human resources optimally without allowing negative forces to operate.

4.5 Stakeholders' Involvement

All the relevant stakeholders should be involved from policy planning to implementation echelons. Environmentalists, women, civil society and NGO's should actively participate in all the deliberations.

4.6 Environmental Advocacy

It is the foremost duty of environmental scientists and engineers to educate the masses about potential threats of degrading environment. They are ethically bound to inform the political leadership, planners and policymakers about the adverse environmental impacts of the food related activities. The environmentalists must be prepared to work with the food experts and agriculturists in unison for bringing green revolution in their respective countries in the realm of food industry. It is emphasized to apply the concept of Collaborative Environmental Planning.

5. RECOMMENDATIONS

Consequent to above discussion following recommendations are made:

5.1 FAO should regulate the food production and ensuing losses with assistance of member countries.

5.2 Global, Regional and National Research and Development Centres should be established for carrying out research about food production and losses.

5.3 It is the global, national and moral duty of every individual, organization and nation to contribute towards increasing food production and minimizing food wastes/losses.

5.4 Mass awareness programmes should be launched at all levels for minimizing/controlling food wastages/losses

5.5 With a view to protect the fundamental human right for food, the World Trade Organisation and other relevant market players should work together for keeping the food prices within affordable limits of world hungry people.

5.6 Divine injunctions should be followed to ensure availability food stuff to the poverty stricken and undernourished and malnourished communities irrespective of colour, creed and faith differences.

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