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FOR MEMBERS ONLY

Pakistan Engineering Congress is a prestigious professional body established in 1912 dedicated, *inter-alia* to technical advancement of Science & Engineering in the country

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(75th Session)

FOREST COVER

The Land mass without trees is devoid of aesthetic. Values, does not look pleasing, bereft of songs and flight of colorful birds, barren turns into deserts, shorn of life. Forests contribute to scenic beauty of Land-scape and a harbinger of economic development in several ways.

- A source of valuable goods, lumber used as building material, Furniture, fruits, medicinal herbs, fuel wood.
- Trees act as a carbon sink/check rise in temperature/global warming, checks, floods, landslides, desertification, invite rains etc.

Increasing Forests cover, checking deforestation are crucial for socio-economic development (lumber plays a major role in the Housing Sector of the United States as well as other countries). A recent study states that houses may be built with greater use of wood to check rise in temperature/global warming. In the Mughal period, the Indian sub-continent was thick with forests as also praised in the following couplet.

سفر ہے شرط ،مسافر نواز بہتیرے
ہزار ہا شجر سایہ دار راہ میں ہیں

Pakistan has inadequate forests cover vis-à-vis other neighboring countries .

- China 21.83%
- Malaysia 59.50%
- India 23.68%
- Myanmar 63.64%
- Pakistan 5.31%

Although very late, the country has realized the urgent need of increasing forest cover and are making strenuous efforts in massive plantation with public/private participation (WWF and other NGO's are playing pro-active roles). Students community can play a significant role in plantation campaign. The general public in particular rural population can also be apprised of the benefits of planting trees at empty space. It can be a good source of income as well.

Deforestation also needs to be strongly checked as timber mafia is engaged in cutting down the trees. Already the economists, sociologists are taking a grave view of deforestation of Rain forests of Amazon, Indonesia etc. as amongst other destructive outcomes it will release the stored-up carbon dioxide that will further worsen phenomena of global warming.

Chief Editor

INTRODUCTORY REMARKS

By

ENGR. TARIQ RASHID WATTOO

PRESIDENT

PAKISTAN ENGINEERING CONGRESS

AT

THE SEMINAR ON SATURDAY, THE 15TH SEPTEMBER 2018
ON THE THEME OF

"NANOTECHNOLOGY AND ITS APPLICATIONS"

Honorable Chief Guest, ***Engr. Fazal Ahmad Khalid S.I.***

Distinguished Guests,

Members of Pakistan Engineering Congress,

Fellow Engineers, Ladies and Gentlemen!

Assalam-o-Alaikum

Ladies & Gentlemen!

I Welcome you all to this colorful assembly of highly educated and experienced Professional Engineers, Scientists, Educationalists, Engineering Consultants, Constructors engaged in Planning, Execution and Management of Mega Socio-economic Development Projects.

And the speakers who are luminaries of Nanotechnology, a field of Technology being actively practiced in advanced as well as emerging economies of the world and which is still to take Root in Pakistan.

Ladies & Gentlemen!

Professor Dr. N. M. Butt is M. Sc Physics (1957) from Government College, Lahore, and Ph.D. (Nuclear/Solid State Physics, 1965) and D.Sc. (Physics, 1993) from the University of Birmingham, U.K.

He is an internationally acclaimed Scientist and an authority on Nanotechnology. In view of his outstanding services the Pakistan Atomic Energy Commission conferred on Dr. Butt the Life Title of Scientist Emeritus.

He has been awarded numerous National and International Awards for his services in the field of Science & Technology. In recognition of his Services in the field of Science & Technology the Pakistan Govt. conferred on him the Prestigious Award of "***Sitara-e-Imtiaz"***.

Dr. Butt will be speaking on the topic of ***"Nanotechnology: Revolutionary Multidisciplinary Science and Engineering for Industrial and Socio-economic Need"***

Ladies & Gentlemen!

Dr. Shahzad Alam is currently the Chairman of the Prestigious PCSIR Laboratories. He is B.SC Engineering, (Metallurgy) With specialization In Materials Science and Ph.D. in Engineering from ENGLAND 1991.

Established Pakistan Institute of Technology for Minerals and Advanced Engineering Materials. Also, Represented Pakistan in United Nations Meetings in Bangkok, Manila, Jakarta and Johannesburg.

He has been awarded Numerous Awards for his outstanding services. His publications in International Journals are Overwhelming.

He will be speaking on the topic of ***"The Impact of Nanotechnology on Industry & Engineering Sector"***.

Ladies & Gentlemen!

Dr. Irshad Hussain is among the pioneers to initiate Nanoscience & Nanotechnology research in Pakistan. He has developed Nano biotech group at National Institute for Biotechnology & Genetic Engineering (NIBGE), Faisalabad, and has played a leading role in the development of Department of Chemistry & Chemical engineering at SBA School of Science & Engineering at LUMS, Lahore.

He will be Presenting a Lecture on the topic of ***"Development in Nanoparticles Research for Applications in Biomedical sciences, Renewable Energy Technologies & Industry"***.

Thank you all for your patient hearing.

PAKISTAN PAINDABAD

TECHNICAL LECTURE

ON

"NANOTECHNOLOGY AND ITS APPLICATIONS"

SATURDAY, SEPTEMBER 15, 2018

CONCLUDING REMARKS BY CHIEF GUEST

Honorable President, Pakistan Engineering Congress, Tariq Rasheed Wattoo Sb, Secretary Najam Sb, Former President Riaz Sb, Executive Members, Distinguished Guests, Ladies & Gentlemen, Dear Students and Participants of this Program, AOA and very good Afternoon.

First of all, let me thank Pakistan Engineering Congress for giving us all an opportunity to participate in this very important program in the context that Iqbal said that

جہاں تازہ کی افکارتازہ سے ہے نمود

کہ سنگ وخشت سے ہوتے نہیں جہاں پیدا

So, they have given us an opportunity to learn and talk about the new developments which are happening in the field of science, engineering and Technology. Thank you so very much sir and its also a great opportunity and honor for me to be part of this Program and also meet my colleagues and friends specially Dr. N.M. Butt, Dr. Shehzad Alam Chairman PCSIR, and Dr. Irshad Hussain Prof. LUMS been working and as Dr. N.M. butt has mentioned that the first activity that got started officially recognizing this important development in the field of Science & Technology was started in 2003-2004 and almost 15-years have gone perhaps we have not been able to make that much progress, we should be doing and I just wanted that it should not become another issue like making and Building Dams in Pakistan.

It's very unfortunate, I can give you a little update and Dr. sb has mentioned that so far 22 labs are working in Pakistan and recently Higher Education commission has opened to invite calls for research proposals within the country with Rs. 1-Billion allocation. It can be seen with the kind of allocation which was reflected in the slides of Dr. N.M Butt was showing that was in Billions of Dollars than Rupees. So, our focus on Science and Engineering education has to go up. No country in the world can progress without focusing on Education, science, Innovation and the Development in the new fields. And people say, "Knowledge is Power" and that knowledge can only be possible to create in our institutions and R&D Institutions by providing the opportunities and learning environment and the facilities and the funding is needed for making progress in the field of Science & Technology.

In certain areas where there has been a focus in Defence, the Engineers and Scientists certainly have produced and delivered. I don't see any reason why they can not do wonders in the modern and new frontiers of Science & Technology.

As we all know Ladies & Gentlemen, Nanotechnology is also listed in the disruptive technologies 10-12 to list like internet thing, internet of everything, Robotics advance material and Nanotechnology. These technologies have been changing the world at a much faster pace and some of the things that we have learned in these excellent presentations by our learned speakers and that highlights that we have long way to go might have taken a little start in our institutions but we have a long way to go to catch up with the rest of the world so that we can also translate the benefits of Science, Engineering and the Development which are happening to the society within our country and as we all know that this important field is interdisciplinary and has made a tremendous progress so far but still as we say that Nano, Bio, Info these are the three important areas where has to be a focus in the scene and we are witnessing the benefits of IT and connected with the old world and the next one is Bio, Genetic Engineering, working at molecule level, atomic level and the building blocks and these can really not only changed the properties based on size dependence but also can bring the kind of performance and accuracy because while working at the atomic level, molecular level in clean rooms can give you a much smaller drones or may be the kind of new developments in concrete for example, if you reduce the porosity and at Nano silica particles in concrete you can reduce its weight, you can change its design and you can have a much stronger and even flexible concretes. So, these are the developments which are happening in the world and we have just witnessed many things that have been highlighted by the learned speakers. So, it's a great honor for all of us to learn and I'm sure that the Congress will continue to organize similar kind of activities and I have also the honor to give a talk on this topic some years back when honorable Riaz sb was the President of the Congress and I think we should bring the connectivity between our institutions and also our professional forums so that we can maximize learning opportunities for our students and for the young engineers working in different fields of Science / Engineering and in different organizations.

So, it's a great honor for me to be in this Program Thank you very much and it's a good learning experience specially meeting my colleagues at this forum and with it, I conclude my remarks on the fact that Iqbal Said;

دیارِعشق میں اپنا مقام پیدا کر
نیا زمانہ، نئے صبح وشام پیدا کر

Thank you so very much.

LECTURES ON NANO-TECHNOLOGY

A. Nanotechnology involves the study, control, synthesis and manipulation of materials at Nano-scale sizes and their consequent uses for making industrial products. The physical properties of materials, whether mechanical, chemical, electrical or magnetic etc. at Nano sizes are greatly improved. Therefore, the industrial products using nanotechnology, in addition to miniaturization of devices, improves their performance and efficiency as well as leads to increased production and their better quality. Nano size means a size of material one billionth of a meter and in terms of common understanding this size of a material is about 100,000 times or one lakh times thinner than the human hair. Such small size material cannot be seen with naked eyes, but atomic microscopes are available to Industry through which such small size materials can be seen and actually used in making the industrial products.

The applications of nanotechnology are enormous and all kinds of Industries including defense organizations use this technology for their products.

B. In view of the importance of this newest technology, Pakistan Engineering Congress organized a Seminar on the new discipline by the leading luminaries as stated below;

i. **Nanotechnology: Revolutionary Multidisciplinary Science and Engineering for Industrial and Socio-economic Need**

Dr. N. M. Butt S.I, Preston Professor Nano-Technology/Chairman (PINSAT)

ii. **The Impact of Nanotechnology on Industry & Engineering Sector**

Dr. Shahzad Alam, Chairman PCSIR

iii. **Development in Nanoparticles Research for Applications in Biomedical sciences, Renewable Energy Technologies & Industry**

Prof. Dr. Irshad Hussain, Department of Chemistry/Chemical Engineering LUMS

And above all, the Chief Guest was Engr. Dr. Fazal Ahmad Khalid S.I. Vice-Chancellor of University of Engineering & Technology Lahore. Welcome Address was presented by Engr. Tariq Rashid Wattoo, President of the Congress. A lively Question/Answer Session ensued after the Lectures and the Concluding overview by the Chief Guest. Shields presented to the speakers.

SEMINAR ON THE THEME OF

"NANOTECHNOLOGY AND ITS APPLICATIONS"

SATURDAY, SEPTEMBER 15, 2018



(From Left) The Chief Guest **Engr. Dr. Fazal Ahmad Khalid S.I.**, Vice Chancellor, University of Engineering & Technology, Lahore on arrival. Engr. Ijaz Ahmad Cheema Member Executive Council is on Right



The Speakers Dr. Shahzad Alam, Chairman PCSIR, Prof. Dr. Irshad Hussain, Department of Chemistry/Chemical Engineering LUMS in deep conversation with Dr. N. M. Butt S.I, Preston Professor of Nano-Technology/Chairman (PINSAT)



(From Left) Engr. Tariq Rashid Wattoo, President-PEC, The Chief Guest **Engr. Dr. Fazal Ahmad Khalid S.I.**, Vice Chancellor, University of Engineering & Technology, Lahore and Engr. Najam Waheed, Secretary-PEC



Engr. Najam Waheed, Secretary-PEC presenting the Program of the Event



Engr. Tariq Rashid Wattoo, President-PEC presenting the Introductory Remarks



Dr. N. M. Butt S.I., Preston Professor Nano-Technology/Chairman (PINSAT) presenting his Lecture on the topic of **"*Nanotechnology: Revolutionary Multidisciplinary Science and Engineering for Industrial and Socio-economic Need*"**



Another picture of Dr. N. M. Butt S.I. presenting his Lecture on the topic of **"Nanotechnology: Revolutionary Multidisciplinary Science and Engineering for Industrial and Socio-economic Need"**



Dr. Shahzad Alam, Chairman PCSIR presenting his Lecture on the topic of ***"The Impact of Nanotechnology on Industry & Engineering Sector"***



Another picture of Dr. Shahzad Alam, Chairman PCSIR presenting his Lecture on the topic of **"*The Impact of Nanotechnology on Industry & Engineering Sector*"**



Dr. Shahzad Alam explaining the Salient features of the connectivity between Industry & Engineering Sector during his Lecture on the topic of **"*The Impact of Nanotechnology on Industry & Engineering Sector*"**



Prof. Dr. Irshad Hussain, Department of Chemistry/Chemical Engineering LUMS presenting his Lecture on the topic of **"Development in Nanoparticles Research for Applications in Biomedical sciences, Renewable Energy Technologies & Industry"**



Prof. Dr. Irshad Hussain, Department of Chemistry/Chemical Engineering LUMS presenting his Lecture and giving the details of the sojourn of the Academic/Practical applications of Bio-Medical Sciences & Nanotechnology and contribution being made at LUMS



Another picture of Prof. Dr. Irshad Hussain, Department of Chemistry/Chemical Engineering LUMS presenting his Lecture on the topic of **"*Development in Nanoparticles Research for Applications in Biomedical sciences, Renewable Energy Technologies & Industry*"**



The Chief Guest, **Engr. Dr. Fazal Ahmad Khalid S.I.**, Vice Chancellor, University of Engineering & Technology Lahore presenting his over-view of the Presentations on Nanotechnology and its implications on Socio-economic advancement



(From Left) Engr. Tariq Rashid Wattoo, President-PEC and the Chief Guest, **Engr. Dr. Fazal Ahmad Khalid S.I.**, presenting Shield to Dr. N. M. Butt S.I. for his presentation on the topic of "***Nanotechnology: Revolutionary Multidisciplinary Science and Engineering for Industrial and Socio-economic Need***"



(From Left) Engr. Tariq Rashid Wattoo, President-PEC and the Chief Guest, **Engr. Dr. Fazal Ahmad Khalid S.I.**, presenting Shield to Dr. Shahzad Alam for his presentation on the topic of "***The Impact of Nanotechnology on Industry & Engineering Sector***"



(From Left) Engr. Tariq Rashid Wattoo, President-PEC and the Chief Guest, **Engr. Dr. Fazal Ahmad Khalid S.I.**, presenting Shield to Prof. Dr. Irshad Hussain for his presentation on the topic of **"*Development in Nanoparticles Research for Applications in Biomedical sciences, Renewable Energy Technologies & Industry*"**



(From Left) Engr. Tariq Rashid Wattoo, President-PEC, Engr. Anwar Qaseem Qureshi Member Executive Council, Engr. Najam Waheed Secretary-PEC presenting Shield to the Chief Guest, **Engr. Dr. Fazal Ahmad Khalid S.I.** Vice Chancellor University of Engineering & Technology Lahore

Questions/Answers Session



Engr. Hussain Pervaiz seeking clarification from speakers on some points



Dr. N.M. Butt S.I. explaining some point during Questions and Answers Session

Questions/Answers Session



Engr. Ismat Beg in discussion with the speakers



Dr. N.M. Butt S.I explaining the issue raised by Engr. Ismat Baig

Questions/Answers Session



Engr. Issa Billal discussing about application of the Nanotechnology in Pakistan



(On Right) Chief Guest Prof. Dr. Fazal Ahmad Khalid S.I. making the Concluding Remarks after the presentation of the Lectures by the Prominent speakers.

Group Photos



(Row-1 From Left) Engr. Amjad Agha, Engr. R.K.Anver, Engr. Ijaz Ahmad Cheema, Engr. Anwar Qaseem Qureshi, Engr. Tariq Rashid Wattoo, The Chief Guest Prof. Dr. Fazal Ahmad Khalid S.I., Dr. N. M. Butt S.I., Dr. Shahzad Alam, Dr. Irshad Hussain, Engr. Najam Waheed, Engr. Anwar Ahmad, Engr. Ch. Muhammad Arif

(Row-2 From Left) Engr. Capt. (R.) M. Qadir, Engr. Hussain Pervaiz, Engr. Riaz Ahmad Khan, Engr. Dr. Muhammad Saeed



Scholarship Awardees of M.S. Engineering Studies

Glimpses of the Audiences





Glimpses of the Audiences





Glimpses of the Audiences





Glimpses of the Audiences





Glimpses of the Audiences





Glimpses of the Audiences





Glimpses of the Audiences





Scholarship Programme of Pakistan Engineering Congress

- Pakistan Engineering Congress instituted 100-Scholarships of Rs.6000 per month for MS Engineering Studies for two years period as under So far 42-Scholarships have been awarded

1)	University of Engineering & Technology Taxila	01
2)	Fast University Lahore	01
3)	University of Engineering & Technology Peshawar	02
4)	University of Lahore	04
5)	NUST Islamabad	04
6)	University of the Punjab	04
7)	University of Agriculture Faisalabad	05
8)	University of Engineering & Technology Lahore	21
		42

- Disbursement to the students have been made in the amount of Rs 36000 each for the period of January 2018 to June 2018, a total amount of Rs. 15.12 Lac. The cheques were distributed in a ceremony held on Saturday, 15th September 2018 at Congress Headquarters by Engr Najam Waheed Member Executive Council/ Welfare Engineers Committee and Secretary PEC.

Pictures of the ceremony are appended




Pakistan Engineering Congress
Seminar on the theme of
"Nanotechnology and its Applications"


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Subject: **Technical visit to 720-Karot Hydropower Project**

A 22- Members delegation of Pakistan Engineering Congress under the leadership of Engr. Capt. (R) M. Qadir Khan and Engr. Dr. Muhammad Saeed, Member Executive Council paid a Technical Visit to 720-Karot Hydropower Project located near Kahuta on September 29, 2018. The delegation was received by the Senior Officers of the Project and given detailed briefing on the salient features of the Project followed by visits to the various sections of the Project coupled with site visits.

The visit was concluded by presentation of the Congress Shield by Engr. Capt. (R) M. Qadir Khan Joint Secretary-PEC to Mr. Allan G Christer, Chief Resident Engineer. Mr. Allan G Christer presented a picture of the Project to Engr. Capt. (R) M. Qadir Khan, who thanked him and expressed his gratitude for the Co-operation / Felicitations extended to the Congress delegation.

720MW KAROT HYDROPOWER PROJECT

Introduction

720 MW Karot Hydropower Project is being constructed on River Jhelum about 74 km upstream of Mangla Dam. It is fourth level of 5 cascade hydropower projects on River Jhelum. Karot HPP is designed to produce 3206 GWh. It is being built on BOOT basis by a Chinese lead Consortium, viz; Karot Power Company Private Ltd. (KPCL) on a concession of 35 years including construction period of 5 years. Total estimated cost is US$ 1.8 Billion.

Project History

In 1975, under a grant from the Canadian International Development Agency (CIDA), WAPDA started to prepare a ranking study of a number of cost effective hydropower power schemes, with a view to meeting the long-term power needs of Pakistan. The study was conducted by an integrated interdisciplinary team comprising of specialists provided by the Consultant (MONENCO) and staff of HEPO WAPDA. This study was completed in 1983.

In November, 1984, Karot Hydropower Scheme upstream of Mangla Dam was proposed for conducting feasibility study. Later, in 1994, GTZ of Germany and HEPO, WAPDA were entrusted with a task of conducting further studies of medium size schemes on Jhelum River basin. GTZ / WAPDA prepared and submitted a report in December, 1994 titled, “Comprehensive Planning of Hydropower Resources in Jhelum River Basin”. In this Report, a 240MW run-of-river scheme, just downstream of Karot Bridge was proposed. No work on this Project was ever done till it was taken over by PPIB to be offered as an IPP to the private sector.

A group of Pakistani and Chinese sponsors were awarded Letter of Interest, after an International Competitive Selection Process in March, 2007. They signed a contract on August 21, 2007, after ICB, with a Consortium of Consultants for carrying out the feasibility study and preparation of a Bankable Feasibility Report, which was submitted in 2009. The said consortium comprises of the following:

a. SMEC International (Pty) Ltd. Australia.
b. Engineering General Consultants EGC (Pvt.) Ltd. Pakistan.
c. Mirza Associates Engineering Services (Pvt.) Ltd. Pakistan.

Project feasibility was prepared by the above consortium after carrying out detailed field investigations and office studies. Power generation was estimated at 720 MW. Based on the results of these investigations and studies, a Feasibility Level Project layout, which is technically sound and economically viable was proposed.

As per the study conducted by MONENCO in 1984 the envisaged net head was 51m and rated capacity of 93 MW for design discharge of 215 m^3/s. The work done by GTZ Germany in 1994 had presented a rated capacity of 240 MW with net head of 51 m for design discharge of 550 m^3/s in their report. Whereas, the Feasibility Study Consultants in 2009 proposed power generation to be 720 MW with design discharge of 1,200 m^3/s and gross head of about 79 m.

Present Situation

Karot HPP is “Run of the River” hydropower project under construction on Jhelum River. The project is being developed in the private sector under the Power Policy

2002 on a Build-Own-Operate Transfer (BOOT) basis with an expected concession period of approximately 35 years, which includes the construction period of 5 years and the operation period of 30 years, after which the ownership of the project will be transferred to the Government of Punjab, Pakistan.

The feasibility stage tariff was determined by NEPRA on 11th December 2012 and the Letter of Support ("LOS") was issued subsequently by PPIB on 29th August, 2013. The development of the Project is being undertaken on a BOOT basis by the Karot Power Company (Private) Limited (KPCL). The Implementation Agreement between PPIB and KPCL was signed on September 20, 2016.

Karot Power Company Private Limited (KPCL) comprises of Three Gorges South Asia Investment Limited (TGSAIL), a subsidiary of China Three Gorges Corporation (CTGC), owner and operator of world's biggest hydropower project that produces 22,500 MW in China Three Gorges Hydropower Project and Associated Technologies (Pvt.) Ltd of Pakistan.720 MW Karot Hydropower Project is the first investment by China Three Gorges Corporation in Pakistan in renewable sector and the first hydropower funded and built by a Chinese company in Pakistan which will be another milestone in cooperation in clean energy between China and Pakistan. The Project has been listed as the "Actively promoted Project" in the China – Pakistan Economic Corridor (CPEC) since 2014.

Karot HPP development is on "Engineering, Procurement and Construction" (EPC) basis and the EPC Contract has been awarded to a Consortium comprising Yangtze Three Gorges Technology and Economy Development Co., Ltd (TGDC – Engineering and Construction) and China Machinery Engineering Corporation (CMEC - procurement) at the beginning of 2015. They will produce the detailed Project design and construct the Project. The EPC contractor is wholly owned by CTGC. The EPC contract commencement date was December 2016 and the proposed completion date is November 2021.

Location of Karot HPP

The Karot Hydropower Project site is on the Jhelum River at 1km upstream (U/s) of Karot bridge at the junction of Punjab province and AJK in the north-eastern part of Pakistan, 55km away from Islamabad in the west and 74km away from Mangla Dam in the south. Islamabad-Kahuta-Kotli road leads to the site of Karot HPP. The location of the project site in relation to Islamabad and Mangla Dam is illustrated below.



Location of Karot Hydropower Project

Adopted Scheme

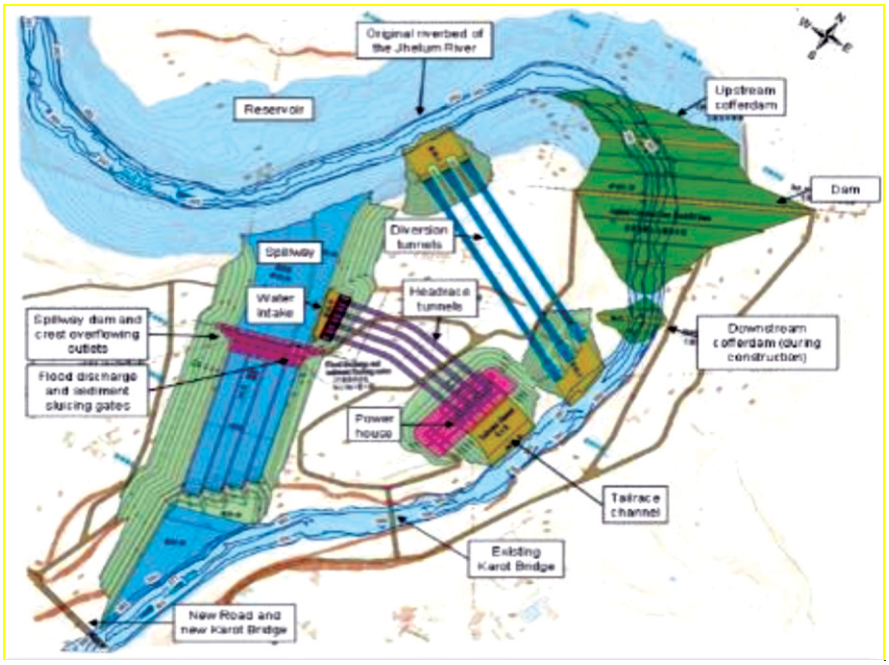
The 720MW Karot Hydropower Project is designed exclusively for power generation under Build Own Operate Transfer (BOOT) basis with a concession period of 30 years. It has an asphalt core rock-fill dam of 95.5 m height, a separate spillway, intake structure, 3 diversion tunnels, 4 power tunnels and a surface power house containing 4 x 180 MW Francis turbines with installed capacity of 720 MW and mean annual electricity output of 3206 GWh.

The EPC Contract's construction period is 5 years plus Defects Notification Period of 2 years for civil works and 3 years for E & M Works. Trial run and commercial operation is planned at the end of 5th year.

The Civil Works and E & M Works are two separate Contracts with Civil Works Contractor bearing the responsibility to coordinate with the E & M Contractor for timely delivery of the project. Following are the EPC Contracts:

1. **Engineering and Construction Contract:** Three Gorges Economy Development Company (TGDC)
2. **Equipment Supply Contract:** China Machinery & Electric Company (CMEC)

Following figure illustrates the main Project Layout;



Main Project Layout of Karot HPP

Summary

- 720 MW Karot HPP is "Run of the River" hydropower project under construction on Jhelum River, being developed in the Private sector under the Power Policy 2002 on a Build-Own-Operate Transfer (BOOT) basis with an expected concession period of approximately 35 years, which includes the construction period of 5 years and the operation period of 30 years, after which the ownership of the project will be transferred over to the Government of Punjab, Pakistan.

- Karot HPP is the first investment by China Three Gorges Corporation in Pakistan in renewable sector and the first hydropower funded and built by a Chinese company in Pakistan.
- The dam site controls the drainage area of 26,700km^2; having long term average runoff of 819m^3/s and long term average annual runoff of 25.83 billion m^3. The project is a single power generation task hydropower complex, with reservoir's Full Water Level (FWL) of 461m, reservoir storage at FWL of 152 million m3.
- In order to ensure the necessary reservoir balancing storage and safeguard the normal water intake to generate electricity, the sediment flushing outlets are arranged in the spillway near the power intake.
- Asphalt Concrete Core Rockfill Dam (ACCRD) has been proposed, which is more adaptable to the geological conditions, anti-seismic feature is better, the excavated materials can be used as dam construction material and the quantity demand for concrete aggregate is less.
- The ground powerhouse will avoid large cavern, geological risk is smaller, and the investment can be better controlled.
- The total duration of constructing of Karot HPP is 5 years (60 months). The period from the commencement of the project to the time when the installation and trial operation of the first unit is completed is 53 months. Defects Liability Period is 36 months.
- Critical paths would be the construction of ground powerhouse and unit installation during construction of the main project.
- Principal Features of the project include;
    - 95.5m high asphaltic core rockfill dam
    - Gated chute spillway on right abutment
    - Sediment flushing outlet incorporated within the spillway structure
    - 720MW power station
    - 4 power tunnels and associated intake structure
    - 3 diversion tunnels

720-KAROT HYDROPOWER PROJECT

Held on 29th September 2018



The Congress Delegation being briefed on the Salient features and Present Status of the Project



The Congress Delegation being briefed on the Salient features and Present Status of the Project

The Congress Delegation being briefed on the Salient features and Present Status of the Project







The Congress Delegation being briefed on the Salient features and Present Status of the Project



Arial View of the site



Arial View of the site



The Congress Delegation visiting to the various segments of the Project



The Congress Delegation visiting to the various segments of the Project



Mr. Allan G. Christer, Chief Resident Engineer, 720-MW Karot Hydropower Project Presenting a Picture of the Project to Engr. Capt.(R) M. Qadir Khan, Member Executive Council/Joint Secretary - PEC



Engr. Capt.(R) M. Qadir Khan, Member Executive Council/Joint Secretary – PEC presenting Shield to Mr. Allan G. Christer, Chief Resident Engineer, 720-MW Karot Hydropower Project



Engr. Capt.(R) M. Qadir Khan, Member Executive Council/Joint Secretary – PEC presenting Congress Publications to Mr. Allan G. Christer, Chief Resident Engineer,

Group Photos of the Delegation





Group Photos of the Delegation





MOHMAND DAM

HYDROPOWER PROJECT

LOCATION

The project is proposed for construction across Swat River at a distance of about 48 km from Peshawar and 5 km upstream of existing Munda Headworks in Mohmand Tribal District.

The command area is spread across Mohmand Tribal District, Tehsils Shabqadar and Tangi of District Charsadda in Khyber Pakhtunkhwa.

THE PROJECT

Mohmand Dam Hydropower Project is a multipurpose project with the following objectives:

i. Hydropower Generation of 800 MW

ii. Flood Control

iii. Irrigated Agricultural Development of 6,773 Hectares

iv. Drinking Water Supply of 13.30 Cumecs

PROJECT BENEFITS

- Gross storage capacity of about 1.2 MAF
- Irrigated agricultural development by construction of two new irrigation canals along with supplementing existing canals off taking from Munda Headworks
- Agriculture development benefits by increasing existing cropping intensities from 23% to 136% andirrigate new command area of 6,773 hectares
- Power generation benefits by generating an estimated annual energy of about 2.862 billion units with the installed capacity of 800 MW.
- Flood mitigation benefits
- Provision of water supply to Peshawar City and adjoining areas of Mohmand Tribal District

PROJECT IMPLEMENTATION

Construction of the project will be completed in 5 years and 8 months at an approved cost of Rs. 309.558 billion.

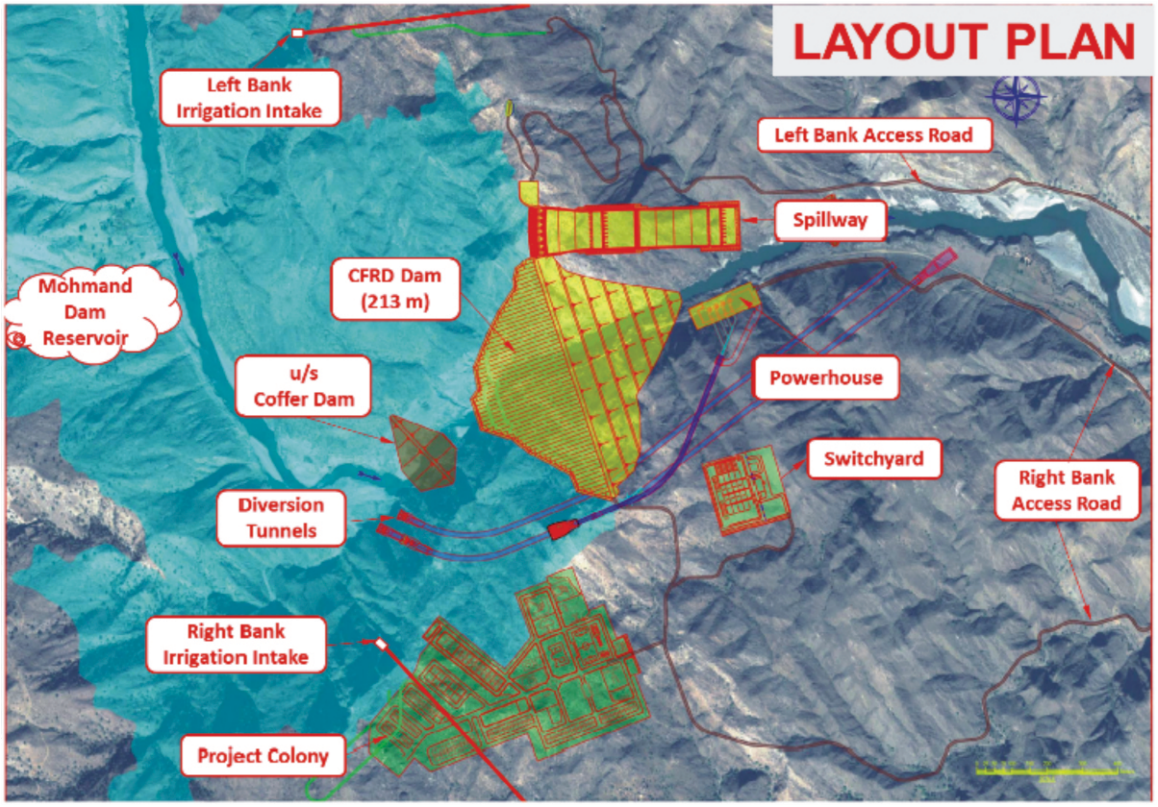
FUNDING STRATEGY

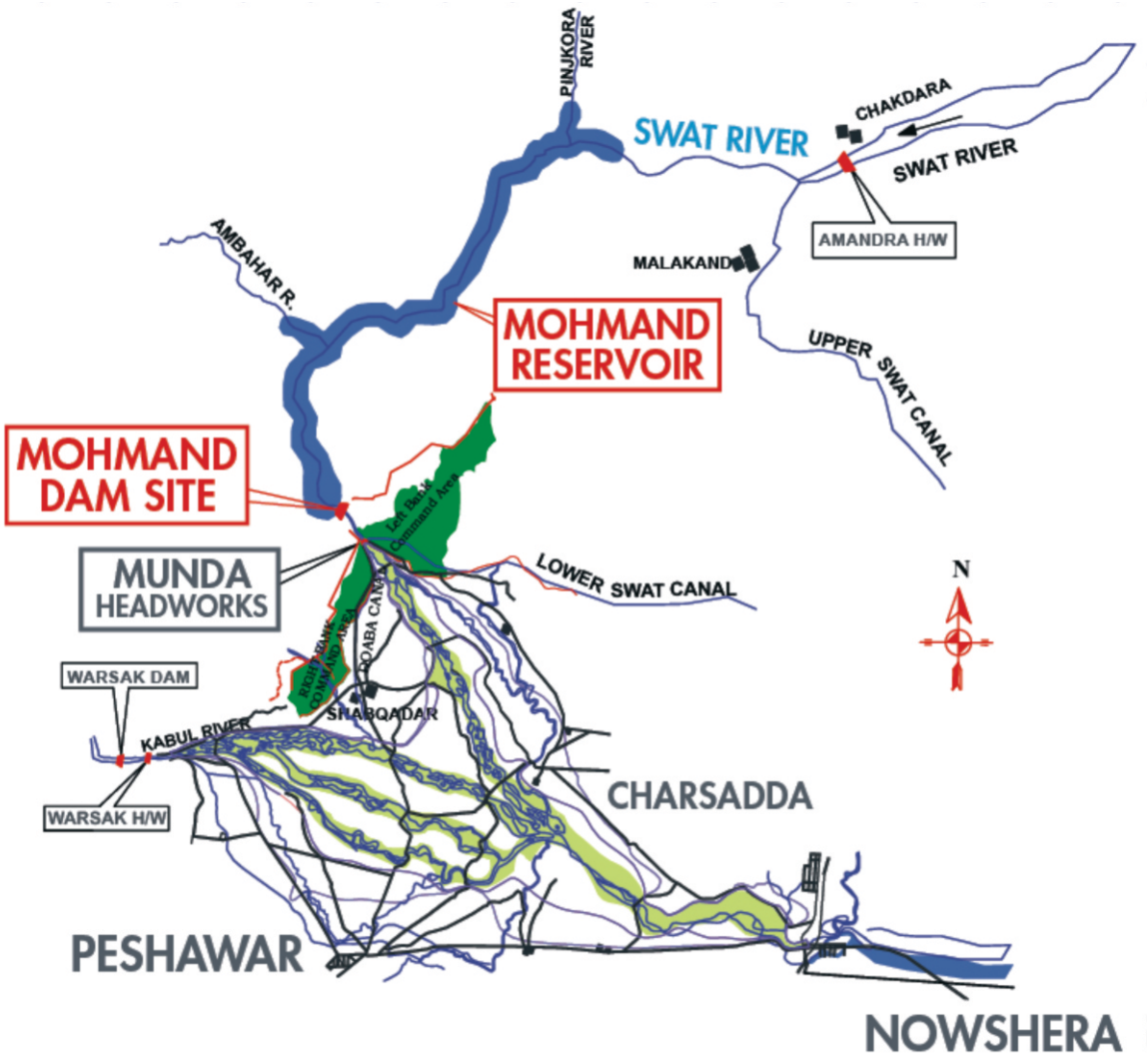
Component	Source	% age
Dam Part	PSDP Grant	**100**
Power Generation Facility (Cost recoverable through Tariff)	**Equity** WAPDA's own Resources	**20**
	Debt Foreign Commercial Financing Local Commercial Financing	**80** 45 35
		100

SALIENT FEATURES

Description	Engineering Design
Dam Height	213 M
Reservoir Capacity Gross Storage Flood Storage (MCM)	 1.2 MAF 100 MCM
Installed Capacity	800 MW
Annual Energy	2.86 Billion Units
Probable Maximum Flood	27,427 Cumecs
Spillway Capacity	25,514 Cumecs
Culturable Command Area Left Bank Right Bank	 3,649 Hectare 3,124 Hectare
Project Cost	**Rs. 309.558 Billion**
IERR	**21.12 %**




LAYOUT PLAN
Left Bank Irrigation Intake
Left Bank Access Road
Spillway
CFRD Dam (213 m)
Mohmand Dam Reservoir
u/s Coffer Dam
Powerhouse
Switchyard
Right Bank Access Road
Diversion Tunnels
Right Bank Irrigation Intake
Project Colony



LEGEND

- RIVER / NALLAH
- CITY / TOWN / VILLAGE
- CANAL
- RAILWAY LINE
- ROAD
- NORMAL YEAR INUNDATION AREA





TECHNICAL VISIT TO ATLAS HONDA COMPANY PAKISTAN

A 13-Member delegation of the Congress paid a Technical Visit to Atlas Honda Company Plant on September 6, 2018 at Manga Mandi on Raiwind Road, Lahore. The Company is a leading motorcycle manufacturers of the country. It is producing 125 cc motorcycle and plans to raise the output to 1.5 million units.

A new 2-wheeler variant with the Chinese collaboration is also on the cards. The company is also contributing to export trade by exporting the 2-wheeler to Sri-Lanka, Bangladesh and Afghanistan as well as providing comparatively cheap means of transportation within the country.

UN SAYS GREENHOUSE GAS LEVELS IN ATMOSPHERE HIT NEW HIGH

GENEVA: The levels of greenhouse gases in the atmosphere, the main driver of climate change, have hit a new high, the UN said on Thursday, warning that the time to act was running out.

Ahead of the COP 24 climate summit in Poland next month, top United Nations officials are again trying to raise the pressure on governments to meet the pledge of limiting warming to less than two degrees Celsius, as enshrined in the 2015 Paris accord.

'Without rapid cuts in CO2 and other greenhouse gases, climate change will have increasingly destructive and irreversible impacts on life on Earth,' the head of the World Meteorological Organisation Petteri Taalas said in a statement. 'The window of opportunity for action is almost closed.

In an open letter to all states ahead of COP 24, UN rights chief Michelle Bachelet warned of cataclysmic consequences if the world did not reverse course.

'Entire nations, ecosystems, peoples and ways of life could simply cease to exist,' she said, citing evidence that nations are not on track to meet the commitments made in Paris.

US President Donald Trump, who pulled his government out of the Paris agreement, again on Thursday appeared to cast doubt on climate science.

'Brutal and Extended Cold Blast could shatter ALL RECORDS Whatever happened to Global Warming?' he said in a tweet.

Asked to respond to Trump, deputy WMO chief Elena Manaenkova told reporters that the science underpinning global warming was 'unequivocal', without challenging the US leader directly.

The Greenhouse Gas Bulletin, the UN weather agency's annual flagship report, tracks the content of dangerous gases in the atmosphere since 1750.

This year's report, which covers data for 2017, puts the concentration of CO2 in the atmosphere at 405.5 parts per million (ppm).

That is up from 403.3 ppm in 2016 and 400.1 ppm in 2015.

'The last time the Earth experienced a comparable concentration of CO2 was 3-5 million years ago, when the temperature was 2-3C warmer,' Taalas said.

Researchers have made reliable estimates of CO2 concentrations rates going back 800,000years using air bubbles preserved in ice in Greenland and Antarctica. But by studying fossilised material the WMO also has rough CO2 estimates going back up to five million years.

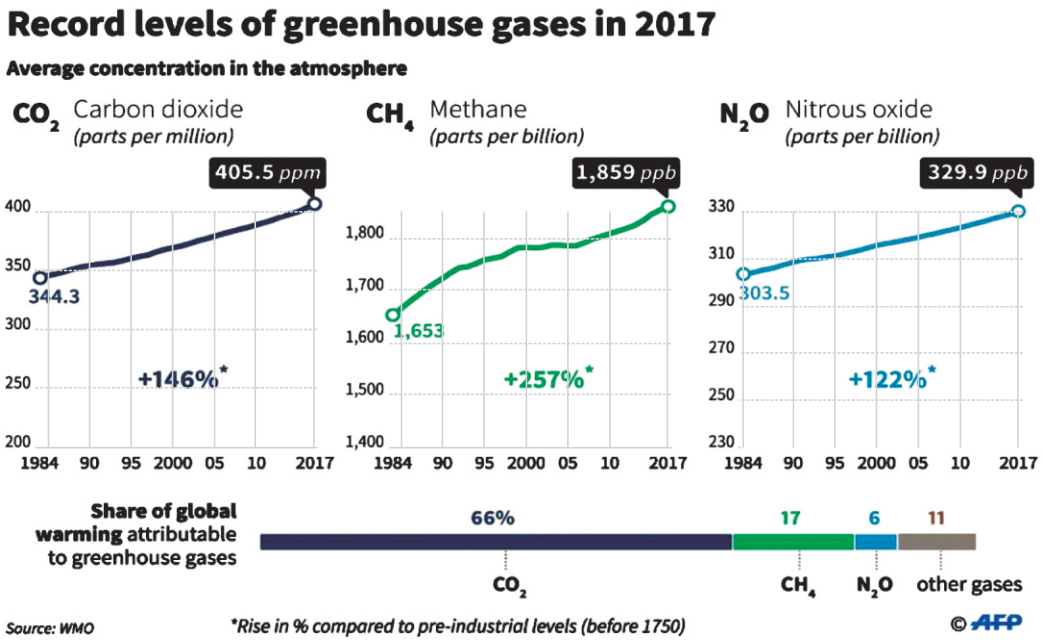
In addition to CO2, the UN agency also highlighted rising levels of methane, nitrous oxide and another powerful ozone depleting gas known as CFC-11.

Emissions are the main factor that determines the amount of greenhouse gas levels, but concentration rates are a measure of what remains after a series of complex interactions between atmosphere, biosphere, lithosphere, cryosphere and the oceans.

Roughly 25 per cent of all emissions are currently absorbed by the oceans and biosphere a term that accounts for all ecosystems on Earth. The lithosphere is the solid, outer part of the Earth, while the cryosphere covers that part of the world covered by frozen water.

The UN's Intergovernmental Panel on Climate Change (IPCC) has said that in order to keep warming below 1.5 degrees Celsius, net CO2 emissions must be at net zero, meaning the amount being pumped into the atmosphere must equal the amount being removed, either though natural absorption or technological innovation.-

AFP



(Courtesy: Dawn of 23-11-2018)

DEFORESTATION IN THE BRAZILIAN AMAZON REACHES DECADE HIGH



The destruction of Brazil's Amazon rainforest reached its highest level in a decade this year, government data released on Friday showed, driven by illegal logging and the encroachment of agriculture on the jungle.

Satellite images for the 12 months through the end of July 2018 showed that 7,900 square kilometers (3,050 square miles) of forest were cleared in the Amazon, equivalent to more than half the territory of Jamaica. That was a 13.7 percent increase from the same period in the prior year.

Deforestation is a key factor behind global warming, accounting for around 15 percent of annual emissions of heat-trapping gases, similar to that of the transportation sector. On Friday, a U.S. government report found that climate change will cost the United States hundreds of billions of dollars by the end of the century.

Brazil's environment minister Edson Duarte said in a statement that illegal logging was the main factor behind the increase in deforestation in the Amazon. He called on the government to increase its policing of the jungle.

The states of Pará and Mato Grosso were the largest contributors to the deforestation increase. Mato Grosso is Brazil's top grains producer, leading Brazil's booming soybean output.

Brazil's Climate Observatory, a network of non-governmental organizations, said in a separate statement that the increase was not a surprise. Besides illegal logging, it said Brazil's growing commodities sector was contributing to forest destruction as farmers sought to expand.

Marcio Astrini, from the local office of Greenpeace, said the Brazilian government had not done enough to fight deforestation and recent policy moves such as ones reducing areas under federal protection fueled environmental destruction.

Both groups said they were worried that deforestation could increase further during the government of President-elect Jair Bolsonaro, due to take office in January. He has sharply criticized the Brazilian environmental protection agency, and the agriculture sector is one of his main political bases.

Despite the recent rise, deforestation remains sharply below the levels recorded in the early 2000s, before the Brazilian government launched a strategy to fight forest destruction. In 2004, for example, more than 27,000 square km were cleared, an area the size of Haiti.

Scientists consider the Amazon as one of nature's best protections against global warming, as it acts as a giant carbon "sink" by absorbing the gas. The jungle is also rich in biodiversity, hosting billions of species yet to be studied.

(Courtesy: Daily Times of Sunday, November 25, 2018)

TEST PROVES TARBELA 4 PROJECT'S EFFICIENCY HIGHER THAN ENVISAGED

T4 PROJECT CONTRIBUTES 1.26 BILLION UNITS TO NATIONAL GRID SINCE COMMISSIONING

TARBELA 4, OTHER PROJECTS INCREASE PEAK HYDEL GENERATION BY 46%

November 24, 2018: The Pakistan Water and Power Development Authority (WAPDA) successfully carried out simultaneous load rejection test of all three units of Tarbela 4th Extension Hydropower Project. The test was conducted at the load of about 1100 Mega Watt (MW) under the supervision of the Consultants and the Contractor of the project. The simultaneous load rejection test was aimed at testing the stability of under-water parts and rise in speed and pressure of the turbines. Simultaneous load rejection test is carried out once a hydropower project is complete and its all generating units are fully operational.

Turbine efficiency test was also carried out last week under the supervision of International Expert, hired for the purpose. The test ascertained that the turbine efficiency was more than the efficiency envisaged during the model testing of the turbines.

The completion of Tarbela 4th Extension and Neelum Jhelum hydropower projects this year has exerted positive impact on overall hydel generation, as it surged to 5241 MW during the peak hours yesterday, registering an increase of about 46 percent if compared with 3581 MW, generated on this day last year.

Since its commissioning, Tarbela 4th Extension Hydropower Project has so far contributed 1.26 billion units of low-cost hydel electricity to the National Grid despite low flows of water this year.

The 1410 MW-Tarbela 4th Extension Hydropower Project has been constructed on Tunnel No. 4 of Tarbela Dam. The Project has three generating units, each of them having capacity of 470 MW. The project will provide 3.84 billion units of electricity on the average to the National Grid per annum. Annual benefits of the project have been estimated at Rs. 30 billion. With completion of Tarbela 4th Extension Hydropower Project, the installed capacity of Tarbela Hydel Power Station has increased from 3478 MW to 4888 MW.

###

MOODY'S TERMS IMF BAILOUT CRUCIAL FOR PAKISTAN

By:

Shahbaz Rana

Ratings agency says the bailout will help meet external financing needs of $30b

An International Monetary Fund bailout programme is crucial for Pakistan to meet its $30 billion external financing needs, said Moody's Investors Service while casting doubt over the government's plan to restrict the budget deficit to $.1% of COP without additional measures. "An IMF programme will not only bridge the financing gap but will also serve as a strong signal to other official sector creditors that will be crucial to meet financing requirements over coming years." said Moody's, a credit rating agency, in its country assessment report.

Ongoing implementation of CPEC projects, which will likely be 9% to 10% of GDP in this fiscal year, and higher oil prices will keep the import bill elevated.

Moody's has estimated Pakistan's gross external financing needs for ongoing fiscal year at around $30 billion, of which around $8 billion are the government's external repayments, The financing gap is likely to be $8 billion to $9 billion, taking into account the government's borrowing plans and Moody's expectations of capital inflows including foreign direct investment and portfolio flows, it added.

These assessments are largely in line with the finance ministry's estimates, which have become the base for approaching the base for approaching the IMF for a bailout package. The Fund's team is coming early next month.

Moody's said a more front-loaded programme would provide greater market confidence when Pakistan's Eurobond and Sukuk repayments totalling $1 billion each are due in April and December 2019.

Moody's has again highlighted high external and fiscal challenges, particularly in light of investments, imports and external borrowing related to projects under the China-Pakistan Economic Corridor (CPEC). But it said the government had pledged a reform-based policy agenda, including raising economic competitiveness through pro-business policies, addressing corruption issues, reforming state-owned enterprises, enforcing greater discipline in government spending and broadening the tax base.

The ratings agency said the programme would be credit-positive for Pakistan because access to a cheap, stable source of external financing would provide immediate support to the government's external financing needs. Additionally, support and technical assistance from the IMF would aid macroeconomic rebalancing and the government's structural reform agenda.

Macroeconomic and external imbalances have risen since the country's previous IMF programme ended in 2016. In particular, foreign exchange reserves have fallen

to low levels, sufficient to cover barely two months of goods imports and below the IMF $ minimum adequacy threshold of three months.

Moody's has projected budget deficit of 5.4% of GDP or Rs.2.1 trillion, which is higher than the revised target of 5.1%.

The Pakistan Tehreek-e-Insaf (PTI) government has enforced the mini-budget to achieve 5.1% deficit target by introducing new tax measures and cutting development spending.

The ratings agency said despite the State Bank of Pakistan letting the rupee depreciate approximately 25% against the US dollar and hiking its policy rate by a cumulative 275 basis points since December 2017, the current account deficit remains wide. It has projected the current-account deficit equal to 4.6% of GDP in the current fiscal year, which is lower than the last year's deficit.

Macroeconomic and external imbalances have risen since the country's previous IMF programme ended in 2016

Moody's said external and fiscal risks would remain significant, in the absence of further macroeconomic adjustments. Ongoing implementation of CPEC projects, which will likely be 9% to 10% of GDP in this fiscal year, and higher oil prices will keep the import bill elevated.

It said the government's export package in June 2018 was ex tended for three years through fiscal 2021 and is designed to boost export competitiveness and incentivise investment in export-oriented production by removing customs duty on export goods, reducing sales tax on exporters' inputs and providing subsidies on certain raw materials.

Although this extension will benefit exports, they remain half the level of goods' imports. Higher government spending has also contributed to the macroeconomic imbalance, according to the ratings agency.

(Courtesy Express Tribune 19.10.2018)

SCIENTISTS: WORLD'S WARMING; EXPECT MORE INTENSE HURRICANES

A warmer world makes for nastier hurricanes. Scientists say they are wetter, possess more energy and intensify faster. Their storm surges are more destructive because climate change has already made the seas rise. And lately, the storms seem to be stalling more often and thus dumping more rain.

Study after study shows that climate change in general makes hurricanes worse. But determining the role of global warming in a specific storm such as Hurricane Florence or Typhoon Mangkhut is not so simple — at least not without detailed statistical and computer analyses.

The Associated Press consulted with 17 meteorologists and scientists who study climate change, hurricanes or both. A few experts remain cautious about attributing global warming to a single event, but most of the scientists clearly see the hand of humans in Florence.

Global warming didn't cause Florence, they say. But it makes the system a bigger danger.

"Florence is yet another poster child for the human-supercharged storms that are becoming more common and destructive as the planet warms," said Jonathan Overpeck, dean of the environment school at University of Michigan. He said the risk extends beyond the Atlantic Ocean, such as Typhoon Mangkhut, which hit the Philippines on Friday.

For years, when asked about climate change and specific weather events, scientists would refrain from drawing clear connections. But over the past few years, the new field of attribution studies has allowed researchers to use statistics and computer models to try to calculate how events would be different in a world without human-caused climate change.

A couple of months after Hurricane Harvey, studies found that global warming significantly increased the odds for Harvey's record heavy rains.

"It's a bit like a plot line out of 'Back to the Future,' where you travel back in time to some alternate reality" that is plausible but without humans changing the climate, said University of Exeter climate scientist Peter Stott, one of the pioneers of the field.

A National Academy of Sciences report finds these studies generally credible. One team of scientists tried to do a similar analysis for Florence, but outside experts were wary because it was based on forecasts, not observations, and did not use enough computer simulations.

As the world warms and science advances, scientists get more specific, even without attribution studies. They cite basic physics, the most recent research about storms and past studies and put them together for something like Florence.

"I think we can say that the storm is stronger, wetter and more impactful from a coastal flooding standpoint than it would have been BECAUSE of human-caused warming," Pennsylvania State University climate scientist Michael Mann wrote in an

email. “And we don’t need an attribution study to tell us that in my view, we just need the laws of thermodynamics.”

Georgia Tech climate scientist Kim Cobb looks not just at basic physics but all the peer-reviewed studies that especially link climate change to wetter storms.

“We have solid data across decades of rainfall records to nail the attribution — climate change is increasing the frequency of extreme rainfall events,” Cobb said.

Several factors make scientists more confident in pointing the climate-change finger at Florence.

For every degree the air warms, it can hold nearly 4 percent more water (7 percent per degree Celsius) and offer measurably more energy to goose the storm, scientists said.

“The amount of water that comes out of hurricanes is certainly the most robust connection that we have,” National Oceanic and Atmospheric Administration climate scientist Jim Kossin said.

And to look at Florence specifically, “it’s very likely that climate change has warmed the ocean such that the hurricane’s intense rainfall is more destructive than without global warming,” said Weather Underground Meteorology Director Jeff Masters, a former hurricane hunter.

The warmer air and water also makes storms more intense or stronger, Stott said.

(Courtesy Daily Times, September 16th, 2018.)

ARGENTINA BETS ON $600M SATELLITE TO BOOST AGRICULTURE

Radar antennae technology will allow prediction of harvest yields, floods and droughts

BUENOS AIRES

Argentina is launching a new microwave imaging satellite to monitor natural disasters and soil moisture in a long-term bid to bolster the farm sector, an industry that has historically been the backbone of the country's economy.

Scheduled to launch on a SpaceX Falcon rocket from Vandenberg Air Force Base in California on October 6, Argentina's Saocom 1a satellite "is going to boost the high-quality precision agriculture Argentina relies on," President Mauricio Macri told farmers and industry representatives last week.

Scientists say the soil and sub-surface mapping data provided by the $600-million project should help increase crop yields.

The radar antennae technology will allow Argentina to access a real time water map', almost unique in the world, which will allow for prediction of harvest yields, floods and droughts, the government said.

Argentina's already-struggling economy has suffered a series of setbacks since Macri took power, led by a drought that sapped grain exports earlier this year and a sharp devaluation of its peso currency that prompted the government to seek a $50-billion standby financing deal with the International Monetary Fund.

The government announced earlier this month it would institute fiscal belt-tightening measures, including a tax on the country's primary exports like corn, wheat and soy.

"This mission will be incredibly valuable to the country's farmers. We are hoping that the information will provide a $5-7 return on every dollar invested," said Raul Kulichevsky, Executive and Technical Director for Argentina's National Space Activities Commission (CONAE).

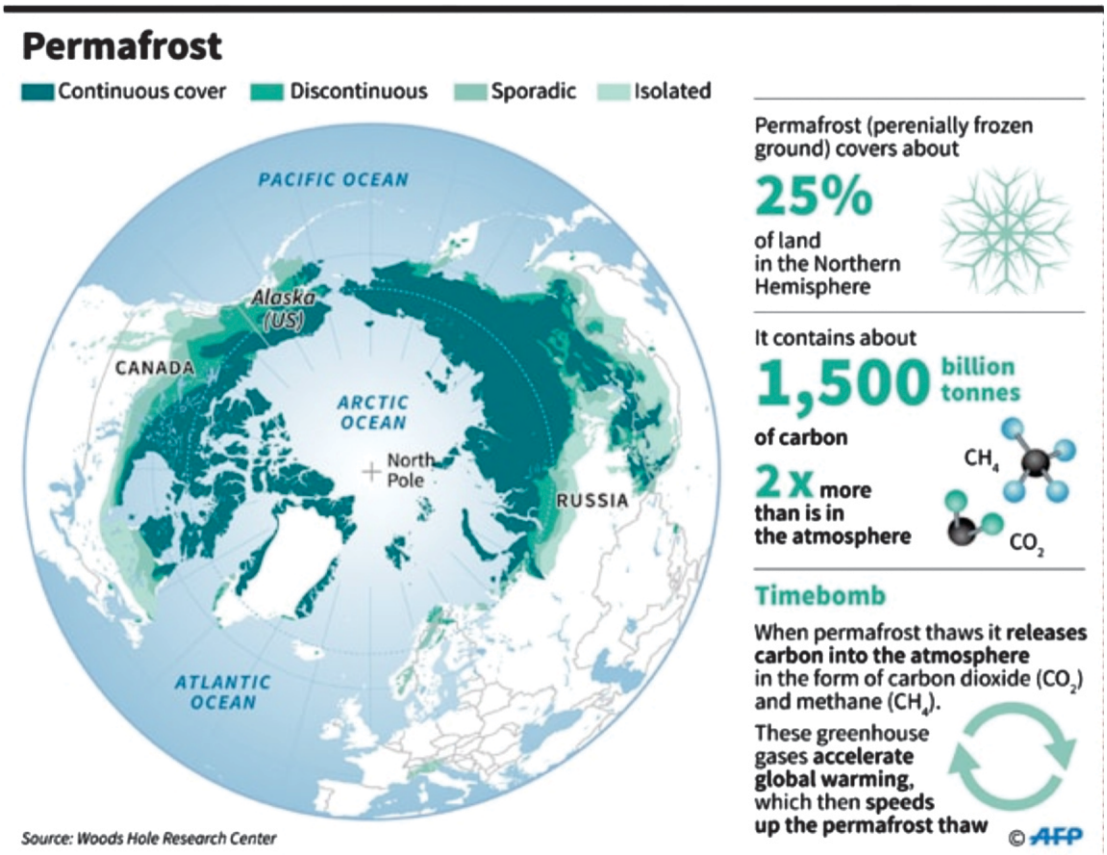
While Argentina's previous satellites have relied on optical surveying, scientists say the Saocom mission will provide precision X-ray and microwave imaging across Argentina's grain-producing plains, regardless of weather or time of day.

"This technology is novel and has never before been used in Argentina. It is the product of 10 years of research," Head Researcher on the Saocom mission, Laura Frulla, said in an interview, But the project will not provide much help to Argentina's cash-strapped economy in the short term, according to analysts.

"Farmers depend on these satellites to ensure good crop yields, but given that this won't become operative until June 2019, there is little it can do to help Argentina's current economic situation," said German Heinzenknecht, weather specialist at the Applied Climate Consultancy.

(Courtesy: Express Tribute: 24th September, 2018)

MELTING PERMAFROST THREATENS CLIMATE RESCUE PLAN, NEW RESEARCH SHOWS



PARIS: Global targets aimed at warding off runaway planetary warming could be breached sooner than expected, experts warned on Monday, as gases released by melting permafrost threaten to undermine human efforts to avert climate disaster.

Under the current rescue plan, outlined in the 2015 Paris climate treaty, countries have agreed to limit global temperature rises to “well below” two degrees Celsius, and 1.5C if deemed possible.

That course of action assumes that dealing with manmade greenhouse gases — whether by slowing their emissions or removing them from the atmosphere — will be enough to bring global warming under control.

What climate models do not allow for are scenarios in which Earth begins to contribute to the problem, new research shows.

A team of experts from the International Institute for Applied Systems Analysis (IIASA) in Austria said on Monday they had for the first time included projected emissions from melting permafrost in global climate change models, and the results prompted concern.

“Permafrost carbon release is caused by global warming, and will certainly diminish the budget of CO2 we can emit while staying below a certain level of global warming,” said IIASA research scholar and lead study author Thomas Gasser.

As reliance on fossil fuels persists, scientists have calculated that we are likely to "overshoot" the Paris temperature targets in the short to medium term.

With only 1C of warming above pre-industrial levels so far, the world's permafrost is already thawing, albeit slowly. But the rate of that melting is sure to accelerate as Earth continues to heat up.

Gasser warned that the overshoot scenario would leave the planet even more vulnerable to permafrost emissions and, in a vicious feedback loop, even more warming.

"Overshooting is a risky strategy, and getting back to lower levels after overshooting will be extremely difficult," Gasser said. "We have to prepare ourselves for the possibility that we may never get back to safer levels of warming."

The problem with the Paris goals, according to Gasser, is that they set emissions targets based on the assumption that global temperature and atmospheric CO2 levels change in lock-step.

They therefore allow countries to exceed the targets on the condition that enough carbon can be captured from the air to bring temperatures back down by the end of the century.

But permafrost is subject to what scientists call a "tipping point", meaning that beyond a certain temperature threshold, it will continue to melt and release greenhouse gases in a self-perpetuating feedback loop independent of falling emission levels.

As the world struggles to curb manmade carbon pollution that amplifies the likelihood and intensity of deadly superstorms, heatwaves and droughts, Monday's study will add to fears that Earth itself could overwhelm efforts to limit climate change.

(Courtesy: Dawn, September 18th, 2018)

HYDROELECTRIC POWER
WORLD BANK WARNS PAKISTAN OF RISE IN DASU PROJECT COST

By:

Shahbaz Rana



HURDLES: The project, which is critical for improving the country's energy mix, faces problems despite the top priority accorded to construction of hydroelectric power schemes by the government and the judiciary.

Says project can face delay due to country's inability to resolve land disputes

As Pakistan snuggles to generate resources to build dams, the World Bank has warned that the cost of $4.3-billion Dasu hydroelectric power project may increase and it can face delays due to the country's inability to resolve disputes over land acquisition. World Bank Country Director to Pakistan Patchamuthu Illango met Minister for Planning Khusro Bakhtiar on Wednesday, seeking intervention of his office in order to prevent the 2,160-megawatt clean energy project from complete derailment.

Usual bureaucratic inefficiencies and procedural hurdles are at the heart of the problem, according to people engaged in the construction of the project.

The Washington-based lender approved a loan of $588.4 million for the construction of the run-of-the-river project in June 2014. It has also extended a partial credit guarantee of $460 million to pave the way for arranging commercial loans to meet the remaining financing requirements.

Owing to slow physical progress, the World Bank released only $176 million or nearly 30% of its loan component by April this year, according to a project progress report of the lender.

The bank cautioned Pakistani authorities that civil works may not be completed by the June 2021 deadline, sources told The Express Tribune.

The project, which is critical for improving the country's energy mix, faces problems despite the top priority accorded to construction of hydroelectric power schemes by the government and the judiciary. The military has also recently contributed over Rs. One(1) billion to the Diamer-Bhasha and Mohmand Dam Fund.

However, it seems that no one will be penalised for creating hurdles in the way of completing the foreign-funded Dasu project.

Due to the poor pace of work, the World Bank has kept progress rating of the first phase of the project unchanged at ‘moderately satisfactory' for the last two years. The project, however, has enjoyed 'satisfactory' raring in terms of expanding the hydroelectric power supply in Pakistan.

The latest progress report of the international lender also mentioned that "further expansion of main works is currently being limited by delays in land acquisition for the construction area".

The June 2018 report added that acquisition of land close to the dam's site area over the next six months was crucial to not cause cost overrun and delay in project implementation.

The office of Deputy Commissioner Upper Kohistan and Project Management Unit of the Water and Power Development Authority (Wapda) are handling land acquisition for the project.

Despite taking services of the provincial land Revenue Department, the people concerned have failed to finish paperwork for land acquisition from the locals.

It is a "high-risk high-reward" project aimed at providing low-cost, non-carbon renewable energy

The Executive Committee of National Economic Council had approved land acquisition rates in mid-2015.

The last PML-N government gave preference to the Dasu hydroelectric power project over the Diamer-Bhasha Dam. Despite that, Wapda could not take appropriate measures to put the project on fast track.

Last progress review report showed that work on transmission lines of the scheme has been finalised by only 35%. Main civil work is focused on finalising temporary work areas such as camps, batching plant and construction of a bridge across the Indus River.

It is a "high-risk high-reward" project aimed at providing low-cost, non-carbon renewable energy.

The World Bank has now described the overall risk in completion of the project as high.

Illango is said to have raised the issue of delay in approval of project documents by the Planning Commission. Sponsoring ministries and project approval authorities take up to two years in just giving necessary approvals, which also affect business operations of the lender, officials said.

(with the Courtesy of THE EXPRESS TRIBUNE 20-9-2018)

PAKISTAN, RUSSIA TO INK $10 BILLION OFFSHORE PIPELINE DEAL THIS WEEK

By:

Zafar Bhutta



PLAN: Russia's energy giant Gazprom would conduct feasibility study on its own expenses to assess economic viability and cost of the project.

Gas supply

Delegation is leaving for Moscow; project will meet energy needs of SEZs

In a major breakthrough, Pakistan and Russia are set to sign a $10-billion offshore gas pipeline deal on September 27 in Moscow, a project planned by the latter to capture the energy market of Pakistan.

Sources told The Express Tribune that the cabinet, had approved the signing of the gas pipeline deal with Moscow.

Interstate Gas Systems (ISCS) - a state-owned Pakistani company established to handle gas import projects and is already working on schemes like Turkmenistan-Afghanistan-Pakistan-India (Tapi) gas pipeline - has been designated by Pakistan for executing the pipeline project along with Russia's energy giant Gazprom. A Pakistani delegation will leave for Moscow to sign the multibiliion-dollar deal.

Talking to The Express Tribune, ISCS Managing Director Mobin Saulat acknowledged that the agreement would be inked in Moscow on September 27. He revealed that Cazprom would conduct the feasibility study on its own expenses to assess economic viability and cost of the project.

"China-Pakistan Economic Corridor (CPEC) has now entered the industrialisation phase and needs gas for duty and tax-free Special Economic Zones (SEZs)," he said. "The offshore gas pipeline will meet energy needs of industries being set-up in the economic zones along CPEC route."

According to officials, the pipeline will connect Pakistan and Russia and act as an energy corridor between the two countries. "Strategically, it is a very important project as the two countries will come closer to each other," an official said. "At the same time, Pakistan will gain access to the Russian market in order to boost its overall exports which remained stagnant." Russia has nominated Public Joint Stock Company Cazprom for implementation of the project. Pakistan's cabinet has permitted the company to conduct the feasibility study at its own cost and risk.

Separately, ISCS is working on the $10-billion Tapi gas pipeline which will connect South and Central Asia. Construction work on the scheme in Pakistan is planned to start in March 2019.

These projects are termed game changer for Pakistan as they will not only lead to regional connectivity, but will also meet growing energy needs of the country.

Owing to a long-running tussle with Europe and the

United States over the annexation of Ukrainian region of Crimea, Russia is looking for alternative markets and wants to capitalise on the increasing energy demand in South Asia.

Russia has been a huge gas exporter to European Union (EU) countries and Turkey since long and despite US anger, Moscow has continued to provide gas to them. Moscow receives gas from Turkmenistan and then exports it to EU states.

Pakistan has been experiencing gas crisis, particularly in winter, for the past many years as domestic production has declined with new additions being offset by depleting old deposits. In a bid to tackle the crisis, the government started liquefied natural gas (LNC) imports from Qatar under a 15-year agreement and brought supplies from other sources as well.

According to a government official, after signing of the memorandum of understanding (MoU) for the offshore pipeline, work on the feasibility study will begin. Russian gas exports touched an all-time high in 2017. According to Cazprom, gas flow to Europe and Turkey, excluding ex-Soviet states, hit a new daily record of 621.8 million cubic metres.

REVISED UPWARDS

OGRA increases wellhead gas prices of 23 fields

Islamabad. The Oil and Gas Regulatory Authority (Ogra) has increased wellhead gas prices of 23 fields with effect from July 1, 2018.

Following the price revision, gas utilities including Sui Southern Gas Company and Sui Northern Gas Pipelines will file requests for increase in consumer tariff, which will come into effect on December 31, 2018.

According to the notification, the highest 35% increase has been made in the wellhead price of Mari field from RS141.15 per million British thermal units (mmbtu) to RS189.16 per mmbtu. This has been attributed to the revision in the Petroleum Policy 2012 in an attempt to encourage gas production.

Similarly, the wellhead price for Loti gas field has been increased by 11%. The price will now go up from RS152.99 per mmbtu to RS168.28.

For the Meyal and Dhulian gas field, the wellhead price has been increased by 10%. Its revised rate will rise from RS143.16 per mmbtu to Rs157.46.The price for Daru gas field has been raised to RS157.46 per mmbtu from RS143.16, up 10%.

(With the Courtesy of THE EXPRESS TRIBUNE 26-9-2018)

THE AMAZON ON THE BRINK

By:

Philip Fearnside and Richard Schiffman

Dr. Fearnside is an ecologist based in Brazil; Mr. Schiffman is an environmental journalist.

The Trump administration is not the only government that has been busy slashing funds for environmental protection. Brazil has been doing the same.

While Mr. Trump makes no bones about his desire to roll back environmental laws, Brazil's president, Michel Temer, a signatory of the Paris climate agreement, has sent mixed signals. To his credit, Mr. Temer pledged in Paris to cut his country's carbon dioxide emissions 37 percent below 2005 levels by 2025.

His actions since then tell a different story. Last year, the Environment Ministry's budget was cut nearly in half, as part of a national austerity plan amid Brazil's punishing recession. And the agency responsible for protecting Brazil's vast system of indigenous reserves is being virtually dismantled by draconian staff cuts.

Funding for critical law enforcement to protect the rain forest from illegal timber cutting has also been decimated. In 2017, Brazil was the most dangerous country in the world for people defending the land or the environment, according to a tally by the group Global Witness, in collaboration with The Guardian newspaper. Forty-six people died. (The Pastoral Land Commission, a private advocacy group in Brazil for the rural poor, said at least 65 rural activists were murdered in disputes over development.)

A chain saw used for illegal logging in the Alto Rio Guamá Indigenous Territory in Brazil, abandoned by loggers who fled when government agents raided the site last year.

If the government's retrenchment on environmental protection continues, there may soon be nothing to stop the chain saws on the Amazonian frontier, where the rule of law can be weak and land is frequently seized and cleared illegally. This has implications beyond Brazil. The Amazon's lush forests make up the largest reserve of carbon dioxide on the surface of the earth. This potent greenhouse gas is released when forests are burned or bulldozed and left to decay.

Brazilians are going to the polls on Oct. 7 to choose among nine candidates for the presidency, with a likely runoff later in the month between the top two vote-getters. The outcome will bear significantly on the future of the Amazon.

The current front-runner, Jair Bolsonaro, is a climate-change skeptic who has been called "the tropical Trump." He has threatened to take Brazil out of the Paris climate accord. Another of the leading contenders, the former São Paulo mayor Fernando Haddad, is regarded as a moderate on the environment. Marina Silva, who as Brazil's environment minister pushed to limit deforestation and encourage sustainable development in the Amazon, is running well behind in the latest polls.

Deforestation rates have been trending mostly upward since 2012 and will surely escalate if a raft of proposed laws and regulatory changes to weaken environmental protections are enacted. Brazil lost 2,682 square miles of Amazonian forests in 2017. That is almost nine times the size of New York City and 78 percent above the government's own target for meetings its obligation under the Paris accord.

In an analysis published in July in the journal Nature Climate Change, 10 Brazilian scientists concluded that "the abandonment of deforestation control policies and the political support for predatory agricultural practices" will make it impossible for Brazil to reduce carbon dioxide emissions to the level the country promised in Paris. Continued weak environmental governance, the scientists warned, could lead to the loss of up to 17,000 square miles of rain forest a year, endangering the entire Amazon ecosystem.

Why this change in policy? The scientists put it succinctly: "In exchange for political support, the Brazilian government is signaling landholders to increase deforestation."

President Temer's minister of justice is pushing plans to allow agribusiness to rent indigenous land that had been off limits to developers. Other proposals would effectively freeze the creation of new protected areas, open others to resource exploitation and block the mapping of boundaries of indigenous lands, potentially opening native communities and their forests to invasion by miners and ranchers.

Indigenous territories contain more forest than all of the government's conservation units combined, and historically Brazil's native peoples have been far more effective in defending the rain forest than the government or private landowners.

The anti-environment agenda is being pushed by of a coalition of large landowners and agribusinesses in Congress (the "bancada ruralista" or so-called ruralists). Regular revelations of corruption involving government ministers, legislators — and also, President Temer himself — have provided them with cover to pursue regressive measures, like a proposed constitutional amendment that would prevent Brazil's regulators from blocking environmentally unsound road and development projects.

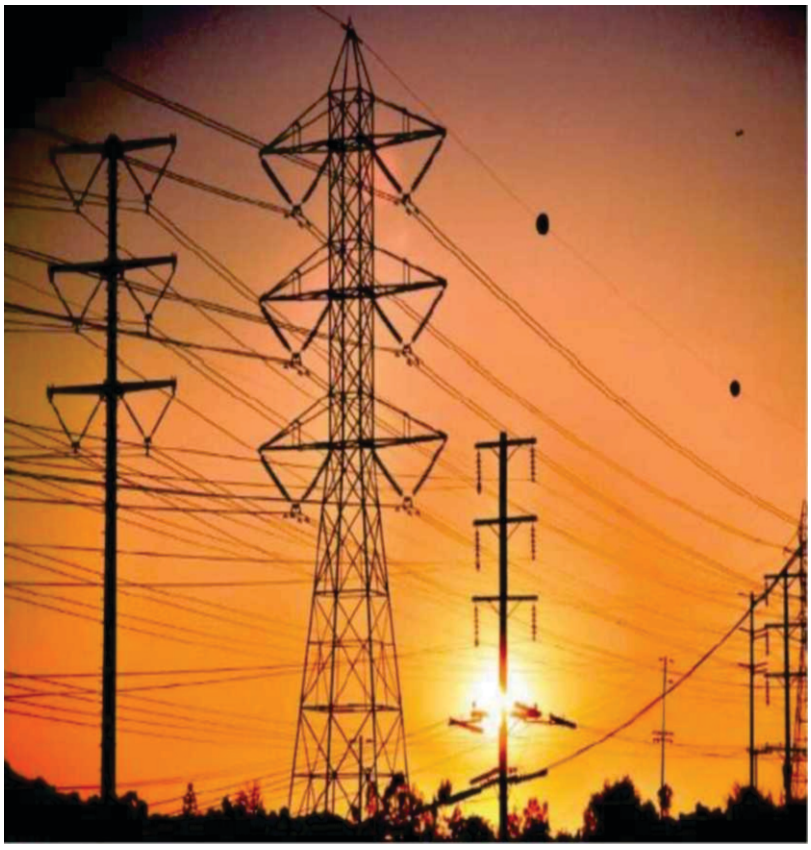
Scores of such projects planned for inaccessible regions of the Amazon may be fast-tracked should the amendment pass and the environmental review process is gutted as a result, as now seems likely. For example, the 540-mile long BR-319 highway would, if completed, open a vast area in the central and northern Amazonia to deforestation.

Not only is little being done to prevent illegal land use, some laws have encouraged it. Last year, the "grileiro" or land-grabber, law legalized tracts of nearly 6,200 acres that were taken illegally — a boon to land speculators and others who seize public lands for their own use.

SWISS ABB LIKELY TO WIN CONTRACT FOR CONVERTER STATIONS

By:

Zafar Bhutta



COST-CUTTING: Originally, three converter stations were planned as part of the Casa project. However, the number of stations has been brought down to two, which will substantially reduce the cost of the project.

CASA-1,000 Project

Germany's Siemens and France's Atom are also contesting to get the contract.

Switzerland-based company ABB is likely to clinch a multimillion-dollar contract for establishing converter stations in Tajikistan and Pakistan for the transmission of electricity under the Central Asia-South Asia (Casa) 1,000 power supply project through an energy corridor.

Three well-reputed European companies which included ABB, Siemens of German}' and Alstom of France had expressed interest and submitted bids for setting up the converter stations.

According to sources, ABB may be declared the successful bidder in the financial bids which are being evaluated. One station each will be set up in Tajikistan and Pakistan. Earlier, bids had been invited one year ago for setting up the converter

stations, which convert high-voltage direct current into alternating current or the reverse, but they were revoked due to high offer prices.

Originally, three converter stations were planned as part of the Casa project. However, the number has been brought down to two, which will substantially reduce the cost of the project.

The Central Asia-South Asia Regional Electricity Market is envisaged to be developed in a phased manner through institutional arrangements and infrastructure building that will utilise Central Asia's power resources to tackle energy shortages in South Asia. All countries participating in the Casa project, which will transport electricity from Tajikistan and Kyrgyzstan to Pakistan and Afghanistan, have separate contracts for laying transmission lines in their territories. Kyrgyzstan and Tajikistan will export 1,000-1,300 megawatts of electricity to Pakistan and Afghanistan. Pakistan will consume a major share of exports whereas Afghanistan will receive around 300MW.

Officials said third-party access rules had been framed for the Casa project, which would allow a third country, originally not part of the project, to export electricity, Pakistan is also eager to purchase thermal electricity as Tajikistan will be providing hydroelectric power for only five months in a year. No hydroelectric power will be supplied by the Central Asian states in the winter season.

The regulator - National Electric Power Regulatory Authority (Nepra) - has already approved a tariff of 9.41 cents per unit for electricity import from the Central Asian states.

This includes energy charges of 5.15 cents per kilowatt-hour (kWn), transmission charges of 2.91 cents per kWh, transit fee for Afghanistan of 1.25 cents per kWh and wheeling charges for Tajikistan of 0.10 cent per kWh. Already, Pakistan is importing electricity from Iran to meet the requirement of Gwadar at a cost of 6.25 cents per unit, which is higher than the 5.15 cents that will be paid to Tajikistan.

The difference is because of the fuel as Iran consumes oil and gas for power generation while Tajikistan will supply hydroelectric power.

Tajikistan's energy sector had been showing sustainable growth for the last 15 years. Apart from big plants, there are 20 medium and 40 small hydroelectric power stations in remote mountainous areas with capacity ranging from 5 kilowatts to 1,500 kilowatts. The Casa power project will not only ease electricity shortages in Pakistan but will also replace fuel-based electricity in Pakistan and Afghanistan. It will establish Kabul as a viable transit nation and offer electricity to other countries in off-peak season.

(With the Courtesy of THE EXPRESS TRIBUNE 21-9-2018)

IRSA CALLS FOR BUILDING TWO MEGA DAMS TO ADDRESS GROWING WATER CHALLENGES

By:

Khaleeq Kiani

ISLAMABAD: The Indus River System Authority (Irsa) on Tuesday anticipated 35-40 per cent shortfall of irrigation water in Rabi season beginning Oct 1, and advised the government to start working on building at least two storage reservoirs to address the increasing future challenges.

This was concluded at a meeting of Irsa's technical committee presided over by Director Operations Khalid Idrees Rana and attended by representatives of the provinces, Wapda and Meteorological Department.

All the stakeholders submitted their estimates for the overall water availability for the upcoming cropping season that ranged between 35-40pc. Mr Rana told Dawn that Irsa would now work out average water availability on the basis of stakeholders' estimates.

A working paper would be submitted to the advisory committee that is scheduled to meet on Monday, to finalise water availability projections and distribution plan for provinces. Advisory committee is led by chairman Irsa and comprised all the four provincial members.

He said the water situation was critical. However, any western wave could bring rainfall in Dec-Jan period which may lower the shortages. Responding to a question, he said the water shortage in Rabi season at 49pc was the highest in 2001-02 in the recent history when the country achieved a bumper wheat crop as overall weather conditions turned conducive.

The water shortage stood at 36pc during the last Rabi and wheat production again touched 25.4 million tonnes, slightly below the output target.

Mr Rana said that the climate change conditions are getting serious each year, making it difficult for the authorities to firm up the water availability anticipations correctly. He said the continuous water shortages had a long term negative impact in terms of increasing stress on water table because of the greater reliance on groundwater extraction.

The farmers start relying more on groundwater extraction through tube wells to meet their crop requirements when canal water availability is below normal which also increase the output costs. He said it was also getting difficult for the authorities to manage groundwater extraction in the absence of any law.

He said that the authority believes the country needs at least two mega dams in addition to under process, Diamer-Basha Dam, otherwise the water woes would keep increasing each year.

The meeting was told that the water shortage for outgoing Kharif season was estimated at around 36pc but actual shortfall on the countrywide basis fell down to about 19pc, as of September 20, owing to good rainfall over the last two months.

As of September 20, Sindh faced the lowest water shortage of 16pc even though its parliamentarians have been raising hue and cry over excessive shortages and losses to crops.

Punjab faced about 20pc shortage while KP suffered 21pc shortage.

Balochistan on the other hand suffered the highest shortage of about 44pc even though the 1991 water accord requires no cut in water shares for Balochistan and KP because of their infrastructure constraints.

An official explained that the lowest shortage to Sindh and the highest to Balochistan was an indication that Balochistan's share was partially consumed in Sindh against which Balochistan has already complained to the Council of Common Interest (CCI).

(With the Courtesy of Dawn, September 26th, 2018)

DIAMER BASHA DAM PROJECT: PREQUALIFICATION BIDS RECEIVED FOR DAM'S CONSTRUCTION

Lahore – September 12, 2018: In the wake of Supreme Court's decision and the Government's resolve for early commencement and timely completion of Diamer Basha and Mohmand Dams, the Pakistan Water and Power Development Authority (WAPDA), while gearing up its efforts for implementation of the projects, today received pre-qualification bids at WAPDA House from as many as five joint ventures of foreign and local firms through international competitive bidding for construction of main dam and appurtenant structures of Diamer Basha Dam Project.

The pre-qualification bids will be evaluated in accordance with the bid documents and the relevant procurement rules of the Public Procurement Regulatory Authority (PPRA) and the Pakistan Engineering Council (PEC).

Diamer Basha Dam is a multipurpose project aims at water storage, flood mitigation and power generation. The project will be constructed across River Indus about 40-kilometer downstream of Chillas town. The 272-meter high Roller Compacted Concrete (RCC) Dam will have a gross water storage capacity of 8.1 million acre feet (MAF). The project will generate 4500 megawatt of electricity with annual energy generation of more than 18 billion units of low-cost and environment friendly electricity. With construction of Diamer Basha Dam Project, the life of Tarbela Dam will enhance to another 35 years.It will also have a positive impact on the annual energy generation of the projects in the downstream areas. It is estimated that the annual energy generation of the existing hydel power stations including Tarbela, Ghazi Barotha, Jinnah and Chashma will increase by about 2.5 billion per annum, while annual energy generation of the future hydropower projects including Dasu, Pattan and Thakot will also surge by another 7.5 billion units.

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Project Site - Diamer Basha Dam

NEELUM JHELUM PROJECT COMPLETES RELIABILITY TESTS COMMERCIAL OPERATION STARTED

May 04, 2018: The first unit of Neelum Jhelum Hydropower Project successfully completed the reliability test today, paving the way for its commercial operation. Under the protocols, the unit will now be checked completely and adjustments if any will be carried out by the manufacturer / contractor. The unit is expected to start commercial operation thereafter. The first generating unit of Neelum Jhelum Hydropower Project was synchronized with the system on April 9. The second unit was scheduled in May, however, WAPDA succeeded in commissioning this unit for trial generation ahead of schedule and synchronized it with the National Grid on April 22. Both generating units, have provided around 20 million units of electricity to the National Grid during their test run.

The 969 MW-Neelum Jhelum Hydropower Project has four generating units, each of them having generation capacity of 242.25 MW. The remaining units are likely to commence by end June 2018 operation at one-month interval each.

Neelum Jhelum Hydropower Project, constructed on River Neelum in Azad Jammu and Kashmir, is considered to be an engineering wonder, 90 percent of which exists underground in high mountainous region.

The project has three main components including a 60 feet high and 160 feet long composite dam, a 52-kilometer long water way system and an underground power house. Besides, a 525 KV switch yard and transmission line have also been constructed to evacuate electricity, generated by the project. Neelum Jhelum Hydropower Project will contribute about 5 billion units of electricity to the National Grid annually. The total revenue generation is expected to be over Rs 55 Billion annually.

May 18, 2018: Following completion of its reliability test and adjustments thereafter, the first unit of Neelum Jhelum Hydropower Project today has started providing electricity to the National Grid. The unit will contribute 242.25 MW power to its full capacity to the system for one month (reliability period) after which its commercial operation will commence.

May 30, 2018: Consequent upon the completion of its mechanical-run tests, Unit No. 2 of Neelum Jhelum Hydropower Project has also been successfully synchronized today with the National Grid. The unit has generated up to 185 MW electricity on trial basis. The unit will gradually attain its maximum generation capacity i.e. 242.25 MW in due course of time. The Unit No. 2 will also undergo reliability test and reliability period in accordance with the contractual obligations.

It is worth mentioning here that Unit No. 3, currently in its 30-day reliability period since May 18, has also been contributing 242.25 MW power to its full capacity to the National Grid. Neelum Jhelum Hydropower Project has so far been injected about 90 million units of electricity to the system, which equals to a revenue of Rs. one billion.

July 07, 2018: After successfully completing the reliability period, the Unit No. 3 has been formally taken over by WAPDA for its operation. Having being successfully

tested on various load rejection, the Unit No. 2 is generating electricity on its 72-hour reliability run. The Unit No. 4 is getting ready for one-month reliability test period.

July 11, 2018: The Power intake system of Neelum Jhelum Hydropower Project at dam site has been completed with the operationalization of the third de-sander in order to meet water requirement for generating power from all units of the project. The de-sanders have been constructed with project's dam to divert water from reservoir to the water way system comprising 52-kilometer long tunnel system to generate electricity at the power house.

At present, three units of Neelum Jhelum Hydropower Project have been generating power, therefore, impounding level in the reservoir has also been enhanced to meet the increased water demands of all units in operation.

It is worth mentioning that Neelum Jhelum Hydropower Project has three main components – dam and de-sander, water way system and power house. The dam and three de-sanders have been constructed across river Neelum at Nauseri in Azad Jammu and Kashmir. The concrete and rock filled dam is 60-meter-high and 261-meter-long. Maximum water storage capacity of the reservoir is 10 million cubic meter, while maximum operation level of the reservoir is 1015 meter above mean sea level. At present, water level in the reservoir is 1006.5 meter above mean sea level as per the demand of power house. As many as 70 cubic meter per second water out flow is required to generate power from each unit installed at the power house.

August 13, 2018: The fourth and the last generating unit of Neelum-Jhelum Hydropower Project has also been successfully synchronised with the National Grid today and started providing power to the system on trial basis. During its trial run, this unit will be tested on various loads ranging up to 242 MW.

August 14, 2018: The strategically important Neelum Jhelum Hydropower Project achieved a historic landmark as the project today attained its maximum generation capacity of 969 MW. All units of the project are generating power to their maximum.



File Photo – Neelum Jehlum Hydropower Project's Dam and Reservoir



July 11, 2018: A view of Dam and De-Sanders of Neelum Jhelum Hydropower Project **(WAPDA Photo)**



July 11, 2018: Water Flowing through 3rd De-Sander of Neelum Jhelum Hydropower Project



A view of Power House-Neelum Jhelum Hydropower Project

DOMINO-EFFECT OF CLIMATE EVENTS COULD MOVE EARTH INTO A 'HOTHOUSE' STATE

Leading scientists warn that passing such a point would make efforts to reduce emissions increasingly futile

By:

Jonathan Watts

A domino-like cascade of melting ice, warming seas, shifting currents and dying forests could tilt the Earth into a "hothouse" state beyond which human efforts to reduce emissions will be increasingly futile, a group of leading climate scientists has warned.

This grim prospect is sketched out in a journal paper that considers the combined consequences of 10 climate change processes, including the release of methane trapped in Siberian permafrost and the impact of melting ice in Greenland on the Antarctic.

The authors of the essay, **published in Proceedings of the National Academy of Sciences**, stress their analysis is not conclusive, but warn the Paris commitment to keep warming at 2C above pre-industrial levels may not be enough to "park" the planet's climate at a stable temperature.

They warn that the hothouse trajectory "would almost certainly flood deltaic environments, increase the risk of damage from coastal storms, and eliminate coral reefs (and all of the benefits that they provide for societies) by the end of this century or earlier."

"I do hope we are wrong, but as scientists we have a responsibility to explore whether this is real," said Johan Rockström, executive director of the Stockholm Resilience Centre. "We need to know now. It's so urgent. This is one of the most existential questions in science."

Rockström and his co-authors are among the world's leading authorities on positive feedback loops, by which warming temperatures release new sources of greenhouse gases or destroy the Earth's ability to absorb carbon or reflect heat.

Their new paper asks whether the planet's temperature can stabilise at 2C or whether it will gravitate towards a more extreme state. The authors attempt to assess whether warming can be halted or whether it will tip towards a "hothouse" world that is 4C warmer than pre-industrial times and far less supportive of human life.

Katherine Richardson from the University of Copenhagen, one of the authors, said the paper showed that climate action was not just a case of turning the knob on emissions, but of understanding how various factors interact at a global level.

"We note that the Earth has never in its history had a quasi-stable state that is around 2C warmer than the preindustrial and suggest that there is substantial risk that the system, itself, will 'want' to continue warming because of all of these other processes – even if we stop emissions," she said. "This implies not only reducing emissions but much more."

New feedback loops are still being discovered. **A separate paper published in PNAS reveals** that increased rainfall – a symptom of climate change in some regions - is making it harder for forest soils to trap greenhouse gases such as methane.

Previous studies have shown that weakening carbon sinks will add 0.25C, forest dieback will add 0.11C, permafrost thaw will add 0.9C and increased bacterial respiration will add 0.02C. The authors of the new paper also look at the loss of methane hydrates from the ocean floor and the reduction of snow and ice cover at the poles.

Rockström says there are huge gaps in data and knowledge about how one process might amplify another. Contrary to the Gaia theory, which suggests the Earth has a self-righting tendency, he says the feedbacks could push the planet to a more extreme state.

As an example, the authors say the loss of Greenland ice could disrupt the Gulf Stream ocean current, which would raise sea levels and accumulate heat in the Southern Ocean, which would in turn accelerate ice loss from the east Antarctic. Concerns about this possibility were heightened earlier this year by reports that the Gulf Stream **was at its weakest level in 1,600 years**.

Currently, global average temperatures are just over 1C above pre-industrial levels and rising at 0.17C per decade. The Paris climate agreement set actions to keep warming limited to 1.5C-2C by the end of the century, but the authors warn more drastic action may be necessary.

“The heatwave we now have in Europe is not something that was expected with just 1C of warming,” Rockström said. “Several positive feedback loops are already in operation, but they are still weak. We need studies to show when they might cause a runaway effect.

Another climate scientist – who was not involved in the paper – emphasised the document aimed to raise questions rather than prove a theory. “It’s rather selective, but not outlandish,” said Prof Martin Siegert, co-director of the **Grantham Institute**. “Threshold and tipping points have been discussed previously, but to state that 2C is a threshold we can’t pull back from is new, I think. I’m not sure what ‘evidence’ there is for this – or indeed whether there can be until we experience it.”

Rockström said the question needed asking. “We could end up delivering the Paris agreement and keep to 2C of warming, but then face an ugly surprise if the system starts to slip away,” he said. “We don’t say this will definitely happen. We just list all the disruptive events and come up with plausible occurrences … 50 years ago, this would be dismissed as alarmist, but now scientists have become really worried.”

“In the context of the summer of 2018, this is definitely not a case of crying wolf, raising a false alarm: the wolves are now in sight,” said Dr Phil Williamson, a climate researcher at the University of East Anglia. “The authors argue that we need to be much more proactive in that regard, not just ending greenhouse gas emissions as rapidly as possible, but also building resilience in the context of complex Earth system processes that we might not fully understand until it is too late.”

IMPROVED WATER SUPPLY TO SINDH, BALOCHISTAN: WAPDA TO ENHANCE STORAGE CAPACITY OF HUB DAM

The Pakistan Water and Power Development Authority (WAPDA) has decided to enhance the storage capacity of Hub Dam in order to meet the increasing requirement of water in the country, Sindh and Balochistan in particular.

The decision to this effect was taken in a meeting presided over by WAPDA Chairman Lt Gen Muzammil Hussain (Retd) and attended by the Members of the Authority.

According to the details, WAPDA will regain Hub Dam's lost storage capacity of about 49,000 acre feet by removing the sediment deposits in the reservoir. The present live storage capacity of the reservoir will be increased by excavating the deposited material lying between the Dead Storage Level (276 feet) and Normal Conservation Level (339 feet) along the reservoir periphery.

Hub Dam Project was constructed in 1981 across River Hub, some 56-kilometer North-East of Karachi. The project was designed to supply 102 million gallon per day (MGD) to Sindh and 59 MGD to Balochistan. At the time of its completion, live water storage capacity of Hub Dam was 760,000 acre feet, which has come down to 646,000 acre feet now.

It is pertinent to mention that Hub Dam Project also has the potential to generate hydel electricity. The concept paper, prepared by WAPDA Hydropower Planning says that 1.4 MW of electricity can be generated from the Dam by installing two generating units of 0.7 MW each, with annual energy generation of 5.85 million units of electricity. The electricity generated through Hub Dam can be provided to the institutions and households located in vicinity of the project. Therefore, WAPDA has also decided to implement Hydropower Project at Hub Dam. The offices concerned have been directed to prepare feasibility study, detailed engineering design and tender documents for the purpose. ###



File Photo of Hub Dam

OBITUARIES

July 2018 to December 2018

Fateha for the Departed Souls

1. ***Engr. Riaz Hussain Warraich,*** former Secretary, Irrigation Department (1996-1997) Government of the Punjab. Former Project Manager, Flood Emergency Project (NDC) passed away and was buried in Canada on 7th July 2018. He was suffering from cancer.
2. ***Engr. Abdul Khaliq Khan,*** Advisor Mega Dams WAPDA and a very active Member of the Congress passed away on 28th July 2018.
3. ***Engr. Qazi Khan,*** Chief Engineer Tarbela Dam (Mid Sixties) passed away.

WELCOME TO NEW MEMBERS

The Executive Council of the Pakistan Engineering Congress 75th Session 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 75th/6th Meeting of Executive Council held on December 1st, 2018.

1 Engr. Muhammad Ali Sabri
2 Engr. Muhammad Iqbal Bhalli
3 Engr. Nisar Ahmed Janjua
4 Engr. HafizTalha Nadeem
5 Engr. Nabeel Anis Khan
6 Engr. Faizan Elahi Malik
7 Engr. Muhammad Tayyab Aamir
8 Engr. Daud Ali
9 Engr. Bashir Ahmad
10 Engr. Qamar Hassan Iqbal
11 Engr. Sumayya Noshin
12 Engr. Abrar Shafiq
13 Engr. Abeer Abrar
14 Engr. Muhammad Rashid Bilal
15 Engr. Tanveer Abbas
16 Engr. Faisal Malook
17 Engr. Mahrukh Zafar
18 Engr. SundusTariq
19 Engr. Nisar Ali Lodhi
20 Engr. Sohaib Arshad
21 Engr. Asif Mahmood
22 Engr. Faizan Ahmed Waris
23 Engr. Husnain Nazir Shairwani
24 Engr. Kashif Ali
25 Engr. Rana Muhammad Asif
26 Engr. Amroza Anwar
27 Engr. Sidra Rashid
28 Engr. Tauqeer Aslam
29 Engr. Waseem Abdullah
30 Engr. Muhammad Zeeshan Ashraf
31 Engr. Noman Khan
32 Engr. Usama Riaz
33 Engr. Farhan Chaudhry
34 Engr. Hafiz Muhammad Waqas Bada
35 Engr. Ghulam Jilani
36 Engr. Amir Hussain
37 Engr. Usman-e-Ghani
38 Engr. Muhammad Riaz
39 Engr. Muhammad Zaheer Asghar
40 Engr. Faiza Kulsum
41 Engr. Rizwan Latif
42 Engr. Ahsan Mahmood
43 Engr. Usman Habib
44 Engr. Muhammad Ahmad Noor
45 Engr. Muhammad Irshad
46 Engr. Ishaq Hussain Tariq Farooqui
47 Engr. Abdul Basit
48 Engr. Muhammad Faizan
49 Engr. Muhammad Mohsin
50 Engr. Syed Sohaib
51 Engr. Muhammad Tahir
52 Engr. Intazar Ahmad
53 Engr. Usama Asif
54 Engr. Majid Ali Tunio

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55 Engr. Haseeb Baloch

56 Engr. Muhammad Kamran Hussain

57 Engr. Ali Raza

58 Engr. Muhammad Uzair Safdar

59 Engr. Ajab Khurshid

60 Engr. Muhammad Zohaib Lateef

61 Engr. Bushra Maryam

62 Engr. Nimrah Ijaz

63 Engr. Muhammad Umair Anwer

64 Engr. Simon Naseem

65 Engr. Muhammad Ammar Ali

66 Engr. Muhammad Saif Ullah

67 Engr. Nadeem Iqbal

68 Engr. Tausif Ahmad

69 Engr. Muhammad Usman

70 Engr. Hamza Azam Cheema

71 Engr. Usama Rahim Sukhera

72 Engr. Najeeb Ullah Babar

73 Engr. Zeeshan Sharif

74 Engr. Saqib Qayyum

75 Engr. Asad ur Rehman

76 Engr. Ihsan

77 Engr. Hamza Hanif

78 Engr. Ahmad Shahzad Babar

79 Engr. Tamoor Haider

80 Engr. Muhammad Hammad Ahmad

81 Engr. Hafiz Zain Akram

82 Engr. Zeeshan Khalid

83 Engr. Ateeq ur Rehman

84 Engr. Farah Saleem

Position Paper on Water Accounting as a Sustainable Agricultural Water Management Tool 2018

Background

Food and Agriculture Organization of the United Nations (FAO) organized an online discussion on "Water Accounting and Water for Food" from 9 June to 21 July 2017 in which International Commission on Irrigation and Drainage (ICID) and several of its stakeholders participated actively. This discussion, facilitated by FAO, was organized as part of the World Water Council (WWC) Members' initiative on water accounting (WA) for decision-making in the agricultural sector. It aimed to raise the profile of WA for water strategy and policymaking and demonstrate the value addition that WA can bring in smart planning processes in water governance and management. The main objective of this initiative was to raise the awareness of the significance of WA for decision-making and planning and gather evidence and experiences through a process consisting of expert consultations and interactions. The online discussion covered topics starting from how to define WA, how it should be implemented to who can benefit from it and how.

Few WA examples from around the world were also shared during the e-discussion and in coordination with the topic of the discussion, ICID organized webinars on water accounting and Australian experiences of using WA in national water management. The Webinars were very well attended by both ICID members and the participants of the above online discussion. During the online discussion, ICID also got an opportunity to state briefly its position on the whole issue of WA through various contributions and this paper further elaborates on these contributions and updates on ICID activities in this area.

As a follow up of the above e-discussion, WWC members, including ICID, prepared a White Paper on WA for policymakers. Considering the potential utility of WA as an AWM tool, ICID has developed this detailed position paper parallelly, based on the ICID work on "water balance approach" over the last several years and its ongoing activities, for sharing with its national members as well as international partners including WWC and FAO. The WWC White Paper was launched at the 8th World Water Forum in March 2018. It should also be noted that this initiative further contributes to the work plan of the Global Framework on Water Scarcity[1] (currently named as Water Scarcity in Agriculture, WASAG) launched at the Marrakech climate conference in 2016.

The main objective of this ICID paper is to initiate a discussion and evolve a consensus among ICID stakeholders on WA and its potential benefit in AWM through national-level planning. ICID as a multi-country professional group is committed to improving the status of agricultural water management and water governance through its various avenues such as facilitating research and technology, raising awareness and water stewardship through knowledge exchange and knowledge dissemination. The concept of water accounting and auditing is gaining popularity amongst the technical experts in the field of hydrology and water resources management. However, it is equally important for the other stakeholders

[1] Water Scarcity is defined as the excess demand of water over the supply (FAO, 2012).

to appreciate the water data democracy offered by WA process and consider it as a legitimate tool for decision-making in the agricultural sector.

To this end, ICID is organizing events and activities with the active participation of hydrology experts, irrigation managers, policy-makers, extension community, farmers and other relevant stakeholders on the same table to discuss the topic at length and various avenues through which it can contribute to a sustainable AWM. Such events include triennially organized congress, world irrigation forum and regional conferences organized all over the world. These events focus on the sustainability of irrigation where international and national experts participate and discuss strategies to combat global water and food security issues. ICID has also conducted multi-lingual educational Webinars on WA topics for a wider audience from different fields of expertise. In addition to English, the most recent ICID Webinars were conducted in Spanish and Arabic for the benefit of professionals from Latin America and the Middle East. ICID believes this approach will encourage better worldwide participation of water experts in the formulation of a transparent water governance system.

To design appropriate AWM strategies, consistent hydrological information and appropriate decision-making tools should be available which can form the basis of sound policies. This institutional decision-making process entails participation from different institutions involving multiple stakeholders such as researchers, lawyers, environmentalists, and so forth. Technical experts from international organizations such as IWMI, IHE-Delft, FAO, and UNESCO-WWAP are advocating WA as a robust, integrated and standardized concept for effective and sustainable AWM. Another important objective of this paper is to establish a common understanding of the basic terminology used by practitioners from different sectors working to avoid confusion during decision-making towards a common goal of efficient water management. In this regard, ICID's Multi-lingual Technical Dictionary is being updated as a validated repository of technical terms pertaining to irrigation, drainage and agricultural water in general.

Abstract

Owing to fast-paced demographic and climate changes, water scarcity has become a critical issue that needs to be quantified in a systematic manner at various spatial and temporal levels. Unfortunately, the present global water demand is projected to increase by 55% with increased competition among various sectors of economy by the year 2050 which could result in a reduced share for agriculture. Most countries lack coordination between water governance, management and technological upgrades due to lack of appropriate water information systems resulting in an inefficient agricultural water management. Furthermore, water governance is not based on a scientific analysis and the outcome is inconsequential policies. To remedy this, based on the water balance approach, a framework for water accounting and auditing is proposed to systematically report the water resources and associated hydrological information comprehensively to facilitate the decision-making for sustainable agricultural water management (AWM). As a consistent, reliable and transparent source of water information, water accounting (WA) can play a key role in resolving environmental, economic, political and social issues at individual, organizational, state, national and even international levels by providing necessary water information to the respective stakeholders in agriculture as well as

other sectors. Water Accounting Framework can also serve as the potential stepping stone to accomplish higher economic growth and responsive water governance and consequently contribute towards the sustainable development and management of water resources for all.

Water Sector and Current Issues

Amongst the vital natural resources, water is rapidly becoming the most critical topic of discussions centered on environmental management, food security, climate change impacts and adaptations, future industrial development, human health and sanitation issues, and global sustainable development. Although freshwater is a renewable source, in the present scenario, the rate at which freshwater resources are being consumed/withdrawn/used is much higher than the rate of its natural replenishment resulting in closing/closed river basins[1]. Due to changes in the human consumption pattern and standard of living, the water demand is much higher than its present supply in most sectors, making it a scarce natural resource. Coupled with global warming, the increase in population worldwide and their competing demands, the stress on water resources is becoming even more unbearable. Other critical challenges faced by freshwater resources are chemical and thermal contamination, eutrophication, tourism and excessive consumption in all sectors (Box 1).

Box 1: Major Water Consumption Sectors

Agriculture	food, livestock, feed, fishery, fibre, timber, energy crops, etc.
Environment and Ecosystems Services	biodiversity, greenhouse gas emissions, carbon sequestration, etc
Industry	majorly including harbours, navigation, beverages, and energy generation (hydropower and thermal plants), and smallholder enterprises
Domestic Usage	drinking, sanitation, cooking and other activities, etc.
Leisure Activities	lakes, parks, riverfronts, etc.

According to FAO, sector-wise water withdrawal has been the highest (nearly 70%) for agricultural production in the last century globally (FAO, 2012). This data is much higher in Asian and African regions, where agriculture plays an imperative role in the national economy from an employment point of view. Such high amount of water withdrawal in the agricultural sector and growing competition from other sectors coupled with climate change have created water scarcity, which is expected to worsen in many parts of the world resulting in more hardships. According to de Fraiture et. al. (2010), the annual agricultural water use is expected to increase by 20% globally to satisfy the projected food demand by 2050. Additionally, water governance is under pressure due to variable supply, conflicting demands from all sectors and declining water quality. The problems with water governance exist due to weaker infrastructure, poor institutional arrangements, inadequate skills to address the emerging problems, limited financial budgets and gaps in water information resulting in poor decision-making. Additionally, the water sector, especially agriculture, is facing several other challenges such as environmental, technological, management, economic and social issues as listed below:

[1] Closing/closed river basins are basins where the demand for the water exceeds the supply.

- Increasing water scarcity, especially in closing basins and limited reserves for supply
- Imbalance in supply, demand and distribution of water equitably and sustainably
- Higher competition among different sectors such as agriculture, industry, municipalities, etc.
- Undesirable polarization within the water sector such as irrigation v/s environment, urban v/s rural and so forth
- Higher water variability and shortages due to climate change and other factors
- Inability to control flooding and supply augmentation using infrastructure
- Lower water productivity in agriculture
- Mismanagement of river basins because of over-irrigated agriculture
- Lack of strong infrastructure leading to poor water use efficiency
- Incoherence between the water-food-energy nexus and other trade-offs and their correlation with SDGs
- Negative effects of non-water policies on the water sector, especially agriculture
- Less priority in the national agenda because of information gap
- Lack of awareness amongst users to save water or optimize the usage.

Need for Water Measurement

In general, the management approaches are based on the belief that if it cannot be quantified, it cannot be managed. The same should hold true for sustainable management of our natural capital (water) for future generations. Since water is considered a social good in most countries, there is a lack of a mechanism for water pricing leading to frequent overuse and wide-spread mismanagement of the resource. Just like for saving on financial capital, we need sound financial planning where we essentially require the knowledge of availability and flow of funds to identify critical points where money-saving is possible; similarly, it is evident that for effective planning and management of water resources, an extensive knowledge of water balance, water availability, consumption, water wastage and return flow within a specific region/catchment is of utmost importance.

Keeping in mind the critical nature of issues that water sector is facing, advancements in technology solely cannot curb the problem, prudent governance, best management practices, and other factors (e.g., pricing of water services, long-term investments in the infrastructure projects) also need to be brought into effect to improve the current status of water resources, especially in agriculture.

Furthermore, the water abstraction at one location in the basin affects the water availability in another part of the basin, making the local management efforts ineffective and therefore, demanding for an integrated approach for smart water management across the basins. While climate change mitigation and adaption strategies are already a focus area of policymakers, a robust and integrated framework to design more efficient AWM policies and contribute to sustainable solutions for food insecurity and water scarcity.

A typical smart water management process requires the participation of multiple-stakeholders from various disciplines to evaluate management strategies based on multiple criteria decision making as shown in Figure 1. A "Measure; assess; evaluate; improve," approach promotes an investigative water balance approach to improve water use efficiency in irrigation and the adapted water balance framework assists managers and designers alike to apply it at any level to improve the system's performance (ICID Webinar on Water Use Efficiency, 2017). A detailed analysis of water status of various hydrological systems (e.g., nation-wide, river basins, irrigation scheme level, or farm level) based on near real-time available data is the first essential step for water resources planning (Bastiaanssen, W. G. M., et. al., 2003).

To establish a robust water information system as a first step towards smart water management, measurements of hydrological parameters are required:

- To assess the amount of water available, and to balance the supply and demand according to availability, apt dynamic and robust management strategies need to be devised
- To choose appropriate interventions such as the need for modernization, new infrastructure and/or rejuvenation, etc.
- To evaluate the SDG target indicators to identify the progress in sustainable development
- To increase the priority of water in the national agenda. Lack of appropriate data reduces the priority of water resources management by the decision-makers in the national development agenda (WWAP, 2014)
- Generating awareness towards a water-wise society. Similar to financial accounts, water accounts can inform users for judicious use of water at the sector and individual levels

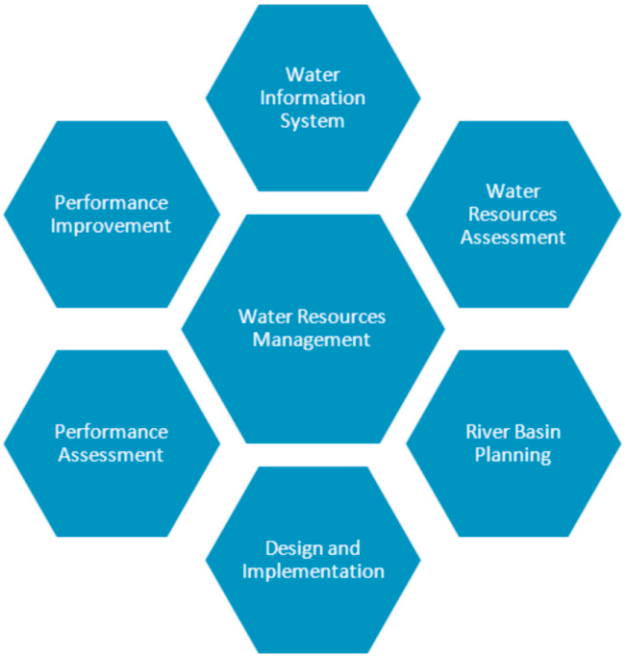


Figure 1 A typical schematic proposed for Water Resources Management Process

Inconsistent Terminologies

The main focus of AWM is improving irrigation efficiency and productivity. However, the term 'efficiency' in irrigation can mislead the policymaking while looking at the economic, hydrological and ecological aspects (Perry, 2011). Since the agricultural revolution, the definition of the term 'irrigation efficiency' has evolved and defined in many ways creating ambiguity. While the generic aim is to improve the water-use efficiency in agriculture, the terminologies used within the concept are somewhat divergent, which creates confusion amongst different stakeholders. The definition of the term 'irrigation efficiency' is often used synonymously with 'water-use efficiency' which can cause ambiguity amongst the decision-makers. Irrigation efficiency, originally, did not discount the water which is returned back to the system and hence counted twice, the losses are also somewhat misleading. The ICID webinar on the SDG 6.4 (water-use efficiency) also points out this difference of how water diversion and water consumption are considered identical in most cases and the difference between them is overlooked. Hence, the water use in irrigation is divided into change in storage, consumed fraction (beneficial and non-beneficial consumption) and non-consumed fractions (recoverable and non-recoverable flow). Among these, the beneficial consumption fraction needs to be optimized in the context of irrigation (ICID Webinar on Water Use Efficiency, 2017).

This clear distinction of consumed and non-consumed fraction of water usage in different sectors, especially agriculture, is crucial to identifying the actual amount of water used by the respective sector and thus defining the water measurements. The water balance approach, within defined boundaries, or across different levels of irrigation systems is crucial to assess the performance of the systems within the Water Management Area. The fraction of the water abstracted from the source that can be utilized by the crop, can be called the beneficial water use component and optimized irrigation water supply is therefore aimed at maximizing this component (ICID Webinar on Water Use Efficiency, 2017).

ICID Definitions

According to ICID's Irrigation and Drainage journal, a peer-reviewed publication, the following standardized definitions/terminologies have been recommended for water use and water withdrawal (Perry, 2007; Willardson et. al., 1994 and Allen et. al., 1997). ICID's Multi-Lingual Technical Dictionary (MTD) is currently being updated with standardized terminologies in the context of irrigation and drainage, and the following terms (Table 1) are under active consideration.

Table 1: Terms and Definitions

Term	Definition
Agricultural Water Management	Application of right amount of water on a crop at the right time according to the vegetative state of plants.
Integrated Water Resources Management (IWRM)	A process that promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

Irrigation Efficiency	The ratio of the volume of water beneficially used to the volume of water delivered to field. During each stage of irrigation water delivery from source to soil, there is loss of water and the volume coming out is less than the volume entering.
Sustainable	S*ustainability* promotes principles of durability, equity, affordability, sufficiency and efficiency, whilst a) not undermining social and natural resources and b) managing multiple risks such as drought, flood, declining water quality and increasing resource competition (FAO White paper, 2018).
Water Accounting	Water Accounting (WA) is an analytical tool to quantify inflows, outflows and changes in storage as a function of time (including agricultural drainage systems) in any given hydrologic system/sub-system such as an agriculture field, a canal system or a river basin. WA should address quantitative, qualitative, associated potential energy characteristics of the water fluxes and storage and the uncertainties related to the measurements.
Water Auditing	Verification of water accounts conducted by an independent agency consisting of hydrologists, water resource managers, engineers, consultants and analysts. Two kinds of audits should be conducted, i.e., auditing of the process of WA and auditing of the performance of the WA.
Water Use	Any deliberate application of water to a specified purpose. The term does not distinguish between uses that remove the water from further use (evaporation, transpiration, flows to sinks) and uses that have a little quantitative impact on water availability (navigation, hydropower, and most domestic uses).
Water Withdrawal	Water abstracted from streams, groundwater or storage for any use – irrigation, domestic water supply, industry, etc. The water withdrawn from these systems is further categorized as: changes in storage, consumed fraction and non-consumed fraction
Changes in storage (positive or negative)	Changes in storage include any flows to or from aquifers, in-system tanks, reservoirs, etc. The key characteristic of storage is that the water entering and leaving is of the same quality.
Consumed fraction (evaporation and transpiration)	The quantity of water used by the vegetation in transpiration and building of plant tissue, plus that evaporated from the soil or from intercepted precipitation, at any specified time. It is further divided into beneficial and non-beneficial consumption
Beneficial consumption	Water evaporated or transpired for the intended purpose – for example evaporation from a cooling tower, transpiration from an irrigated crop.

Non-beneficial consumption	Water evaporated or transpired for purposes other than the intended use – for example evaporation from water surfaces, riparian vegetation, and waterlogged land.
Non-consumed fraction (return flows)	The fraction of water that is not consumed by the plant and is returned to the system. This return flow is further divided into recoverable and non-recoverable fraction.
Recoverable fraction	Water that can be captured and reused – for example, flows to drains that return to the river system and percolation from irrigated fields to aquifers; return flows from sewage systems.
Non-recoverable fraction	Water that is lost to further use – for example, flows to saline groundwater sinks, deep aquifers that are not economically exploitable, or flows to the sea.
Water Governance	Water governance is the arrangement of infrastructure, technologies, institutions, finances and operations to manage water (FAO White Paper, 2018).
Water Scarcity	The excess demand for water over the supply.

Water Accounting

In general, there is a lack of coordination amongst the different institutions and stakeholders within and outside the government when formulating sectoral policies on agriculture, industry, municipality, and river systems. This disintegrated institutional approach towards water resources management (WRM) has proved to be counter-productive in many countries. Furthermore, unavailability of standardized spatial and temporal data makes it difficult for practitioners to strategize and coordinate efficiently with a certain degree of confidence. Thus, for a sustainable AWM to be implemented efficiently on a national level, the effect of which can be measured at the grassroots level (field scale), there is a strong need of knowledge amalgamation from all the relevant stakeholders from science, engineering, management, political, social and economic disciplines and sectors.

Water Accounting presents the "water balance analysis" and informs the stakeholders for designing best management practices in agriculture and a reliable water governance fabric to achieve equitable allocation to all users while maintaining the sustainability of the resource for current and future generations. From AWM point of view, WA is an analytical tool to quantify inflows, outflows and changes in storage in any given hydrologic system/sub-system such as an agriculture field, a canal system or a river basin during a cropping season, annual hydrologic cycle or given time period, distinguishing between the beneficial and non-beneficial consumption. Final WA should be closed at the river basin level, working from parts to the whole. Its purpose or objective can be an equitable/rational allocation for various human activities, understanding various paths for environmental services, or formulating a response to climate change, etc. WA should also include agricultural drainage systems as they are an integral part of an irrigation cycle. Mechanisms within WA should be available to address quantitative, qualitative, associated potential energy characteristics of the water fluxes and storage and the uncertainties related to the measurements. WA can quantify water resources, the performance of

the management and governance of water, and the links between water and economic, human and environmental development (FAO, 2018).

Water auditing is suggested as a further step to analyze the authenticity of the WA results and provide a comprehensive information system for further planning by placing trends. Within the concept of water auditing, two kinds of audits should be conducted, i.e., auditing of the process of WA and auditing of the performance of the WA. This auditing should be carried out by hydrologists, water resource managers, engineers, consultants and analysts from an external independent agency. WA should provide the physical distribution of water and auditing provides the basis for the formulation of policies, together which provides a clearer picture of the water balance, not only at the irrigated field but of the entire irrigation system or the basin, and consequently, a framework on agriculture water resource management can be designed and implemented efficiently and effectively.

Water accounting and auditing provide a transparent assessment of water in the specified spatial boundaries within a certain timeframe, and in the similar format as financial accounts. This data democracy provided by WA facilitates a direct communication channel between government institutions, research institutions and other non-governmental organizations including policymakers, hydrologists, agronomists, economists, lawyers, farmers and other stakeholders without any external assistance.

Through the years, with the experts working on the subject from premier institutes, many tools have been developed based on the WA concept to account for water abstraction and usage, its flow and its availability within the catchment with a higher precision in a standardized format which can be applied to any given country/region or river basin. Physical accounting of water requires quantifying water flows in the hydrological system which is regulated through the dynamic hydrological cycle and its various components (precipitation, evapotranspiration, interception, surface runoff, infiltration and groundwater storage). The hydrological data varies extensively in both temporal and spatial dimensions, and physical measurements for each parameter is impossible and sometimes may result in double counting of water. Moreover, the data obtained from different sources might be inconsistent resulting in the biased outcome to different stakeholders and creates confusion among them. Hence, the experts recommend implementing WA concept to establish an independent consistent source of information and produces standardized and reliable results. WA tools can be developed which furnish data obtained mostly through easily available field measurements, remote sensing, GIS and other hydrological models which are open source and the background information is available to different institutions and individuals. There is an urgent need to introduce standardized WA procedures that quantify the watershed processes, assess a safe level of exploitable water volumes and fix the maximum amount of water that could be withdrawn and consumed by the agriculture sector sustainably.

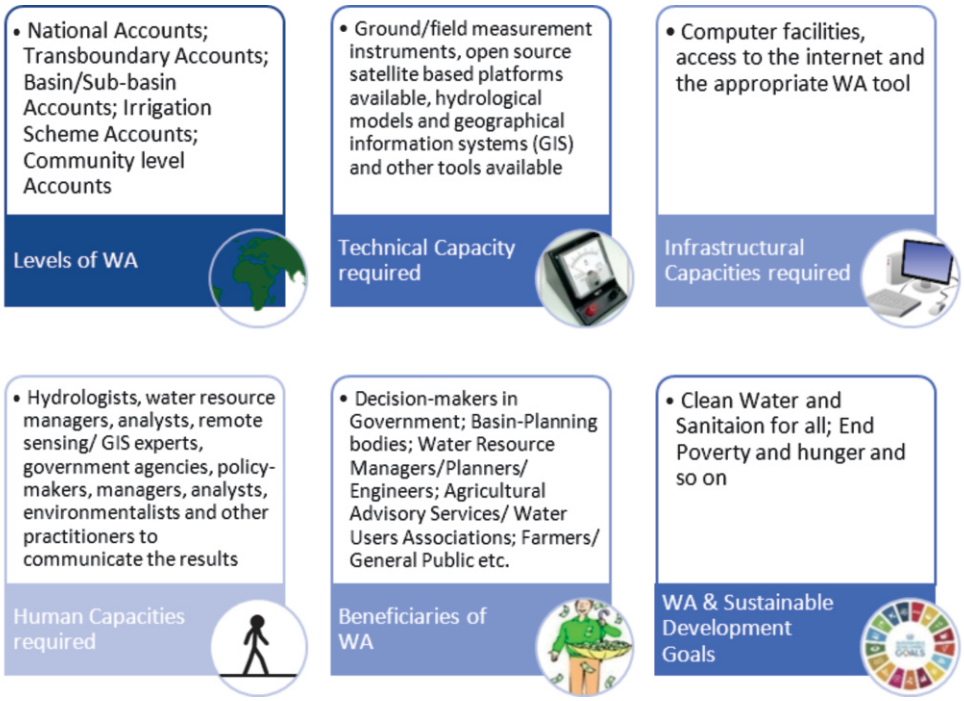


Figure 2: An Overview of Water Accounting

Water Accounting Framework

WA should be based on best possible scientific and engineering measurements to begin with and improving upon them (the tolerance levels) according to the end objectives. Institutional framework and its mandate to implement WA should be clearly defined and agreed upon by all the actors. There should be a prescribed common/standard format for reporting by diverse agencies within a basin. International organizations, governments and other regional institutions active in agriculture water management have to create an appropriate knowledge base to steer the national entities within the countries through their respective national focal points/agencies to take WA from experimental to operational mode.

Remote sensing, GIS and other hydrological models are very powerful tools which can help in bringing standards to the WA process. Apart from field measurements, with the help of remote sensing, the spatial and temporal variations of hydrological data can be evaluated. And this data derived from satellites is publicly accessible at all times. Some WA tools already make use of this data and simulate hydrological processes of a given area. While the policymakers and stakeholders from non-technical background might not be well-versed with the concepts and the underlying processes, the results generated by the WA tools provide consistent information required for taking better-informed management decisions on agriculture and water stress. The methodology adopted for WA makes a clear distinction between the consumed and non-consumed fraction of water (Perry, 2007). A general water accounting framework can be summarised as below in Figure 3:

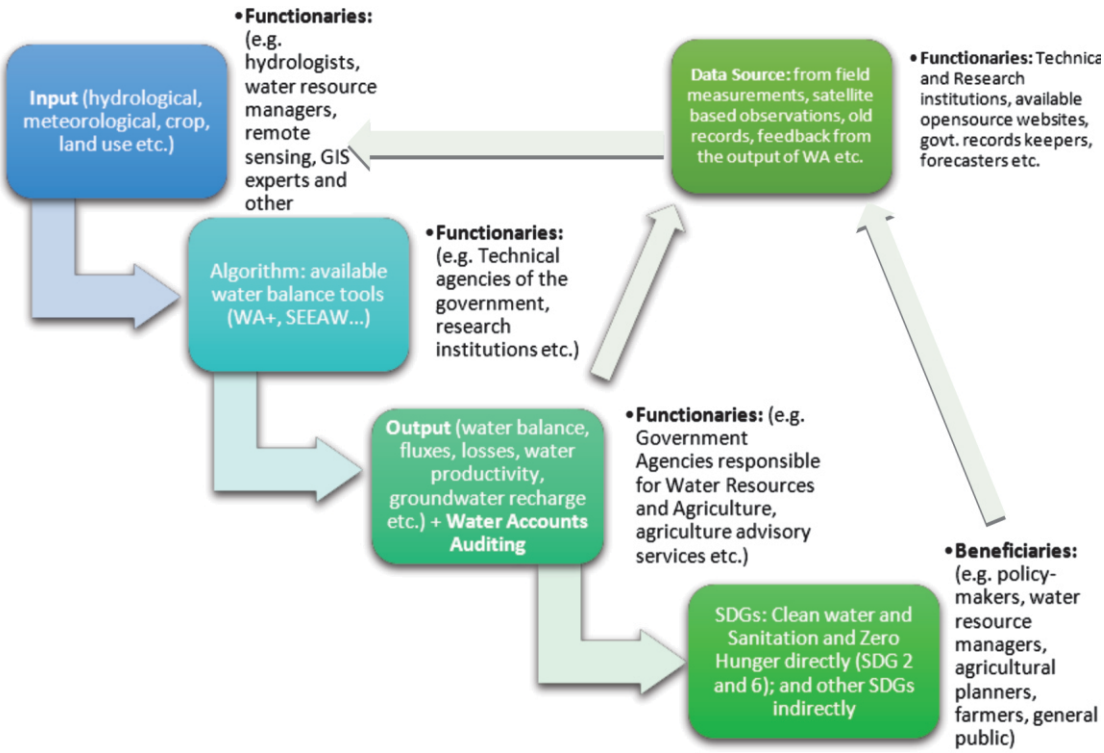


Figure 3: Water Accounting Framework for Agricultural Water Management

Lack of information on water availability, water rights and allotment, groundwater withdrawal and recharge prove to be a hindrance to the projects which provide long-term investments in infrastructure. Also, in case of development projects, there is often miscommunication in terms of proper accounting. A well-established framework acceptable to all the stakeholders from different sectors will help in expediting the process and better planning for the required infrastructure and trade. To address the issue of water scarcity and other water-related problems through institutional reforms, the approach to WA aims to standardize this so as to have a reliable, high quality and consistent source of information available and communicate this information to the different actors of the water sector. This standardization of concepts, definitions and processes consolidated through WA are a significant value addition contributing to the process of decision-making. Decision-makers and stakeholders from different institutional levels are dependent on this information for better water governance.

Since the demand for water is time-specific, the temporal aspect of the water information helps us in understanding the past and current patterns of water usage and predict the trends of future availability and consumption. Since the water yield is not constant throughout the year, and thus it impacts the water availability and consumption seasonally. Hence, understanding of these temporal changes in the water supply and demand need to be considered in the WA. Similarly, for different spatial scales, different planning strategies need to be designed and hence, the experts from ICID are suggesting to define the WA concept at different spatial scales, as given below in Table 2 based on different data requirements.

Table 2: Different Modules of Water Accounting

No.	Spatial Extent	Stakeholders and Beneficiaries	Input Data requirements
1	National Accounts	Policy-makers in ministries of Water Resources, Agriculture, Natural Resources, and Industry	Low
2	Trans-boundary basin accounts	Government Technical Agencies responsible for water resources management	Medium
3	River-basin accounts	Basin-planning bodies	Medium
4	Sub-Basin accounts	Sub-basin planners and managers	Medium
5	Irrigation Scheme accounts	Water Resource planners and managers, Agricultural advisory services, Scheme operators, etc.	High
6	Community-level accounts	Water User Associations, Farmers, Rural Development agencies and population	High

Water Accounting Tools

Maintaining natural capital is essential to ensure sustainable environment (Winrock, 2015). For evaluation of the natural capital, water resources as considered in this paper, some of the tools available which provide water accounts are: System for Environmental-Economic Accounting (SEEA-Water); National Water Accounts Australia; and Water Accounting Plus (WA+) provided in Annexure 1. Implementation of such standardized tools across countries would ensure cohesive and integrated results since similar concepts, definitions and methodologies are used for assessing the accounts. The raw hydrological data required for these tools is obtained either through field experiments or through hydrological and remote sensing/GIS models, or a combination of these.

The input requirements, algorithms used for processing and accordingly the output of all the tools are defined for each of the models separately. However, commonly, the boundaries need to be specifically defined for each spatial scale, i.e., national, state/district/regional, irrigation scheme and/or project level. The output of water accounting quantifies hydrologically relevant information such as rainfall, evapotranspiration, crop yield, consumptive use, crop water productivity; water withdrawals, consumptive use, river flow, lateral flow, base flow, outflow, return flow, drainage, recharge, storage changes, surface runoff, water yield, water storage capacity, soil moisture and so forth.

Benefits and Beneficiaries of Water Accounting

A tool is as useful as its artisan who uses it. Usefulness and reliability of WA would depend on the capacity of the national agencies to integrate the WA tools in water

planning, policy and operational decision-making. The smart water management process develops specific connections between water scarcity, variability, productivity, efficiency, water governance and water accounting (FAO, 2018). The smart water management attributes to:

- Mitigating water scarcity, especially in closing and closed river basins.
- Balancing the distribution of water supplies, demands and benefits equitably between rural and urban sectors to safeguard and boost economic productivity and human and ecological health.
- Balancing hydrological variability.
- Balancing water with other inputs (such as energy) to optimize water productivity and minimize externalities.
- Balancing the range of water interventions so that institutional, political and technological solutions fit together and to the problem.
- Balancing is a long-standing financial accounting principle of determining a balance sheet of credits and debits (thereby in water resources respecting the law of conservation of mass).

There are several avenues through which WA can contribute to achieving smart water management (FAO, 2016):

- to provide a common source of information so that all the stakeholders are on the same platform;
- to provide the basis for water distribution and allocation and facilitate stakeholder's dialogue for resolution of any conflict;
- to identify and analyze problems related to water and strategize accordingly;
- to modify existing and design new water policies;
- to provide a suitable framework for planning for varying political, social and biophysical environment;
- to form water regulatory frameworks between different stakeholders to avoid conflicts; and provide unbiased information from an open source.

While WA facilitates the outcomes as shown in Figure 4, according to FAO, the potential beneficiaries and stakeholders in the water accounting and auditing processes consist of water users from different sectors (agriculture, industry, urban, environmental and municipality), diverse mix of experts/professionals/administrators/policymakers from various government departments and agencies; elected representatives at different institutional levels; non-government organizations; regulatory organizations; private sector organizations; water engineers and managers, deliverers and users of water services; research organizations and academics; water industry professionals; media (traditional and social); general public using the water; training or capacity building organizations (Batchelor et. al., 2016).



Figure 4: Outcomes of Water Accounting

With the availability of such a tool, alternate scenarios of management and their impact on the environment can be easily simulated and studied. Some of the decisions include information regarding sustainable increase in water yield from upstream areas, implications of construction of new infrastructure, groundwater depletion and artificial recharge during high intensity rains, impact of agroforestry on food security, various scenarios of crop productivity and find a suitable crop accordingly, effect of urban settlements on the water balance in the region and so forth.

As of now, the concept of WA and auditing is not adopted by most countries on a national level. A better understanding of water balance, including water supply and water demand across the different regions at different times is required through proper communication channels. Through a series of events and webinar, ICID has continually emphasized the importance of WA for AWM. During these sessions, ICID also provided the provision to the participants to have a discussion with the experts. In collaboration with the Bureau of Meteorology of Australia, ICID organized a Webinar on the first successfully working model of Australia's National Water Account on how the WA process has been implemented in Australia and how other countries can learn from it and can adopt similar accounting model or replicate/calibrate this accounting model in their own countries. The experiences shared during various ICID and other fora and the other evidence reported elsewhere will be collated and compiled to assess the utility of WA as a framework for longer-term water management planning and future development of water resources.

Water Accounting to Support Water Governance

Policy formulation for any kind of development has traditionally been considered the domain of economists, sociologists and political analysts, who rarely get an adequate exposure to physical concepts and ideas such as "water balance approach." Consequently, water governance is not always based on the scientific

analysis. Under the WA framework, the scientific term “water balance approach” has now assumed a new alias “water accounting,” so that it becomes more palatable to the non-engineering stakeholders, especially decision-makers. The concept of water balance envelops hydrological processes with different management of water flows, water consumptions on various land use classes including rainfed and irrigated agriculture within a system. WA follows the scientific principles of water-balance approach and informs the results similar to the well-established guidelines of financial accounting. The result is an exhaustive report of all-inclusive water-related information to assess the status of water resources within a specific system for policy formulation.

WA also supports water governance at different levels of varying spatial resolution, i.e., at the national level, state or district level, basin level, irrigation scheme level and field level. The policies for water and the capacities required for water management at each of these levels might differ. The knowledge provided from this advanced comprehensive water information system for a given system can help the decision-makers for better planning, formulate new policies or reform the existing ones for modernization in irrigation for improving water productivity in agriculture.

The WA provides answers to specific problem issues such as the imbalance between supply and demand, water allocation between different sectors, over-exploitation of groundwater in a region, large investment infrastructures projects in agriculture. It is considered as an indispensable step in the MASCOTTE approach adopted for the modernization of irrigation (FAO, 2007). The MASCOTTE approach has been successfully implemented in many countries, including India, Argentina and Kyrgyzstan for many years (ICID Webinar on Planning for Modernization: MASSCOTE Approach, 2017). Thus, WA should be a part of inter-sectoral or intra-sectoral planning since it can help in setting-up of a benchmarking process, in comparing feasibility of different management options in a particular environmental, political and social scenario and guide the policymakers for efficient governance accordingly (ICID Webinar on Practical Benchmarking for Improving Performance of Irrigation and Drainage Schemes, 2017).

Water Accounting and Water Policy for Agriculture

To boost the land and water productivity, the policymakers need to devise water policies pertaining to agriculture in such a way that it addresses the provision, allocation, consumption and management of water resources in agriculture as well as among different users sustainably so as to control the aquifer depletion and preserve the water reservoirs. WA assists the policymakers and other stakeholders in achieving the following goals:

- Manage nexus connections and trade-offs
- Distribute water more equitably within domains
- Allocate water between sectors
- Achieve and monitor SDGs
- Manage and regulate rising water demands arising from economic growth
- Manage supply. Cope with and benefit from increased variability – droughts and floods

Some of the important policies that need focus are incentivising the water use efficiency, investments in infrastructure for agriculture and water harvesting, disaster risk management related with water (floods and droughts), improved wastewater treatment and access to water supply and sanitation, improved/revised water allocation plans through water rights reform and pricing, and improvements in water governance through stakeholder participation (OECD, 2011). Some measures, suggested by Perry (2011) and agreed upon by ICID, to achieve higher water-use efficiency through smart management practices are:

- To reduce the non-consumed fraction of water by deducting the irrigation deliveries to minimize the excessive runoff of irrigation water and deep percolation of water in the field;
- To reduce the consumed fraction through drip irrigation to minimize the non-beneficial evaporation of water, wherever possible; and
- To increase the productivity of beneficial consumption by fully irrigating at specific crop growth stages

Capacity Requirement for Water Accounting

At the recently organized ICID Congress (Mexico, 2017), many ICID member countries expressed the ground level issues indicating lack of water accounting and relevant institutional reforms as a major barrier in smooth functioning of Water User Associations (WUAs) to achieve equitable water distribution and sustainable use of water.

Several international organizations, governments and research institutions are fairly well equipped to carry out WA for national, regional and basin levels. The WA and auditing reports can be developed by a wide range of practitioners such as hydrologists, water resource managers, engineers, consultants and analysts. However, at the sub-basin or micro-basin levels, capacities need to be built to carry out WA. In this regard, institutional policies need to be developed for capacity development within the WUA's and extension services at the micro-basin levels.

The technical capacity required for the input data measurements include ground/field measurement instruments, open source satellite-based platforms, hydrological models and geographical information systems (GIS) and other related tools. For the water assessment and monitoring stage, the infrastructural and institutional requirements include computer facilities, access to the internet and the WA tool. In terms of human and intellectual capacity, the requirements vary at different stages of WA which includes hydrologists, water resource managers, analysts, remote sensing/ GIS experts, government agencies, policy-makers, managers, analysts, environmentalists and other practitioners, all working through an agreed multi-disciplinary institutional framework or structure. Proper reading of WA accounts, awareness building and sensitization of policymakers are some of the factors which are crucial while strategizing for long-term water policies.

Equally important is correct reading of WA outputs and translating them into long-term water policies, and for this awareness building and sensitization of policy makers is crucial.

Water Accounting in Agriculture and other Sectors

While the focus of this paper is mainly agriculture, WA is equally beneficial in other sectors, namely, industry, domestic, environment and ecosystem services. Since planning for water resources is equally crucial in other sectors, the outcome of WA can prove to be extremely useful for other sectors as well. The framework developed for the WA in agriculture can be replicated and altered based on the indicative parameters from other sectors. Accordingly, the policies need to be developed to inform other sectors, especially industry and municipal uses with special attention to the quality of the water emissions (i.e., grey and black water). Since pollution is one of the major environmental concerns, overlapping sectoral policies should be developed to curb water quality degradation.

In the environmental and ecosystem services, broadly classified as provisioning (e.g., food, water), regulating (e.g., climate regulation, hydrological cycle, flood retention), supporting services (e.g., soil formation) and cultural services (e.g., recreation), WA quantifies several crucial indicators pertaining to these environmental and ecosystem services such as water yield, soil erosion, carbon sequestration, resilience to floods and droughts, greenhouse gas amount in the atmosphere among others.

Water Accounting Case Study

A very successful example of WA implementation was shared during the ICID Webinars on Australian National Water Accounts managed by the Bureau of Meteorology, Australian Government in collaboration with the Australian water industry. The National Water Account is Australia's most comprehensive water information report. It provides a picture of water resources management for the previous financial year for ten nationally significant water regions: Adelaide, Burdekin, Canberra, Daly, Melbourne, Murray–Darling Basin, Ord, Perth, South East Queensland and Sydney. It is a systematic process of identifying, recognizing, quantifying, reporting, assuring and publishing information about water and people's rights and obligations with respect to it. The National Water Account discloses information about water stores and volumetric flows, water rights and water use. It also reports on the volumes of water traded, extracted and managed for the economic, social, cultural and environmental benefit.

One of the main concerns of water allocation between different sectors is the issue of conflicts for a claim on water rights. To plan for this water allocation justly and sustainably, information regarding water availability, water consumption, current allocation, how much water is traded, change of water in the aquifers and rivers, water loss through evaporation and other leakages is needed from the involved actors. The Australian Bureau of Meteorology considers the actors involved in the water sectors as the central government, state and local government, water utilities, industry, agriculture and public. Some of the significant outcomes of this water accounting report provides information regarding cyclone warning, flood warning, marine weather warning, heat wave warnings, El Nino and La Nina, water resource assessment and account, sea temperature and currents, climate monitoring, temperature and wind, rainfall and sunshine, UV protection, coral bleaching, aviation forecasts, disaster mitigation, commercial weather services, information infrastructure, etc.

The management strategy based on this WA report suggested water sharing in a cyclic pattern (planning, implementation, monitoring and evaluation; and then further planning to improve the process). The strategy is subjected to review every 10 years to account for biophysical, institutional and social changes in the region. Some other important characteristics considered while the formulation of policies based on these water accounts is integrated management approach of natural resources water, soil, land and vegetation with a shared responsibility between the government and the community considering environmental, social, economic, cultural and heritage aspects.

The main benefits of the national water accounting include the availability of water-related information (water available, entitled and used, traded and lost) in a standard format for all basins, transparent water management and accountability, spatial and temporal information, guidance to policymakers, regulating authorities and actors involved on WRM, awareness of water issues among general public and also identification of gaps and inconsistencies in data and knowledge. For example, the Australian national water accounts provide integrated, detailed, standardized water information. It also addresses water security issues in the basins and changing supply and use of water in metropolitan cities and irrigation areas, provides data check and quality control for national comparison (ICID Webinar on National Water Accounts: Australian Experience, 2017).

While the accounts of successful implementation of WA has been given in this section, Box 2 provides an example of the reality of not accounting for water resources in the northern states of India.

Box 2. The Real Cost of Not Accounting Groundwater. Access to subsidized agricultural electricity has led to promotion of an unsustainable cropping system (Rice-Wheat) in North India's agro-ecological zones as almost freely available power is used to pump groundwater excessively to grow water-intensive and non-native paddy crop, a lucrative export commodity, but an environmental disaster for the region. Every October Delhi becomes the SMOG capital of the world as in a hurry to prepare their fields for winter wheat sowing, farmers resort to stubble burning after paddy harvest. Satellite images show the accumulation of smoke from this burning activity over this densely-populated foggy area, a leading cause of respiratory diseases in the millions of children and elderly during this month, an incalculable health cost for national economy. Stagnant October winds and other sources of air pollution rub the salt over this wound because groundwater was not accounted when power subsidies were calculated.

Water Accounting (WA) and Sustainable Development Goals (SDGs)

As discussed in this paper, WA can help make better decisions for sustainable AWM, economic growth, poverty reduction and environmental protection. A systematic approach to AWM requires actions at all levels, from farms to irrigation schemes, and from local to national action and strategies. Reallocation of agricultural water share, modifying or changing crop patterns, and water charges are among the self-control policies. However, effective capacity development at various levels, appropriate national/local guidelines and transparent regulations are major pre-conditions for incentivizing the self-control. A thoroughly worked out "water law" can definitely promote a more effective use of water to support the SDGs, particularly goal 2 and 6 by providing a transparent legal framework to ensure

equality and social justice in rural areas of many developing countries. WA can also provide a way to determine the combined effect on SDGs or the possible trade-offs in the SDGs using long-term water-food-energy nexus, e.g., to fulfill SDG 7 on energy, overuse of water can lead to water scarcity and affect SDG 6 negatively (FAO, 2018).

The dependence of societies on water resources makes it a key factor in the achievement of sustainable development expressed through outputs such as water and food security, biodiversity, and so on. The sustainable development goals (SDGs), laid by the UN, provide a comprehensive and internationally accepted framework for achieving development of society, economy and environment sustainably for current and future generations, measurable through various indicators. According to Vision 2030 (ICID, 2015), the experts of different technical working groups have established that agricultural water management directly or indirectly influences seven SDGs out of the seventeen, i.e., no poverty (goal 1); zero hunger (goal 2); good health and well-being (goal 3); ensure availability and sustainable management of water and sanitation for all (goal 6); decent work and economic growth (goal 8); climate change adaptation (goal 13) and partnership for the goals (goal 17).

The SDG 6 corresponds to sustainable development and management of water in all sectors and WA provides an integrated information base of water-use across sectors. A direct assessment of almost all SDG 6 indicators synergizing with other SDGs, which are also related with other SDGs can be facilitated through WA and auditing which helps in assisting the formation of sectoral policies. Additionally, WA also helps in addressing the impact of development programs and policies on the SDGs and other existing water governance reforms. FAO's online discussion also considered how WA outcomes help in monitoring SDG 6 directly and other indicators indirectly. This particular deliberation can be summarized as given below in Table 3.

Table 3: Role of Water Accounting towards Sustainable Development Goals

SDG Target Indicators	Goals	Indicators	Role of WA
Goal 6.1 [Also target 3.9]	To achieve universal and equitable access to safe and affordable drinking water;	Proportion of population using safely managed drinking water services	Accounts for different uses of water, i.e., agriculture, industry, drinking water, municipal water, etc. WA reporting on the water quality will directly contribute to safe and affordable drinking water
Goal 6.2	To achieve access to adequate and equitable sanitation and hygiene, particularly women;	Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water	
Goal 6.3 [Also target 14.1]	To improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals	Proportion of wastewater safely treated	Provides water budget and distinguishes between blue and green water. Assesses water quality degradation due to pollution.

SDG Target Indicators	Goals	Indicators	Role of WA
	and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	Proportion of bodies of water with good ambient water quality	Water accounts provided by industries, municipality and agriculture combined can report on this SDG
Goal 6.4 [Also targets 1.4, 2, 8.4, 12.2, 12.4]	Substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	Change in water-use efficiency over time Level of water stress: freshwater withdrawal as the proportion of available freshwater resources	Differentiates between consumptive (beneficial and non-beneficial) use and non-consumptive (recoverable and non-recoverable) uses of water which helps in determining the actual amount of water used and more accurate estimations of water use efficiency and water productivity
Goal 6.5 [Also targets 2.4, 11.a and 15.9]	Implement integrated water resources management (IWRM) at all levels, including through trans-boundary cooperation as appropriate	Degree of integrated water resources management implementation (0–100) Proportion of trans-boundary basin area with an operational arrangement for water cooperation	Assesses integrated water stocks, uses and fluxes across spatial scales and thus provides the basis to implement IWRM at all levels
Goal 6.6 [Also targets 15.1, 15.2, and 15.3]	Protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	Change in the extent of water-related ecosystems over time	Reports on ecosystem services such as estimating the exchanges between land and atmosphere, reduction of greenhouse gases due to land-use change and climate-smart agriculture, groundwater recharge, non-recoverable flow because of degraded water quality, decrease in soil erosion due to vegetation cover etc.
Goal 6.a [Also targets 12.a, 15.a, 15.b, 17.6 and 17.7]	Expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies	Amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan	

SDG Target Indicators	Goals	Indicators	Role of WA
Goal 6.b [Also targets 16.7, 16.8, and 17.9]	Support and strengthen the participation of local communities in improving water and sanitation management	Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management	

Specific SDG indicators that can be calculated directly from the WA is water-use efficiency and/or productivity. For example, WA determines the beneficial consumption of agricultural water out of the total water abstracted which corresponds to the water-use efficiency. From source to the irrigation scheme to the field and ultimately to the crop, the water is conveyed through irrigation infrastructure incurring evaporation and seepage losses at each level. WA proves to be an important instrument in this aspect as it provides spatial and temporal water balance at each level and thus helps in assessing the status of the infrastructure by keeping a track of such losses. Long-term investment projects in water infrastructure are very critical with respect to the water-use efficiency to minimize such losses at each level from source to the crop. Another parameter that can indicate efficient water use and translate into agro-economic growth is water productivity, a direct concern for the field level farmer who pays for the cost of irrigation water and associated losses in terms of evaporation and nutrients due to over-irrigation.

While quantitatively an excess of water demand over the supply has created water scarcity, an acceptable quality of water is crucial for sustainable growth/development of water resources and subsequently fulfill relevant SDGs. Since water accounts provide the quantitative aspect of water, qualitative aspect of water is not reported by several tools currently. Water quality is assessed by chemical, physical, and biological attributes. Estimation of some of the critical determinands[1] still remains difficult due to lack of standardized methods to evaluate them or standards for threshold amounts of determinands in the water bodies to define quality classes (SEEAW, 2012). While WA+ does not account for all the determinands for detailed assessment of water quality, SEEAW model can evaluate certain parameters pertaining to the quality of water. A possible solution of WA+ in collaboration with SEEAW can be explored to include the economic aspect of water use (Winrock, 2015).

Currently, there is no specific framework under which SDG target indicators related to water in agriculture are reported. Water reporting through WA provides quantifiable figures which can help directly or indirectly to identify the progress especially with respect to the SDG2 on food, SDG6 on water, SDG 7 on energy, SDG 13 on climate adaptation and SDG 15 on terrestrial ecosystems. For regular

[1] Determinand is defined as a constituent or property of the water that can adversely affect the water's taste, odour, colour, clarity or general appearance. E.g. organic and oxidizable matter; nitrogen; nitrates; phosphorus; suspended matter; colour; temperature; salinity; acidity; phytoplankton; micro-organisms; mineral micro-pollutants in water; metal on bryophytes (moss); pesticides in water; and organic pollutants (except pesticides) in water. (SEEAW, 2012)

monitoring and reporting on the sustainable water use at different spatial levels (from local to national level), different outcomes of WA and auditing can be used for multi-criteria decision-making in the water sector. A common opinion shared by several experts is that the use of WA can be very beneficial to comprehensively report on several SDG target indicators related with water, sanitation, food security, ecology, economy and poverty for sustainable development. Hence, a strategic framework should be put in place considering WA as an essential feature of integrated water resources management (IWRM) at various spatial levels.

Conclusions

From agricultural production point of view, the importance of WA lies in the fact that the effect on the water productivity with respect to different water users can be easily determined. WA also gives the information about the consumptive and non-consumptive use of water, clearly providing information/knowledge where there is the scope to improve water use efficiency. It gives information on water fluxes and flows in the basin; climate change variations can be evaluated; cost-benefit analysis of water services can be done; ecosystem and environmental services can be assessed based on modified, protected, utilized and managed water use. In addition, the trends in the water supply and demand can be analyzed for current status and future scenarios in specific social, political and institutional contexts.

The implementation of WA is recommended at various levels of water governance. However, certain gaps still need to be addressed. Quantitative indicators such as water-use efficiency and water productivity discussed in this paper largely concentrate on the quantity of water and how it can be better utilized across spatial and temporal dimensions; the quality of water (reporting on all the indicators of water quality) still remains a major concern to address some SDGs. The water quality assessment across space, especially from upstream to downstream, would be needed to identify changes in potential energy, chemical properties and biological aspects that directly influence the potential use of water for different purposes and the cost of water quality restoration. Another concern towards achieving data democracy in water resources is to account for the uncertainties and bias in the water measurements through WA tools. Apart from addressing technical gaps, without proper communication about the WA process, the whole exercise could prove to be futile. Communication regarding the WA process among the stakeholders and all the related beneficiaries including the general public needs to be strengthened in order to establish WA as a standard procedure for advanced water information systems.

In conclusion, ICID supports the view that WA should form the framework for assessing, sustainably managing and planning of current reserves of water resources in order to secure the scarce natural resource for current and future scenarios. Same as agriculture, other sectors can also benefit from the concept of WA or through a more comprehensive framework.

Way Forward

An integrated analytical planning framework inclusive of technological advancements, traditional practices, the involvement of all the stakeholders and sound institutional engagement needs to be implemented for sustainable AWM at various levels. The way forward to bring WA into effect is through raising awareness of the gravity of problems and the concept of WA amongst the various actors and

the beneficiaries of the water sector. By proper communication and collaborations, WA can be incorporated in the national agenda for water resources planning and management at various spatial and temporal levels. Policies and practices must be drafted to suit the water requirements of the beneficiaries inclusively and sustainably. And, there should be regular monitoring of the effect of these policies and practices on the water resources and revise them accordingly to changing climate and demography.

Currently many specialized organizations are working on tools which can store global and local data on hydrological and climatic processes in the selected region and possibly future projections through a cloud-based platform and make it available to a wide range of users, especially in data scarce regions of the world. The ongoing work is focusing on providing comprehensive water information, in particular to specific biophysical, social and economic conditions in developing as well as developed countries in order to find sustainable alternative solutions which are also economically beneficial, especially to the rural population. The main idea behind such an approach is to have a low-cost, easily accessible and readily available tool for all users to assess the water-related information. Such a tool would address institutional challenges and would require lower institutional or intellectual capacity and would bridge the knowledge gap with the current systems to provide comprehensive information based on which broad policy measures can be deduced which contribute to SDGs related with water-energy-food nexus.

As mentioned in this position paper, technically, there are tools available to carry out water accounting and auditing such as WA+, Australian National Water Accounts, SEEAW among others. The combination of currently available tools can be further researched to assess the quantitative and qualitative aspects of water accounts. Continually, state-of-the-art research is being applied to improve the technology part of the water accounts. However, the adoption of WA into practice worldwide still remains a challenge. To this end, the World Water Council (WWC) members (FAO, IHE-Delft, IWMI, ICID, DWFI, and WWAP) are working to raise the profile of WA for decision making and demonstrate the added value WA can bring in smart planning processes in water management and water governance. The WWC members prepared a White Paper on WA for policy making and it was launched at the 8th World Water Forum in March 2018.

The National Water Accounts of Australia offer an opportunity to test-case WA at national level as they are planned to be developed with similar principles as are defined for financial accounting. Apart from furnishing the general-purpose water accounting reports, an equal emphasis is being given to the auditing of the water accounts so as to ensure the reliability of the results and have the confidence of the investors and the general public regarding the management and investment strategies implemented. Given the importance of the knowledge of such issues, water accounting is proposed to be included in the curriculum in academia, particularly in water resources related subject areas. WA is planned to increase awareness among the stakeholders and also ensure the consistent use of water terminology for improved multi-disciplinary, collaborative, inter-sectoral, trans-boundary communications (A Possible Water Accounting Vision 2030).

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Water Accounting Plus (WA+)[1] (www.wateraccounting.org)

Water accounting (WA+), a tool developed by UNESCO-IHE, IWMI, FAO and UNESCO-WWEP, provides water resources related information and the services generated from the net amount of water used (consumptive use) locally, basin-wise or nationally to users such as policy makers, water authorities, managers, and hydrologists to name a few. WA+ relies mostly on satellite-based information of water and land resources rather than detailed hydro-meteorological measurements. Several performance indicators are developed to test the outcomes of WA+ results (Karimi et. al., 2013). The WA+ tool generates 8 sheets which provide the water-related information of the system and consistent standards for reporting on water usage and availability.

- WA+ provides an analytical framework that summarises water resources conditions and management in complex river basins.
- WA+ uses accessible satellite measurements as its main input data source, instead of detailed hydro-meteorological measurements, and global hydrological models which determine the water flow, including groundwater flow, in irrigated river basins.
- The WA+ framework evaluates the impact of interventions such as (i) water re-allocations, (ii) reduced groundwater withdrawals, (iii) deficit irrigation, (iv) modernisation of irrigation, (v) artificial recharge, (vi) water retention and storage, (vii) wastewater treatment, (viii) water productivity improvement, (ix) urban expansion, (x) deforestation, (xi) introduction of biofuel crops, (xii) cropping pattern change, (xiii) altered cultivation practices, etc.
- Accordingly, different management aspects can be assessed using WA+ in order to provide sustainable water supply for agriculture and control depletion of aquifers.
- **WA+ Input**: Precipitation; and changes in storage of surface water, groundwater and snow packs to arrive at net inflow
- **WA+ Output**
    - **Resource Base**: Rainfall, ET, storage, outflow, net withdrawals, atmospheric moisture flow
    - **Evapotranspiration**: evaporation from soil and water, transpiration, interception
    - **Agricultural Services**: Yield, consumptive use and water productivity
    - **Utilized Flow**: Withdrawals, consumptive use, return flow, drainage, recharge
    - **Surface Water**: Runoff, drainage, withdrawals, actual flow, marginal flow, return flow, storage changes
    - **Groundwater**: Recharge, withdrawals, return flow, lateral flow

[1] https://www.hydrol-earth-syst-sci.net/17/2459/2013/hess-17-2459-2013.pdf

- **Ecosystem Services**: Recycled rainfall, surface runoff, baseflow, river flow, water yield, erosion, exchanges between land and atmosphere, i.e. greenhouse gases (H20, CO2, CH4, N2O), carbon sequestration, water storage capacity
- **Sustainability**: Time series of rainfall, soil moisture, land use changes, ET anomalies

National Water Accounts – Australia[1] **(**http://www.bom.gov.au/water/nwa/about.shtml**)**

The standard prescribed by AWAS assists in an integrated and coherent water accounts for all the river basins in Australia. A general-purpose water accounting report (GPWAR) is generated inclusive of the contextual statement, accounts, information regarding water assets and liabilities, net water assets, changes in water assets and liabilities and statement of water flow across the basins including rights and claims to water resources. The report is further reviewed by qualified practitioners to assess the compliance of standards laid out by the AWAS (Australian Bureau of Meteorology, 2017).

- Provides water accounts as a combination of science of hydrology and financial accounting models for a specific financial year developed by water industry experts, financial accountants, and financial accounting standard setters
- Comprehensive annual water information report on major urban and rural water supply systems [customized to Australian conditions] including water rights and water entitlements
- Characteristics of National water accounts data: best available data; standardized information; nationally consistent; easily available to all the sectors and highlights data gaps.
- Provides detailed accounts of water resources management (volumes of water storage, flow, usage, traded, extracted and managed) for 10 major regions in Australia
- Informs water resources planning, water market activity, investment decisions, environmental management decisions, policymaking and community dialogue to ensure water security
- Metering System to account for volumes of water usage
- The water information reports are based on the Australian Water Accounting Standards.
- Water accounting is a systematic process of identifying, recognising, quantifying, reporting, and assuring information about water, the rights or other claims to that water and the obligations against that water.
- Data required: Climate data; Metered data – flows, transfers; Modelled data – runoff, groundwater movement; Licence data
- Water accounting statements for water assets and water liabilities – Assets and liabilities; stocks and flows

[1] http://www.bom.gov.au/water/standards/wasb/wasbawas.shtml

The water information report includes information on:

- Changes in water inflows, outflows and storages
- Existing water access entitlements
- Water management plans applied to govern water access
- Water allocated for use during the reporting period
- Total traded water entitlement
- Amount of water abstraction for use
- Amount of water made available to the environment

Output/Outcomes:

Safety: Cyclone warning; Flood warning; Marine weather warning; Heatwave warnings etc.

Sustainability: El Nino and La Nina; Water resource assessment and account; Sea temperature and currents; Climate monitoring etc.

Well-being: Temperature and wind; Rainfall and sunshine; UV protection; Coral bleaching etc.

Prosperity: Aviation forecasts; Disaster mitigation; Commercial weather services; Information infrastructure etc.

System for Environmental-Economic Accounting for Water - SEEAW[1] (SEEAW, 2012)

Adopted as a provisional international standard developed by the United Nations Statistical Commission (UNSC), SEEA-Water provides the experts with uniform definitions, concepts, classifications and accounts for water resources. SEEAW provides an integral cross-sectoral perspective on water-related issues since it establishes a direct link between water, environment and economic accounts. It focuses more on the flows in the rivers, canals and other utilities, however, it does not consider the biophysical processes in the river basins generating renewable water resources ("SEEAW", 2017).

- SEEA-Water relates the water resource system with the economy. The methods used for evaluation of the water resources are similar as in economic analyses and the accounts are measured in physical and monetary units.
- SEEAW accounts provide information on the water-economy-environment interactions such as contribution of water to the economy, flows between the economy and the environment such as abstractions and emissions and so forth.
- The modular structure of SEEAW (different categories) allows the users to prioritize the modules according to their concerns and data availability and hence provides a problem-oriented approach to design policies

[1] https://unstats.un.org/unsd/envaccounting/seeaw/seeawaterwebversion.pdf

- SEEAW addresses the spatial and temporal characteristics of water in their accounts
- Due to extensive data requirement and other issues, further researches are being conducted to standardize quality accounts and valuation of water resources.
- The social aspect of water resources and the impact of disasters have not been included in the SEEAW yet

The SEEAW Framework comprises the five categories of accounts described below (SEEAW 2012):

Category 1: ***Physical supply and use tables and emission accounts*** (physical supply and use tables provide information on the volumes of water exchanged between the environment and the economy and within the economy; emission accounts quantifies the pollutants added to or removed from the water)

Category 2: ***Hybrid and economic accounts*** (describes in monetary terms the use and supply of water-related products, the costs associated with these products, the income generated, the investments in O&M of hydraulic infrastructure etc.)

Category 3: ***Asset accounts*** (measure stocks at the beginning and the end of the accounting period and subsequently records the changes in the stocks that occur during the period due to natural causes)

Category 4: ***Quality accounts*** (describes the stock of water in terms of its quality)

Category 5: ***Valuation of water resources*** (describes background concepts in the economic valuation of water, different techniques, their strengths and weaknesses as well as their relevance to particular policy questions)

(With approval of ICID)

NUMERICAL MODELLING FOR HYDRAULIC EVALUATION OF MULTIPLE BRIDGES IN PROXIMITY – A CASE STUDY

By:

Engr. M. Mohsin Munir[1], Engr M. Umer[2]

ABSTRACT

Afflux at bridges can be a source of flood as they cause elevated water levels. The presence of bridges in the rivers cause obstruction to flow of water in the river, due to which there is are increased water levels on the upstream side of the bridges increasing severity and extent of the floods. If we don't consider the effect of bridges, the elevated water levels will cause surprise damages and property losses. The bridges in the river also cause the increase in the velocities of the flow near or at the bridge piers causing scouring. Bridge scour is major causes of bridge failure. This study envisages one dimensional study of the effects of bridges on the flow of the channel. The study area chosen is as our case study is River Sutlej near Bahawalpur. One dimensional study is chosen as the depth to width ratio in the tributary is not considerable, nor the slope is incredible. So the longitudinal flow study will constitute most of the flow characteristics Hydraulic modelling is used to analyze the hydraulic behavior of the system and simulating the river flows. According to simulations, afflux and scour corresponding to various return period floods have been computed. Further it is concluded that three soffit of the three bridges in nearby vicinity safe height to avoid even 100-year flood event.

Keywords: Afflux, scour, HECRAS, Hydraulic Modelling etc

1. INTRODUCTION

Due to the presence of bridges, the river cross sections undergoes alteration of the natural geometry of the cross sections because it induces obstruction. A major effect is the water surface elevation on the upstream side of the bridges in comparison to normal water levels ie by considering no bridge in the river. Piers can cause an afflux.

The dashed line in the Fig 1 below is showing the normal water surface level (undisturbed).when a structure is present , water surface level is shown by solid line. Maximum increase of water level is shown by afflux.

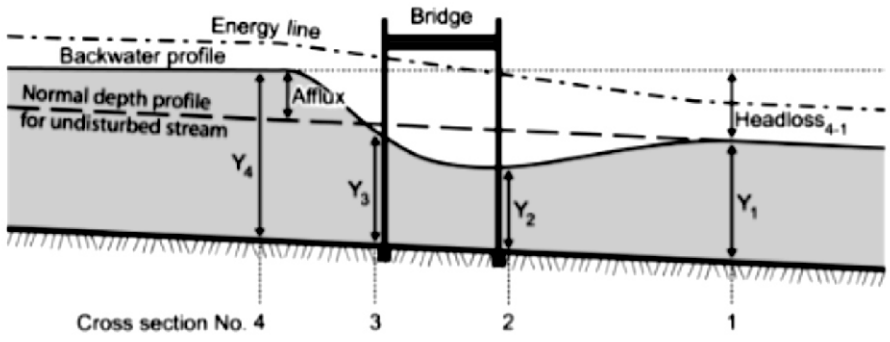


Figure 1: Side elevation at a bridge contraction

Water levels elevated on the upstream of bridges and culverts are a possible source of flood risk. If we increase the flow rate then afflux increases and similarly if we increase the degree of obstruction, afflux increases. In urban areas even, a small increase in water level above a threshold may cause flooding.

Scour is another important phenomena due to the back water effect which results in removing of sediments or gravel around the piers of the bridge. Scour has resulted in many disasters in the past.

The objectives of our research are One dimensional study of the impact of bridges on each other.The parameters under consideration include Water Surface Profiles(Back water effect) Froude number, Head losses Energy and Grade lines. Comparison are carried out under different scenarios of bridges, their mutual interactions and the corresponding afflux.

2. LITERATURE REVIEW

Backwater effect is reckoned to be an unavoidable event, but the affects can be made less severe by adopting economical procedures including structural and non-structural strategic planning. Nonstructural measures include modeling and flood hazard mapping. Digital modelling techniques using computers have been recently used to overcome the abrasive effects of backwater and afflux.

A major effect consists in an increase of water surface elevation. On the upstream side of the bridge structure water levels increases above the normal water surface profile (no bridge).. Backwater at bridges can be investigated in steady flow analysis.

As backwater effect can bring upstream flooding, due to the presence of geometry of the bridge and the characteristics of the floodplain backwater effect varies

Decision is required to be taken depending on the type of method of computation and the amount of topographical data that is required .1-D models are very popular because of reduction in the computational time.

One dimensional hydrodynamic flood modelling is based on the following three Assumptions are There is no remarkable variation in the density of water, i.e. Water is incompressible and homogenous, The stream shape is in such a shape that length is considerably larger than the depth of the water. I.e. the acceleration in the vertical dimension is insignificant, The bottom slope is exceptionally small , Pressure distribution is hydrostatic and there are no sharp curvatures , Flow velocity is uniform across the channel

The 1D model use following equations to calculate bridge energy loss are Standard steep energy method and Momentum Equation

Software we used for 1 D modeling is HEC-RAS. The computational procedure of HEC-RAS is based on the one-dimensional energy equation. By friction and contraction / expansion Energy losses are evaluated. The momentum equation used where WSL are changing rapidly

The capabilities of HEC-RAS are It has attractive and user friendly User Interface , It uses Hydraulic Analysis various Components , Much better data storage and Can also incorporate Graphics.

Water flows in the main channel during normal flow periods and overtops during flood discharges resulting in a compound channel flow section. Compound sections

are those having different flow properties.However, we take the Manning's roughness coefficient to be 0.02 to calibrate our model which is within the range value for our Sutlej River bed and it gave us fair results due to 1D flood modeling.

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3. DESIGN APPROACH AND METHODOLOGY:

- Modeling tools used to obtain required results using AutoCad. It provides elevation profile of the river bed as well as cross sections as shown in Fig 2, which is in turn used in HEC-RAS to run simulations.Since the project was based on a software, HEC RAS, and a software can run a data in a specific format so in this step data is brought in a specific format so that it can be executed by HEC RAS.
- We used this AutoCAD drawing as a acquired data from Authentic source, this drawing were consisted of elevation data of our case study river ie River Sutlej.
- To analyze the area under consideration ie area surrounding the bridges, we take a total reach length of 2200m and drawn total 21 number of cross sections on the AutoCAD drawing at 100 meters, according to the requirement considering the contraction and expansion lengths.

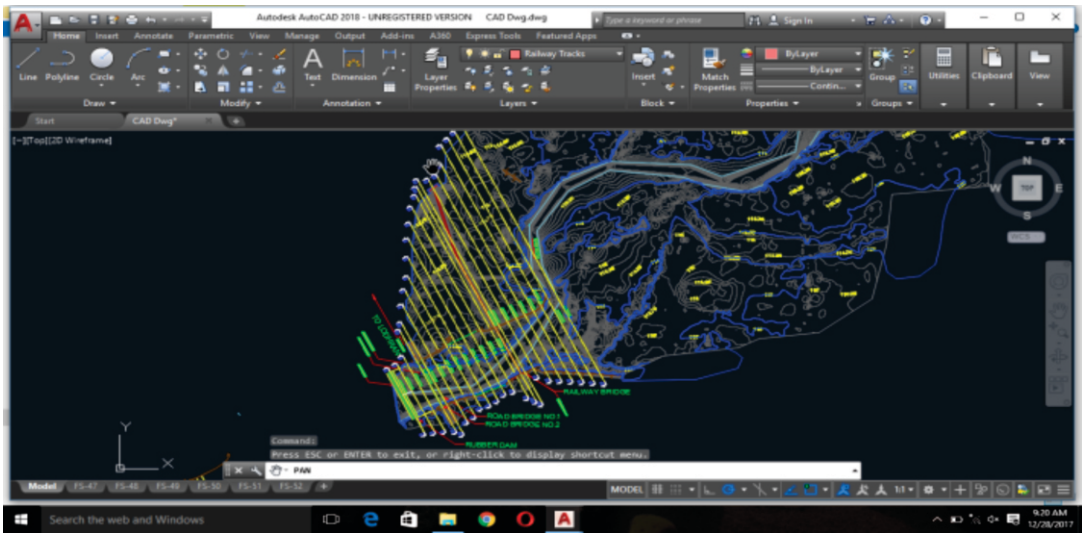


Figure 2: Elevation profile of River bed and cross sections

- Conversion of .dwg into Excel Format of cross sectional data
- Establishment of river reach as shown in Fig 3.

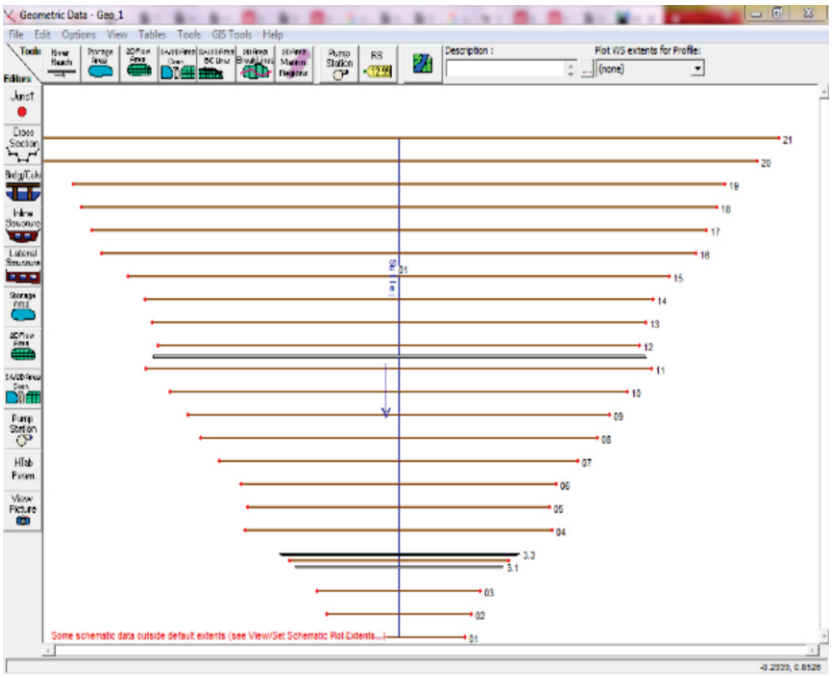


Figure 3: Establishment of river reach in HECRAS

- It is required to locate the cross sections at regular intervals. Cross sections should be perpendicular to the flow line .Cross section spacing also depends upon size of the stream and longitudinal slope.
- Data are required for each cross section as shown in Fig 4 are Cross section coordinates , River station , Channel bank stations , Reach lengths on downstream direction. , Roughness coefficients. Contraction and expansion coefficients.

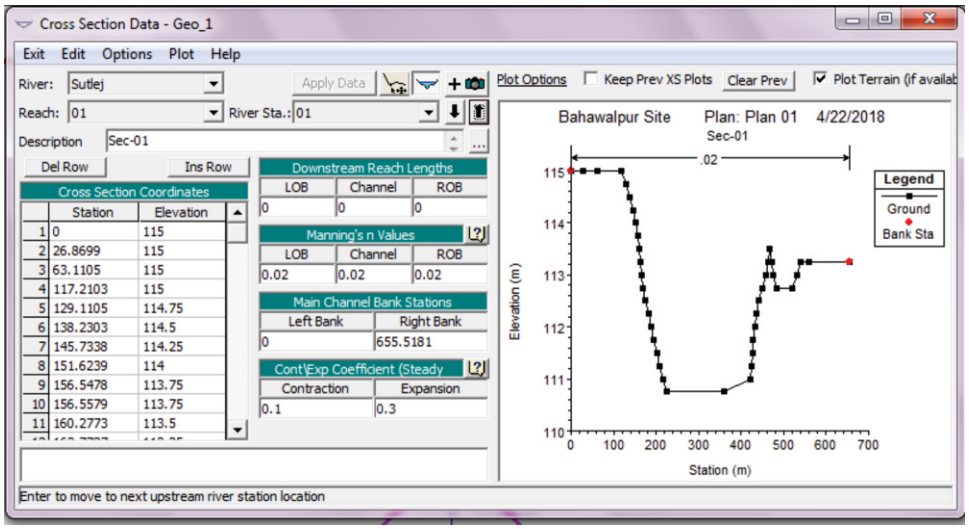


Figure 4: Cross sections imported in HECRAS.

- The bridge routines in HECRAS enables analysis of bridge hydraulics by using different methods so the distance between the cross sections must be within expansion and contraction lengths/coefficients as shown in Fig 5.

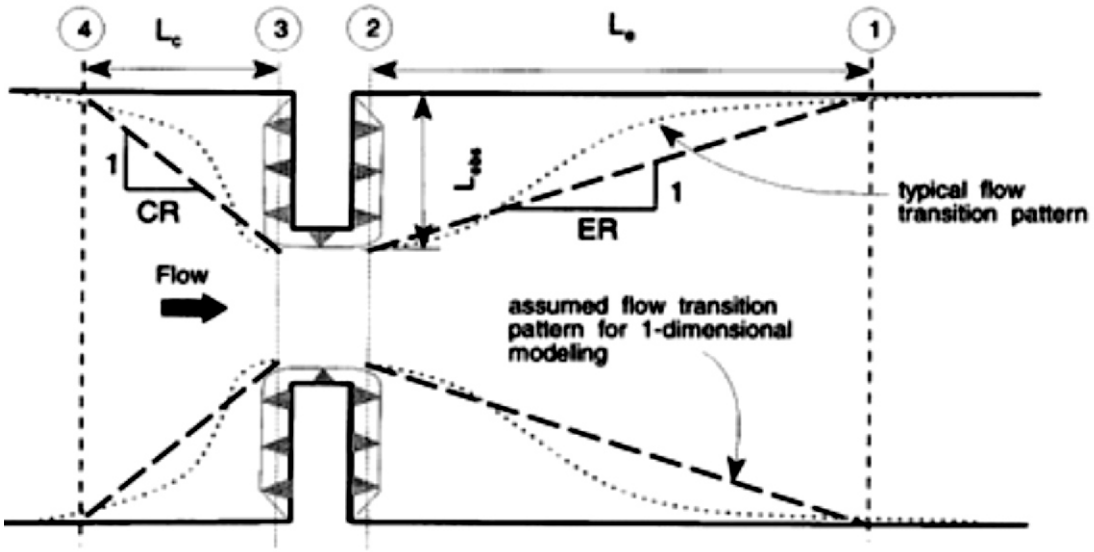


Figure 5: Expansion and contraction lengths overview

- Model CALIBRATION by using Manning's 'n' Values and Contraction and expansion coefficients.The manning's coefficient we selected is 0.02 for our case study according to the flood mark as shown in Fig 6 .we have avoided a section by section calibration of 'n' values , since to calibrate the 'n' values in this way would produce a model where all the parameter effects are marked.

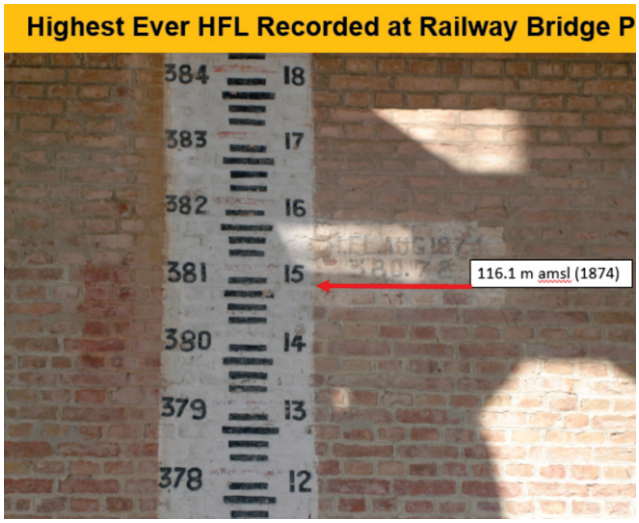


Figure 6: Flood mark at Railway Bridge of 100 year flood.

4. CASE STUDY OF RIVER SUTLEJ:

The Sutlej River is the most extensive of the five rivers of Pakistan. The Sutlej River has a length of 1,450 km (900 miles) long. The Sutlej River is a eastern most branches of the Indus River.When in Punjab, it merges with Beas and further into Chenab.Total length of the river Sutlej in Pakistan is 329 miles .We use Dipalpur, Suleimanki Barrage and Islam Barrage which are constructed on th main river stream for Irrigation purposes and also for the collection of discharge data

Topography of the Sutlej Riverbed shows a mind changes with the longitudinal length showing the normal bed slop of 0.00227 and a lot of sediment deposited on its bed.

In our case study area, we have 3 bridges located on the river sutlej and also we have all the information regardig number of piers under each bridge, their relative distances as shown in Fig 7

Our objective was to analyze the effect of bridges on WSL and other parameters, so we selected this area of Sutlej River near Bahawalpur.

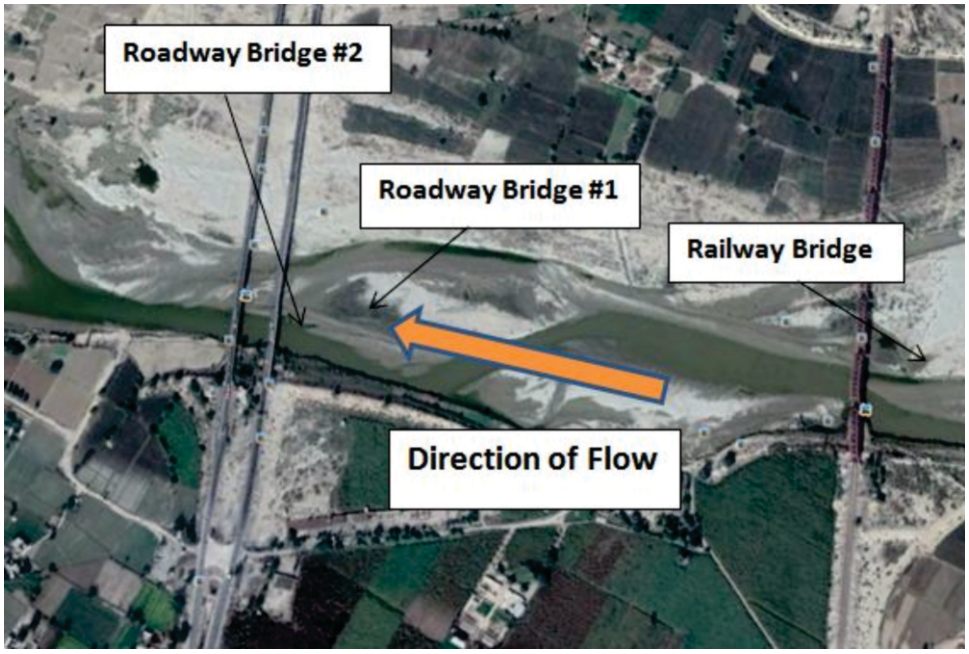


Figure 7: Location of bridges in our case study.

We used the discharge data of the islam river since it was closest to our case study area during our analysis as shown in Table 1.

Table 1: Discharge data on different barrabges on the sutlej river.

Return Period (Years)	Suleimanki Barrage (1963-2014) (cusecs)	Islam Barrage (1963-2014) (cusecs)	Mailsi Syphon (1973-2014) (cusecs)
5	151,291	112,939	84,970
10	213,705	160,026	130,238
25	292,565	219,520	187,433
50	351,068	263,656	229,865
100	409,138	307,466	271,983

Road Bridge # 1 data :

Bridge # 1 exists 356m from downstream Total deck width is 8 m.Total length of the bridge is 585.22m .Depth of slab of bridge is 2m .Total number of piers are 11. Width of pier is 1m. Spacing between piers is 50m. Total number of bays are 12.

When all this data were fed into the HECRAS bridge modeling, HECRAS ploted the bridge as shown in Fig 8.

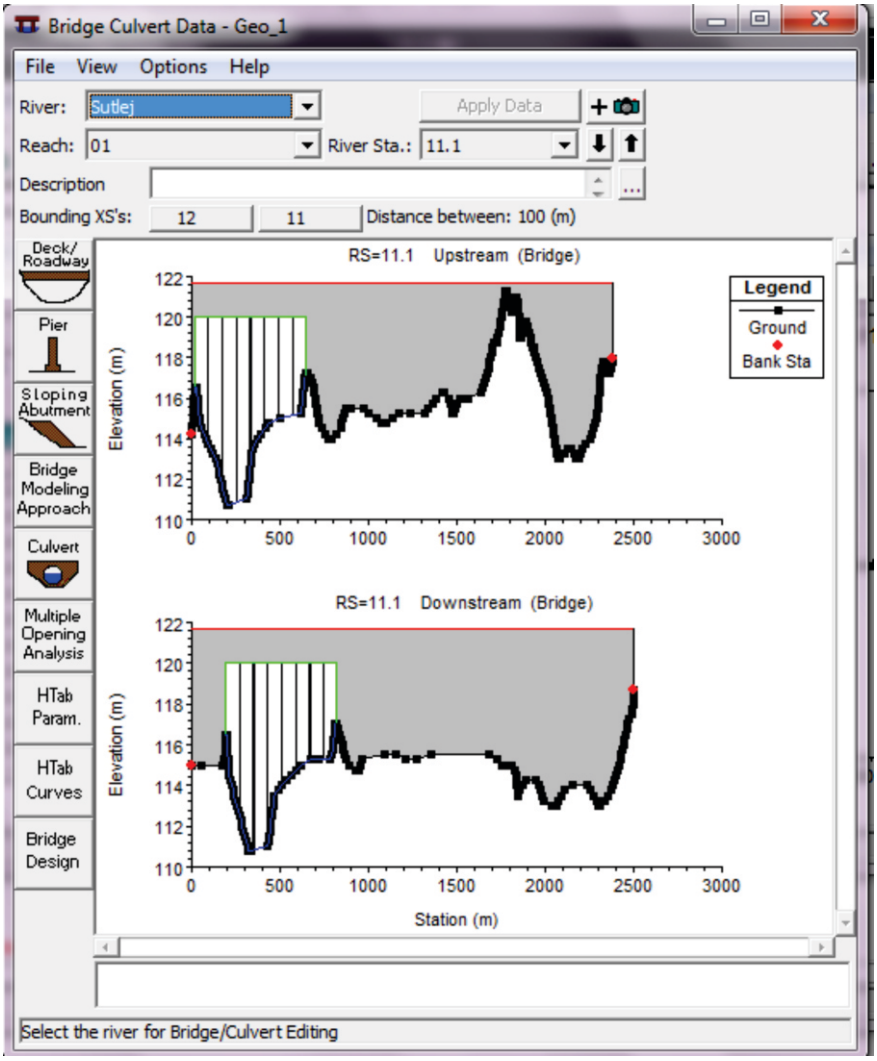


Figure 8: Bridge in HECRAS.

Road Bridge # 2 data:

Bridge # 1 exists 300m from downstream.Total deck width is 8 m.Width of pier is 1m.Total length of the bridge is 585.22m .Depth of slab of bridge is 2m .Total number of piers are 11 .Total number of bays are 12. Spacing between piers is 49.3m

Railway Bridge:

Railway bridge exists 1214m from downstream. Total deck width is 10 m. Total length of the bridge is 635.20 m. Depth of slab of bridge is nearly 1.68m .Total number of piers are 7. Number of bays are 8. Width of pier is 1m. Spacing of piers are 78.3m

5. RESULTS:

5.1 Analysis and Results of WSL

When we plotted the graph between WSL and number of bridges as shown in Fig 9.

It was concluded that if we increase the number of bridges the WSL on the upstream side of the bridges keep on increasing with the percentage depending on how much is the distance of a reference point from the bridge.

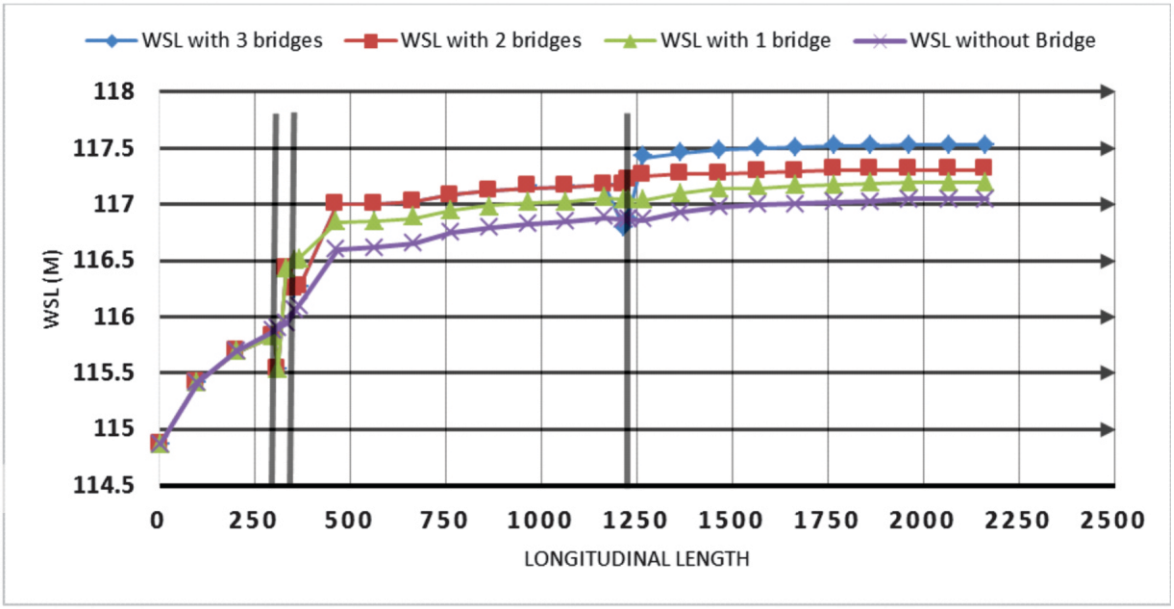


Figure 9: Graph of Water surface elevation Vs Longitudinal length.

Table 2: Water surface levels at upstream and downstream of three bridges.

Location	Min bed level	Water levels at 100 year floods				Change in WSL between with and without any bridge (m)
		Without bridges	with 1 birdge	with 2 bridges	with 3 birdges	
U/S Railway Bridge	110.75	116.86	117.04	117.25	117.42	0.56
D/S Railway Bridge	110.75	116.87	117.05	117.17	116.8	-0.07
U/S Road Bridge #1	110.75	116.6	116.84	117	117	0.4
D/s Roadway Bridge #1	110.75	116.06	116.51	116.26	116.26	0.2
btw Roadway Bridge 1 & 2	110.75	115.94	116.43	116.43	116.43	0.49
U/S Roadway Bridge #2	110.75	115.94	116.43	116.43	116.43	0.49
D/s Roadway Bridge #2	110.75	115.88	115.83	115.83	115.83	-0.05

5.2 Analysis and Results of Froude's number:

When we analysed the effect of bridges on the froude's number, We noticed that the froud's number suddendly increases near the bridges as shown in the Fig 10.

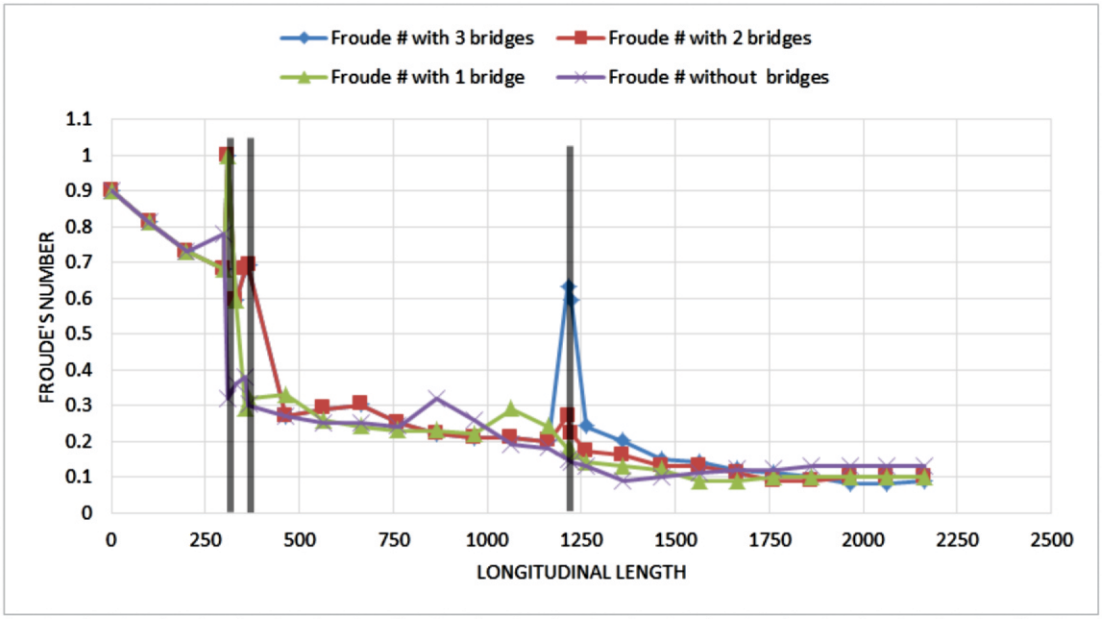


Figure 10: Graph of Froude's number Vs Longitudinal length.

If we consider the Upstream side of the Railway Bridge, then we conclude that the froude number is changing depending upon the addition of more bridges on the downstream side

Considering our case study analysis the froude number under different scenarios of without considering the bridge, with 1 bridge, with 2 birdges and three bridges are increasing ie 0.14 , 0.17 , 0.22 and 0.59 respectively.

5.3 Analysis and Results of headloss:

HECRAS also contain the function to calculate the head losses cause by the application of different bridges as shown in Fig 11.

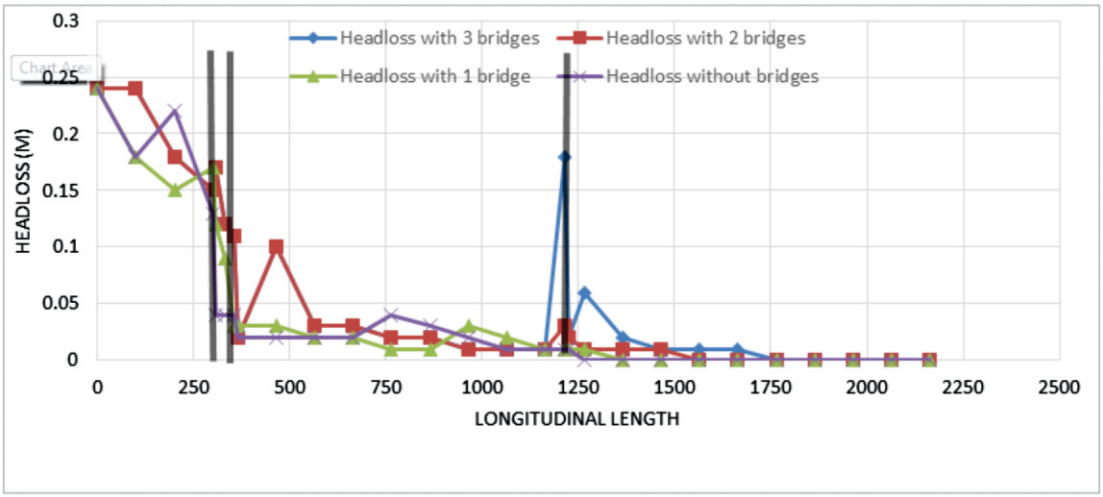


Figure 11: Graph of Head loss Vs Longitudinal length

5.4 Perspective view of case study river with Bridges in HECRAS

This perspective view is developed by HECRAS, showing details how it takes the information about addition of cross sections, addition of bridges, its piers , location of bridges , water coverage area at different discharges as shown in Fig 12 and Fig 13.

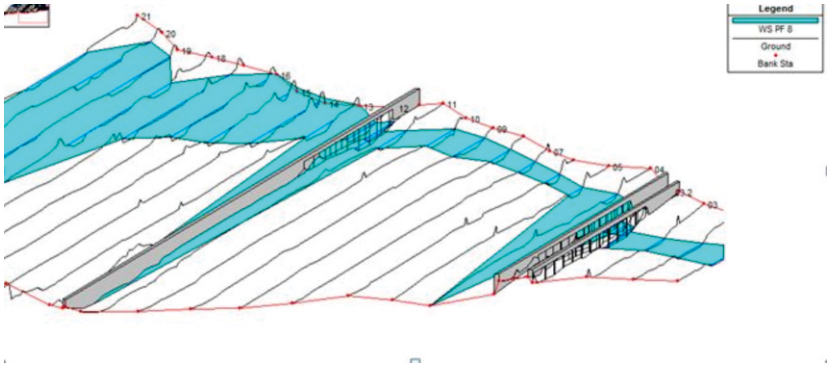


Figure 12: Perspective view of overall study area at low discharge

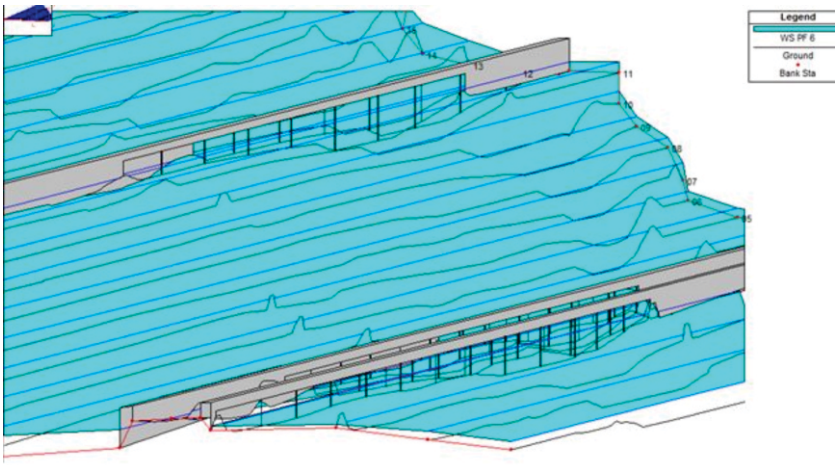


Figure 13: Perspective view of overall study area at 100 year flood discharge

6. CONCLUSIONS

- The discharge at which we analyzed our case study was of 100 year return period.
- The maximum difference we got by comparing the scenarios of WSL without bridges and WSL with 3 bridges is only 0.56m.

However all three bridges are safe under flood discharge of 100 year return period.

- This model also gives those cross sections which were over topped during flow of flood discharge in the model and also give the height of overtopping water with respect to banks.
- According to our model, the areas surrounding those cross sections which overtopped are more likely to be suffered from floods. In our case study all the cross sections were overtopped except section number 3 ,3.2 , 4, 5 and 6.
- So there is a need to raise the levels of side embankment.

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ENVIRONMENTAL DEGRADATION AND IMPACTS ON LIVELIHOODS SEA INTRUSION – A CASE STUDY[1]

By:

Dr. Abdul Majeed[2]

Abstract

The linkages between environmental degradation and poverty have been the topic of extensive debates in the recent past. Previously assumptions such as "poverty necessarily leads to environmental degradation" and "the poor degrade the environment more than the affluent" were taken as accepted facts. Today however, environmental degradation and poverty have been shown to be components of a complex cycle in which both are interdependent and the linkages between them are complicated and multidimensional.

The gradual encroachment of the sea into the Indus Delta and up the main course of River Indus in lower Sindh is increasingly being brought to the forefront of recent policy debates as one of the worst cases of large-scale environmental degradation to have occurred in Sindh. For some people sea intrusion is the main cause of the destruction of several thousand hectares of land in the coastal districts of Thatta and Badin, rendering prime agricultural land barren, contaminating aquifers and causing the degradation of coastal, deltaic and riverine ecosystems. Many believe that the degeneration of land and water resources has seriously affected fishing and agriculture, which constitute the two principal vocations of the local population leading to loss of livelihoods, migration to the hinterland and an ensuing rise in poverty levels.

This case study is an attempt to document how environmental degradation caused by sea intrusion in the coastal and deltaic tracts of lower Sindh has been instrumental in impacting and destroying the livelihoods of the local population, thereby exacerbating their poverty.

The study suggests guidelines and a set of recommendations for the Government departments to follow besides suggesting immediate measures that should be taken to ameliorate the degradation.

Background

The linkages between environmental degradation and poverty have been the topic of extensive debates in the past. It is an accepted fact that environmental degradation and poverty are components of a complex cycle in which both are interdependent and the linkages between them are complicated and multidimensional. This case study undertaken by International Union for Conservation of Nature (IUCN) is an attempt to document how environmental degradation caused by sea intrusion in the coastal and deltaic tracts of lower Sindh has been instrumental in impacting and

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[1] The Study was conducted in 2002-03 with financial support by Norwegian Agency for Development (NORAD)

[2] Water, Energy and Climate Change Expert, International Union for Conservation of Nature (IUCN) Pakistan

destroying the livelihoods of the local population, thereby exacerbating their poverty. Many environmental disasters such as droughts, floods etc. may be precipitated by the degradation of natural resources causing widespread damage and destruction.

According to observation by IUCNP experts, the sea has intruded 54 Km upstream along the main course of the River Indus. That this incursion is taking place against the gradient of the riverbed indicates that there might be an absence of any retarding factor such as a considerable volume of fresh water in the riverbed. Hence the sea surges have driven seawater into the river channel. This is an uncommon phenomenon for a perennial river.

Many are of the view that the fundamental cause may be the progressive upstream diversion of Indus waters and the gradual depletion of freshwater discharges downstream of the Kotri Barrage – the last in a series of barrages and dams on the Indus River.

Adequate freshwater flows flush the coastal and deltaic environments of seawater and salt deposits. Further, the silt load carried by the flow physically prevents the sea from intruding up the river channel. In the absence of a considerable volume of such flows there is no decelerating factor to check sea intrusion. The prolonged drought and water shortages in the country during the recent past have further aggravated the detrimental impacts of the phenomenon.

The ecology and physiology of richly productive but delicately balanced riverine and deltaic ecosystems are undergoing adverse changes, and many experts are of the opinion that this is due to a lack of freshwater flow in their environment, depleting the biodiversity of these areas. Productivity is on the decline and, in some cases, extinction of species has occurred. The mangrove forests of the Indus Delta, one of the most extensive arid coast mangroves in the world, are a case in point. Of the eight species of mangroves recorded to be growing in the Indus Delta in 1950s only three continue to flourish. While the exact reason for this disappearance is not known, experts working in this area consider the lack of downstream flows in addition to pollution, to be one of the prime reasons. IUCN Pakistan has successfully reintroduced a fourth salt tolerant species, *Rhizophora mucronata*, in the region.

In addition a sharp decline in the landing of anadromous fish species, in particular the valuable Pallah (*Tenualosa ilisha*) and Barramundi (Lates calcifer) has been observed.

The volume and quality of shrimp catch that represents a major segment of seafood exports has also fallen. Marine fish such as the Dumbra (*Labeo spp.*) have been sighted several kilometers up the course of the river. These developments point towards the persistent degradation of the ecosystems, their inevitable collapse, and the associated environmental and economic costs that will consequently be incurred.

As mentioned earlier, the livelihoods of the coastal population are mostly dependent on fisheries, agriculture and forestry. With the degradation of the natural resource base, there has been a persistent decline in the socio-economic conditions of the local communities. The loss of livelihoods has caused a rise in poverty levels, malnutrition, and the deterioration of people's health in general. The scarcity of potable and uncontaminated water is a significant factor that contributes to the increasing incidence of diseases of the skin, eyes and the digestive tract.

Sea Intrusion and the Indus Delta

Sea intrusion constitutes the encroachment of saline seawater inland and up the channels of rivers as a result of sea level rise, depletion of fresh water flows in the river channel or both. The planet is undergoing a global warming that is altering climatic trends worldwide. Higher global temperatures are causing ocean waters to expand and glaciers and polar ice sheets to melt.

Sea intrusion is affected by topographic, climatic, and hydrologic conditions such as slope of river channel; tidal magnitude; wind velocity and direction; river flow and duration; and water temperature. Of these parameters, river flow is the dominant parameter determining the phenomenon. Human activities such as hydroelectric, irrigation, and water diversion projects may change the hydrologic conditions including flows and their duration and exaggerate sea intrusion.

The intrusion of the sea in the Indus Delta and up the course of the Indus River is being termed as one of the most disastrous cases of environmental degradation that the province of Sindh has had to experience. The Indus River out falls into the Arabian Sea through 17 major creeks of the delta characterized by several minor creeks, mudflats and mangrove vegetation. The Indus Delta is a typical fan-shaped delta covering an area of 600,000 ha. The mangroves in the delta area serve as nursery and feeding grounds for many varieties of fish and shrimp. The coastal communities depend upon the mangroves for their fuel and fodder requirements.

The Issue

Though the Sindh coast is generally affected by global sea level rise, it is believed that the dominant element responsible for sea intrusion into the Indus Delta and up the Indus River channel might be the diminished freshwater discharge downstream of the Kotri Barrage that has resulted in the degradation of deltaic and riverine ecosystems. Drought conditions over the past few years have further aggravated the impacts of depleted water flows. Due to the absence of water in the river channel, seawater has intruded almost 54 kilometers upstream in the river channel till village Darwesh in Taluka Ghorabari, District Thatta. The upstream salinity data measured at this location ranged between 25,000-35,000 parts per million (ppm).

cerpt – Newspaper "The Dawn", January 10, 20(
THATTA: Sea intrusion destroys forests in Thatta

By Muhammad Iqbal Khwaja

ATTA, Jan 10: The regeneration of Babool, Kandi and La
s on more than 4,500 acres in Marho Kotri, Budhani, Ach
ho, Allah Bux and Bahadipur forests has vanished due to
asion on low-lying forest areas in Thatta coastal belt since
couple of years.

rict Forest Officer (afforestation) Riaz Ahmed Wagan tol
vn that due to acute shortage of flood water in riverine tra
his district for last several years, particularly since 1994, t
position of these forests has been changed by replacing th
ool, Kandi and Lai species with salt tolerant and more
phytic "Mesquite" species.

ides some 20,000 to 25,000 acres of riverine land previou
ivated on river water in riverine tract of Thatta district has
n rendered unproductive due to non-availability of sweet
er in the riverbed.

The data collected during the study indicate a steady decrease in freshwater flows into the Indus Delta. Some people believe that it is the inevitable consequence of

drought and imperatives of economic development upstream. To them, the negative impacts downstream are not as obvious or important. The critics in the lower riparian areas see the reduced flow as a grave concern in terms of loss of income, displacements of large number of people and economic activity. The issue is not who is right or wrong. What is obvious is a lack of communication and informed debate.

Recommendations

Sea intrusion in the Indus Delta and riverine tract has led to widespread environmental degradation and the loss of livelihoods of the thousands of people living here. The fundamental cause of this disaster is the reduced outflow of fresh river water into the sea and the effects of prolonged drought in the country over the last few years. Despite the Indus Water Accord of 1991, the Indus Delta and riverine tract of Thatta and Badin districts continue to receive less water than allocated under the Accord in order to check sea intrusion. The most necessary element in curbing sea intrusion is therefore the increase in downstream flows to the level defined by the Indus Water Accord. The recommendations that emerge from this study focus on the present scenario when downstream flows from the Kotri Barrage may not be available to the desired level.

1. Guidelines for Effective Management of Flood Releases

These have been developed for the conservation of downstream ecosystem and livelihoods of local population. They are described according to various sectors.

a) Riverine and Mangrove Forests

- The mechanism for inundating the forest area is a more important consideration than actual quantities. Consequently, out of bank conditions have to be maintained and developed which need a discharge of around 400,000-500,000 m3/sec to inundate half the reserve forest area and other forest areas outside of the forest reserve. Currently four out of bank events occur every ten years. Any further reductions in the number of out of bank events will be serious.
- The fresh water requirement of mangroves is a question of absolute quantities. For mangroves to flourish, soil and associated soil moisture salinities must be within the physiological limits. Flushing of the mangrove areas with less saline water greatly helps maintain the required salinity level.

b) Fisheries

- The frequency of out of bank flows should not be significantly changed thus continuing to recharge and restock fresh water wetlands.
- Release downstream of Kotri must be managed in such a away that the mangrove stands receive adequate flushing to maintain the fish breeding grounds
- Sufficient flows should be released downstream of Kotri Barrage during the critical breeding period of Pallah to maintain its current population.

c) Coastal and Deltaic Oceanographic Studies

- Any reduction in the current discharge arrangements, especially relating to higher discharges carrying heavy silt loads, will affect the silt transportation to the delta and marine area, with a resultant effect on the mangroves, fisheries and ecosystems of the delta and coastal areas. Hence detailed monitoring should be carried out to determine the siltation/ erosion process that currently operates in the deltaic system.
- Salinity levels throughout the river and creek system should be monitored and evaluated to establish an optimum mechanism for fresh water distribution.

d) Environmental Studies

- Monitoring programmes should be developed and implemented to form a strong database in water quantity at critical locations, industrial effluent discharge, dynamics of Pallah fish etc. in the Indus Basin. The database should be used to develop minimum residual flow requirements as necessary.

e) Surface Water Modeling

- Increased upstream extraction under the Indus Water Accord 1991 will reduce the reliability of low flows. Surface water modeling is essential to maintain at least these minimum flows.

2. Recommendations for Government and Line Departments

a. Tribunals responsible for distribution of water to the provinces should include the subject of seawater intrusion as a factor while allocating the water resources of Pakistan to the various provinces. This will result in reducing the amount of economic loss currently being faced by Sindh, which ultimately affects the country's national accounts. A study may be undertaken that explores the impact on other provinces of increasing the water share of Sindh for release in the Indus Delta.

b. The efficiency of the irrigation system needs to be improved on a priority basis by curtailing wastage. Farmers should be provided training and incentives to practice on farm water management so that the available irrigation supplies are optimally utilized.

c. Private and public sector institutions involved in extending agricultural credit need to incorporate mechanisms within their credit approval and extension processes to evaluate the risks caused by environmental degradation. This will enable such agencies in reducing overall portfolio risk, thereby reducing default rates and increasing returns to the national exchequer.

d. Investment in research and development is essential to develop saline resistant crops on a large scale. Sustained effort in this direction is required urgently and research facilities around the world should be tapped for this purpose.

e. Studies should be undertaken to ascertain how other countries facing a similar problem are dealing with this issue, and how their programs can be adapted to suit our local needs.

f. To avoid large-scale migration, a structured plan to relocate people from the affected areas should be prepared. This should also include a blueprint for vocational training.

g. A maintenance plan should be formulated regarding existing agricultural land in the affected area, together with details of capital required. This plan must be formulated at the Federal Government level and focus on sea intrusion as a national as well as a provincial problem.

h. International Donor Agencies should be made aware of the damage to people and agricultural resources of reducing water flow in the Indus River when they finance large water management projects. The damaging effects of sea intrusion should be included as costs of the projects being implemented by them. This Environmental Degradation and Impacts on Livelihoods would allow for capital for the maintenance of these lands.

i. The same should be the case with projects financed by foreign DFIs (Development Finance Institutions) such as the World Bank etc.

3. Immediate Measures

a. The extent of sea intrusion and its physical impacts should be recorded through satellite imagery and remote sensing. There is an urgent requirement of up to date maps of the coastal areas so that any changes may be monitored and recorded.

b. Salt tolerant inland species of trees should be promoted in the riverine tract. These include inland trees such as *Cassurina equisitifolia* and *Conocarpus lancefolios* (Ethiopian teak). Both these trees have good quality timber. *Prosopis Juliflora* is already thriving in the area. The wood from this shrub is used for making coal.

c. The concerned departments and agencies should provide incentives and training to the communities for the promotion of forestry of salt tolerant species in areas where agriculture is no longer possible. Though a longer-term income yielding exercise than agriculture, forestry will provide fodder for the animals in the interim period and will prevent against further degradation of land. The Forest Department should promote the raising of block plantations of salt-tolerant species such as *Cassurina equisitifolia* and *Cornocarpus lancefolios*.

d. Civil society organizations and government agencies should undertake awareness raising of communities on sustainable resource use.

e. Capacity of local communities should be built for adopting alternative livelihoods. Concerned departments as well as NGOs working in the area should provide vocational training in sectors that offer such a possibility. For example, fishermen dependent on freshwater fishing should be provided training and micro-credit facilities to change their vocation to marine fishing.

f. Micro-credit schemes should be initiated for local communities to facilitate them in adopting alternate livelihoods and developing other sources of income.

g. Detailed studies based on primary data should immediately be initiated on all ecological and socio-economic aspects of the deltaic and riverine areas. Deficiency of data was one of the major constraints encountered during the course of this study.

Finally, it may be mentioned that all these recommendations can be implemented through existing government machinery. What is required is acknowledgement of the problem and a commitment to curtail it.

EFFICIENCY OF GRASS SPECIES FOR THE REMOVAL OF HEAVY METALS FROM WASTE WATER

By:

Fizza Tahir, Abdullah Yasar, Amtul Bari Tabinda, Rizwan Rasheed, Laraib Fatima[1]

ABSTRACT:

The focus of the following study is to treat waste water with two specific strategies 1) phytoremediation 2) constructive wetlands and removal of heavy metals from perennial grasses specifically 1) *Phalaris arundinacea* (ribbon grass 2) *Ophiopogon japonicas* (mondo grass) 3) *Cymbopogon* (lemon grass) 4) *Chrysopogon zizanioides* (vetiver grass). Perennial Grasses are regarded as metal tolerant bio systems in up taking and accumulating heavy metals from contaminated sites. Phytoremediation technique was most effective using vetiver grass for removal of waste water contaminants. Industrial discharge of heavy metals at elevated concentrations of Zn, Cd, Cu, Pb, Fe, As, Ni observed in two major industries of Pakistan LITE (Landhi Industrial Trading Estate) & SITE (Sind Industrial Trading Estate). Constructive wetlands meets the criteria for the heavy metal removal of industrial waste water.

Key Words: Wastewater, Perennial grasses, heavy metals removal, Phytoremediation, Constructed wetlands

INTRODUCTION:

Waste Water:

The water quality is increasingly leading to detoriation, whichisgreatly caused by anthropogenic activities that include liquid waste from domestic residences, commercial areas and properties, mining and agricultural practices and manufacturing industries. The water that is discharged from residential areas, hospitals, commercial buildings and market is referred as domestic wastewater. Whereas the one discharged from industrial units and manufacturing practices is industrial wastewater. The quality and quantity of the wastewater discharged from industrial units depends on several factors as the type of industries from where the wastewater is being discharged, the number of units, working hours, the quality of water that is being utilized by the industry. The industrial wastewater comprise major part of wastewater in cities *(Harmancioglu, 2007).*

Consideration of Treatment Effectiveness Globally:

The industrial and municipal wastewater treatment level for a country is a reflection of its income. On average basis, 70% of wastewater is treated by high-income countries that they generate. This ratio drops for upper middle income countries to 38% and for lower middle countries to 28%. This level is extremely lower for the low-income countries as only 8% wastewater that is being generated undergoes any sort of treatment *(Sato et al., 2013)*. These estimates often support the fact that globally approximately 80% of the wastewater without adequate treatment is released in to the environment (*WWAP, 2012).* For the African countries, the major constraint

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associated with the development of wastewater treatment facility and managing is the lack of financial resources. The ratio of discharge of treated wastewater to drains in Pakistan is only 1%.Table 1 shows the wastewater produced annually by large urban centers in Pakistan as its associated treatment.

Table 1: Wastewater produced annually by cities and towns

City	Urban Population (1998 Census)	Total Wastewater Produced (million m3 /y)	% of Total	% Treated	Receiving Water Body
Lahore	5,143,495	287	12.5	0.01	River Ravi, irrigation canals, vegetable farms
Faisalabad	2,008,861	129	5.6	25.6	River Ravi, River Chenab and vegetable farms
Gujranwala	1,132,509	71	3.1	-	SCARP drains, vegetable farms
Rawalpinidi	1,409,768	40	1.8	-	River Soan and vegetable farms
Sheikhupura	870,110	15	0.7	-	SCARP drains
Multan	1,197,384	66	2.9	-	River Chenab, irrigation canals and vegetable farms
Sialkot	713,552	19	0.8	-	River Ravi, irrigation canals and vegetable farms
Karachi	9,339,023	604	26.3	15.9	Arabian Sea
Hyderabad	1,166,894	51	2.2	34.0	River Indus, irrigation canals and SCARP drains
Peshawar	982,816	52	2.3	36.2	Kabul River
Other	19,475,588	967	41.8	0.7	-
Total Urban	43,440,000	2,301	100.0	7.7	-

Source: Master Plan for Urban Wastewater (Municipal and Industrial) Treatment Facilities in Pakistan. Final Report, Lahore: Engineering, Planning and Management Consultants, 2002

Waste Water Facility in Pakistan:

Pakistan, which was once a surplus country, is now a water deficit country because of the depletion of water resources (*Ensink et al., 2004)*. In Pakistan mostly wastewater is discharged into a sewer tank, drain or a water body without any sort of treatment because there is no efficient and effective wastewater treatment facility. The wastewater is being used for irrigation processes despite the ill effect it would cause to human health *(Pak-SCEA, 2006).*

Major Industrial Contributors:

Several cases have been reported but very few are known for the municipal and industrial wastewater concerns. The first example is related to coastal area of Karachi that suffers from disposal of untreated wastewater by **two major industries LITE** (Landhi Industrial Trading Estate) &**SITE** (Sind Industrial Trading Estate). Both discharge 615 and 550 tons of Biological Oxygen Demand (BOD) per day of pollutants into Malir and Lyari Rivers. LITE is located in Korangi (Karachi) wheresuspended solids (35 tons), dissolved solids (376 tons), ammonia (1 ton) and of arsenic oxide (1.4 tons) are discharged along with other chemical substances along the harbor of the city and polluting it.The second example is related to 250 tanneries located in Kasur City near Lahore that dispose untreated wastewater containing highly toxic chemicals (*Javed et al., 1998).*

The total quantity of wastewater produced in Pakistan as has been revealed by the statistical data is **962,335 million gallons** (4.369*10 m3/yr), 288,326 million gallons (1.309*109 m3/yr) is being produced from industrial units. The wastewater discharge to major rivers as is 392,51 million gallons, where out of it 75,711 million gallons (0.344*109 m3/yr) is of industrial effluents *(PWSS, 2002*).The pollution status of Pakistan is of very much concern and is reflected from different studies which are presented here in the form of a table(table 2).

Table 2: NEQS concentration for effluent discharge

Location	Zn	Cu	Fe	Mn	Cd	Cr	Ni	Pb	As	Ref.
	(mg/L) range (mean)									
NEQS-Pak	5.0	1.0	8.0	1.5	0.1	1.0	1.0	0.5	1.0	[24]
Textile effluents in the Kabul River, KPK	-	0.04–0.17	-	0.01–0.1	0–0.16	0.5–0.8	0–0.04	0.07–0.14	-	[1]
Textile industries Hattar n = 90)	0.014 – 2.482	-	0.039–30.3	0.011 –0.97	0.004–0.181	0.023–2.671	0.013 – 2.482	0.013–2.34	-	[20]
Korangi area, Karachi, Sindh (n = 24)	0.005 –5.5	0.005 –1.19	0.04–5.58	0.01–1.79	0.004–2.4	0.004–5.62	0.02–5.35	0.05–2.25	-	[35]
Gujranwala , Punjab (n=3)	(9.0)	(0.61)	(2.03)	-	-	-	-	(0.35)	(0.475)	[32]
Hudiara drain, Lahore, Punjab	(1.7)	(0.45)	7–9	(0.85)	(0.18)	(0.07)	(0.93)	(0.03)	-	[17]
North and East zone of Lahore, Punjab (urban and industrial wastewater)	0.34–1.39	9.28–32.69	-	0.19–1.13	0.18–0.37	0.19–0.54	0.91–5.94	0.26–0.70	-	[18]

Source: BioMed Research International, vol. 2014, Article ID 813206, 29 pages, 2014.

Heavy Metals and Associated Contamination:

The contamination of aquatic ecosystems due to heavy metals is of great concern. The discharge of industrial effluents in to river bodies worsens and broadens the wastewater pollution. Research and investigations have been carried out and made to the extent heavy metal pollution is caused to surface water, ground water, soil, vegetation by industrial units and industrial activities.

Heavy metals are the metallic elements of periodic table referred as trace elements and are considered as the most persistent pollutants regarding wastewater. The most important metals in wastewater are arsenic, lead, mercury, copper, lead, cadmium, silver and zinc. The environment and human health concern is associated with how these elements flow through each compartment and various pathways and reach humans. The toxic metals as Pb, Co, Cd are differentiated from other

pollutants, as they cannot accumulate in living body and led to causing various diseases and disorders even in lower concentrations (*Pehlivan et al., 2009*).

Phytoremediation, A form of Bioremediation:

Phytoremediation is one of the biological method for the treatment of wastewater. It consist of Greek prefix **phyto** (plant) and Latin word **remediation** (to remove an evil) *(Prasad, 2004*). The various other terms, which could cause a confusion for the novices, are green remediation, botano-remediation, agro remediation, and vegetative remediation *(Andrew, 2007*). The environmentally friendly technology, cost effective process, with aesthetically removing the pollutants, an approach that is suitable for developing countries (*Bruce, 2001*). The idea of using metal accumulating plants for removing heavy metals was introduced in 1983, but the concept has gained implementation since last 300 years *(Henry, 2000).*

The other terms associated with phytoremediation are described as follows:

- **Phytoextraction** is one of the sub processes associated with phytoremediation in which plants uptake the contaminants and the pollutants by their roots and translocate within the plants. *(Andrew, 2007).*
- **Rhizofiltration** is the use of plants to adsorb the contaminants in their roots (rhizosphere) from polluted aqueous sources.
- **Phytostabilization** is the term associated with using the plants in reducing the mobility of the pollutants in the environment through accumulation by roots, thus preventing pollutant migration to groundwater *(Erdei et al., 2005).*
- **Phytovolatilization** is the uptake of contaminants most probably organic compounds from soil or wastewater using plants, transforming them into volatile form, and releasing them in to atmosphere (*Ibeanusi, 2004).*

A Cleanup Technology:

Phytoremediation a form of bioremediation process, which is an advanced cleanup technology for contaminated soils, ground water, wastewater and is considered a cost effective approach. This make use of ability of plants to concentrate pollutants and include grasses, forbs for removing pollutants as trace metals, organic and inorganic compounds. The simpler phytoremediation system that have been used since years are the constructed wetlands using cattails as plant vegetation to treat municipal sewage or acid mine drainage. The phytoremediation process for a contaminated site with heavy metals or radionuclides that involve farming the soil with the selected plant species to bio mine the inorganic contaminants. In case of soil contaminated soil for toxic organics the approach would be similar as the plants take up the contaminants and assist in the process of degradation of organic compounds *(Salt et al.,1995).*

For the treatment of contaminated wastewater, a granular substrate which is mostly sand or gravel in which plants are grown in these bed. The wastewater trickles through the bed, which are ramified by plant roots and contaminants uptake system *(Hinchman and Negri, 1994).*

Plants Consideration for Phytoremediation:

The low cost plants that are easily maintained and used and making the system attractive to be used are the aquatic plants. They are considered as far known for accumulation and concentration of heavy metals*(Outridge and Noller, 1991).*There has been now a growing interest in the use of metal accumulating roots and rhizomes of aquatic and semi aquatic plants for removing heavy metals from contaminated streams.

Ideal Plant Species:

The plants mostly considered for the phytoremediation process are metal hyper accumulators. These plants occur and are found in wide range of families of vascular plants. *(Reeves and Brooks, 1983).*

The ideal plant species, which has to be considered, should have

- considerable capacity of metal uptake
- accumulation capacity
- durability and strength to reduce the length of time

The terms associated with phytoremediation process which describes the metal uptake by plants are accumulating capability, tolerance capability and removal efficiency.

- **Accumulating capability:** The ability or capacity of the plants to accumulate heavy metals in their parts above the ground is referred as accumulating capability and in amounts greater than 100 mg kg-1 for Cd, for Cu, Cr, Pb and Co in 1000 mg kg-1 and in case of Hg 10 mg kg-1 *(Lasat, 2002).*
- **Tolerance capability**: It is the capability of plants to be able to grow in contaminated sites and must have this tolerance without showing any sort of reverse or negative effects as chlorosis, necrosis, and whitish brown color *(Sun et al.,2009).*
- **Removal Efficiency**: It is the ratio based on plant biomass, which is the total concentration of metals and plants dry biomass to the total loaded metals in the growth media *(Soleimani et al., 2010).*

Grasses as the most preferable option:

Perennial Grasses are regarded as metal tolerant bio systems in up taking and accumulating heavy metals from contaminated sites. They are the most considerable option and most evaluated than trees, shrubs (*Shu et al, 2014)*. They have preference in phytoremediation over other plants because of the various characteristics that they represent including rapid growth, large amount of biomass, strong resistance, their efficient ability to remediate contaminated sites in shorter time *(Malik et al, 2010; Sinha et al, 2013*). They are able to adapt to and tolerate stress environment and low nutrient content in soil and are considered as pioneers. Their intensive penetration of soil reduces leaching, runoff, and erosion via stabilization of soil offering advantages for phytoremediation *(Garba et al, 2012).*

Lemongrass (*Cymbopogon**)*** is a perennial, tufted grass shown in (fig.1). Lemongrass flourishes in a wide variety of soils, from loamy to poor laterite. It is tall

grass with height in 1m (Rangari, 2009). Leaves are green, tapering upwards and along the margins and ligules are very short (Qadry and Shah, 2009).



Figure 1: lemon grass

Source: *Lemongrass.gifcontent/uploads/2017/11*

Mondo grass (*Ophiopogon japonicas*) is a low, stemless, glabrous, grasslike, perennial herb with large stolons with tuberous roots. Leaves are leathery, narrow-linear, 20 to 30 centimeters long, gracefully arching and dark green as shown in (fig. 2)



Figure 2: Dwarf mondo grass in Japanese garden

Source: *Ann McCullohOhio Gardener* Volume III Issue I.

Ribbon grass (*Phalaris arundinacea*) is large and course with erect, stems that can reach up to nine feet in height as shown in (fig.3). The leaves have a rough texture and could vary from light green to straw color with length of 3½ to 10 inches.



Figure 3: Ribbon grass act as heavy metal tolerant near river bed

Source: Clinton C. Shock. Malheu (Accessed 5/2014).

Vetiver grass *(Chrysopogon zizanioides)* originates from india from graminae family, it is among a few grass species that remove heavy metals contaminants in water meeting all the criteria required for the removal as shown in (fig.4). Indicating unique physiological characteristics it has high tolerance for heavy metals such as Cu, Se, Zn, As, Ni, Cr, Cd, these metals are present at elevated concentration in waste water. It is a tropical grass and an ecological climax species. Vetiver grass is native in asia, south east asia, and india. It has super absorbent characteristics for the pollutants and contaminants for waste water treatment.*(Darajeh et al, 2014).*



Figure 4: Vetiver grass being used to treat waste water

Source: *Paul Truong, the Vetiver Network International*

The remediation techniques utilize various engineered and structured systems using various and specific planning arrangements, as constructed wetlands, floating plant system and other configurations. Different mechanisms such as sedimentation, filtration, chemical precipitation, absorption, microbial interaction are employed in the removal of wastewater pollutants *(Mitchell, 1996).* The most widely used and effective technology is using phytoremediation technology with constructed wetland system.

Constructed Wetlands:

Constructed wetland systems are the systems designed and constructed having natural function as of wetland vegetation, soil and the associated microbial population involved in treating the contaminants in the aquatic habitats.They have a potential to be used at small scale by households. Constructed wetlands has a potential for treating point and non-point sources. This is an effective option for the removal of nutrients and other contaminants form wastewater. They are of two types of constructed wetlands free water and subsurface flow constructed wetlands. The constructed wetlands are defined based on flow regime, that the flow through the filter bed which could be horizontal or vertical.

Structure:

Constructed wetlands consist of three basic components a **system container, macrophytes and substrate**. A container in which the filter bed provide the space for the biological treatment of the effluent. The aquatic plants such as cattails,

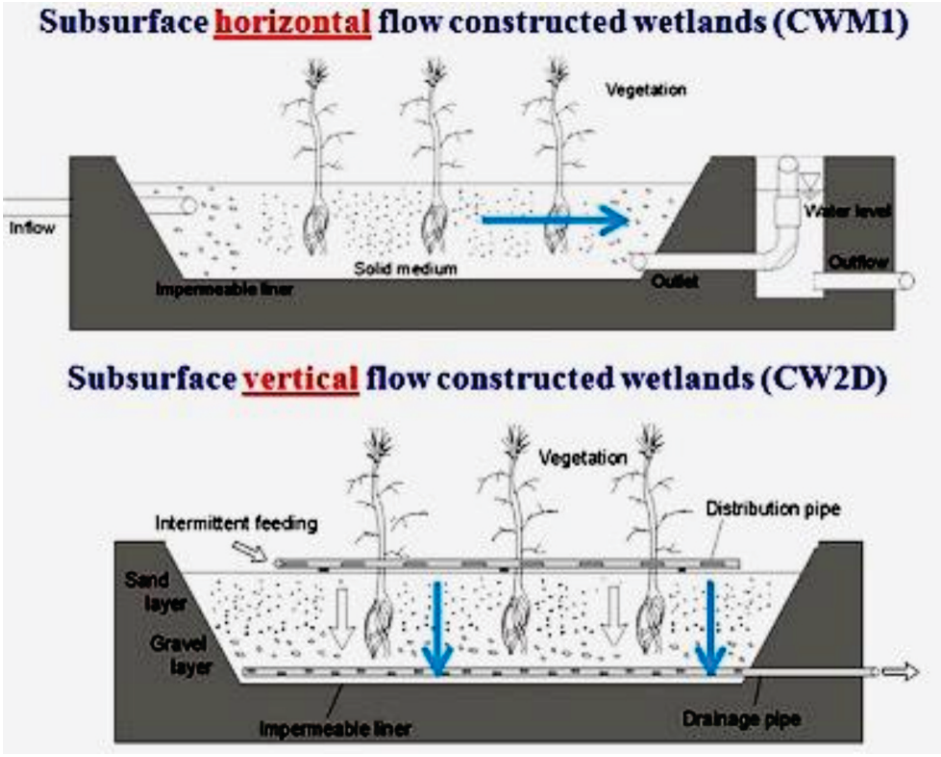
bulrushes and reeds are planted and allowed to grow on the filter bed. Of the two ways, discharge the wastewater into the structured wetland system by either pumping or gravity.

Horizontal Flow Constructed Wetland:

In a horizontal flow (HF) system, water enters through an inlet, flows slowly through the substrate, and exits or drain through an outlet system at the other end. This removes organic material and suspended solids effectively by the processes described in the table below. Ammonia volatilization does not take place in this system, as there is lack of oxygen to proceed with this step.The removal of phosphorous is also low as require some special substances to be inserted in the substrate (*Vymazal, 2010*).

Vertical Flow Constructed Wetland:

This gives high treatment efficiency. The water percolates downward through the sand or gravel medium where water is collected at the bottom and then pumped to the next cell for further treatment. The downward flow of the water in VF systems allows for much more oxygen rich (aerobic) conditions. These systems effectively perform all the physio chemical and biological processes *(Vymazal 2010*).



Role of Plants in Constructed Wetland:

A number of physical, biological and chemical processes take place in wetland system as shown below in (table 3).The major processes of interest are photosynthesis, respiration, fermentation, nitrification, denitrification and phosphorous removal. The most reactive zones in the plant are the root zones that rhizosphere where the most processes occur (*Vymazal, 2011*). In constructive wetland medium treatment, the influent waste water is run through a designed wetland specifically made for the plant nutrient uptake and encourage microbial

activity processes. Medium selection depends on certain characteristics as climate, land availability.

Table 3: The processes in constructed wetland

Waste water Constituent	Removal Mechanism
Suspended solids	Sedimentation Filration
Soluble Organics	Aerobic microbial degradation Anaerobic microbial degradation
Phosphorous	Sorption Plant uptake
Nitrogen	Ammonification Denitrification Plant uptake Sorption
Metals	Adsorption and cation exchange Plant uptake Precipitation Microbial oxidation/reduction
Phosphorous	Sedimentation Filtration Natural die-off Predation UV irradiation

Source: Mechanisms of processes involved in wetland system *(Copper et., 1996)*

The artificial wetland system has been employed for the treatment of municipal, agricultural, industrial wastewater. They are beneficial in a way owing to high nutrient absorption, operation and maintenance costs, low production of sludge and has a potential for creating biodiversity (*Korkusuz et al., 2005*). This proves to be cost- effective approach causing no pollution and have higher rate of transforming the pollutants that occur in the environment in to byproducts that are harmless.

CONCLUSION:

Pollution load from industries is increasing day to day as more of the industrial units are on the road. The pollutants discharge to water courses is an extremely sensitive issue that has to be dealt with for the benefit of the human health and environment. For this purpose the efficient technology and cost effective process to be considered is constructed wetland technology which has proven to be apotential source for the removal of pollutants.

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COPING WITH WATER SCARCITY IN PAKISTAN

By

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Most countries in the Near East and North Africa suffer from acute water scarcity such as Mexico, Pakistan, South Africa, and large parts of China and India. Irrigated agriculture depicting bulk use of water in these countries is the first sector affected by water shortage and increased scarcity, resulting in a decreased capacity to maintain per capita food production while meeting water needs for domestic, industrial, and environmental purposes. For long term sustainability of the needs, Pakistan needs to focus on the efficient use of all water resources including groundwater, surface water and rainfall and on water allocation strategies that will maximize the economic and social returns to limited water resources, and at the same time enhance the water productivity of all sectors. The issue relating to equity in access to water and on the social impacts of water allocation policies needs to be addressed properly. The growing scarcity stands now a major threat to future advances in poor alleviation. Integrated water resources management and water efficiency plans are required at local, national and river basin levels. Uncontrolled groundwater extraction, lack of adequate planning, legal framework and governance are also contributing water scarcity. This paper identifies how to cope with water scarcity being a strategic issue and addresses efficient use of all water resources.

Key words; Water scarcity, agriculture, surface water, groundwater, governance

1. INTRODUCTION

Pakistan lies in the arid and semi-arid region and suffers from acute water shortage affected by droughts and wide climate variability. By 2025, 1800 million people will be living in countries or regions with absolute water scarcity and two-thirds of the world population could be under stress conditions. In Pakistan, irrigated agriculture is a major engine for economic growth and poverty reduction. Growing scarcity and water competition is a major threat to future advances and poverty alleviation. In the past, water development projects have turned down poverty alleviation by providing food security, protection from flood flooding and drought.

Most countries in the Near East and North Africa suffer from acute water scarcity such as Mexico, Pakistan, South Africa, and large parts of China and India. Irrigated agriculture depicting bulk use of water in these countries is the first sector affected by water shortage and increased scarcity, resulting in a decreased capacity to maintain per capita food production while meeting water needs for domestic, industrial, and environmental purposes.

Water scarcity relates to water imbalance between supply and demand. The increasing world population, better living standards, improved consumptions patterns and expansions of irrigated agriculture are main driving forces for rising global water demand. On the other hand, climate change such as altered weather pattern (floods and droughts), deforestation, increased pollution, green-house gasses and waste full use of water can cause insufficient supply. Globally fresh water is enough to meet demand of current population of 7 billion and even sufficient for population growth of

9 billion in future. However, spatial and temporal variation of water demand and availability is large and leading to water scarcity in many parts of the world especially in the East and Africa. Scarcity varies over time due to natural hydrological variability but varies even more as a function of economic policy, planning and management policies. Demand is expected to outstrip supply by 40% in 2030 if current trends and practices continue in various parts of the world.

The reports by the United Nations Development Programme (UNDP) and the Pakistan Council of Research in Water Resources (PCRWR) also warn the authorities that the South Asian countries will reach absolute water scarcity by 2025. The study of PCRWR revealed that rapid depletion of ground water may soon worsen the water crisis in Pakistan's major cities, causing a drought-like situation. Such crisis needs to be taken on war footings; otherwise, a large section of Pakistan's population, especially those living in big cities, will be facing severe shortage of water.

Mitigation measures can be taken-up like formulation of a national action plan for combating chronic water shortage, devising realistic water policy with population-based distribution of water resources, construction of new dams, reducing water losses from seepages, leaching and percolation by lining of canals, distributaries and water channels along with restricted or controlled draining of underground aquifers.

2. POLICY FRAMEWORK

Pakistan is a member of the United Nations' Framework Convention on Climate Change (UNFCCC) 1992 and has passed the Climate Change Act-2017 on April 28, 2017. Katowice (Poland) Climate Change Conference (UNFCCC-COP-24 is scheduled to be held on 3-14 December 2018. The UNEP's (United Nations Environment Program) Adaption Gap Report 2016 warns of the increasing impacts and resulting increases in global adaption costs by 2030 or 2050.

The report indicates that the importance of enhanced mitigation action towards limiting the global temperature increase to below 2oC. Pakistan contributes very little to the overall (globally) Greenhouse Gas (GHG) emissions, but is extremely vulnerable to the impacts of climate change. UNEP and UNFCCC, under its climate change Finance Fund, can assist from their funds allocated for climate change.

There exist big gap between requirements of PCC Act 2017 and actions by the Government of the Pakistan. According to Global Climate Risk Index (CRI-2018), Pakistan ranks at 7th position (period 1997-2016) among the most affected countries by climate change. As per thematic areas/goals indicated by UNFCC, It is dire need to study in detail various aspects of climate change in Pakistan and propose adaptations based on existing scenario of vulnerably and requisite resilience of infrastructures against impacts of climate. The legislation and regulations for implementation should be given priority. The formulation of the strategy covering management of indigenous renewable energy needs to be concentrated.

3. COPING WITH WATER SCARCITY

The UNFCC-1992 provides the bases for actions to combat water scarcity and climate change. The Kyoto protocol 1997 and Paris Agreement 2015 are modeled on UNFCC. The main objective of the UNFCC is to stabilize GHG concentrations in

the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. The complex challenge at present in Pakistan is water shortage with respect to quality and quantity of surface as well ground water. Floodplains of all rivers require special attention for evaluation of floods and management. In this regard, legislation and regulation is of utmost importance. Pakistan is now water stress country with less than 1000 m^3 per capita per annum water availability.

Integrated Flood Management

Proper integrated flood management (IFM) may reduce flood risks in Pakistan within the framework of Integrated water Resource Management (IWRM). As a result of Glacier melt in the Himalayas in future, may cause exceptional high floods. In this regard, integrated approach to flood management is important dealing with the magnitude of the flood hazard/capacity of the streams/rivers and the vulnerability of the adjacent areas.

All nullahs/streams/rivers including three western rivers of Pakistan should be analyzed economically /financially as risk mitigation projects. Adequate legislation regulations regarding Floodplain management based on return period of the floods is now important to cater the adverse impacts of climate change and water scarcity.

Rainwater harvesting

Rainwater harvesting is an important tool and proven method of recharging of aquifers. This tool is helpful as strategic approach to meet water stress /water scarcity/recharging of aquifers in Pakistan.

Drinking water and sanitation

As per World Resource Institute (WRI), the country is among the leading five that face extremely high water scarcity and low access to safe drinking water and sanitation. The quarter to third of Pakistan's population lacks access to safe drinking water. Both the urban and rural areas suffer from water scarcity, water contamination and water-borne diseases. In this regard, better and safe drinking supply and sanitation arrangements needs urgent attention of the Government and should be given priority.

New dams and reservoirs

Tarbela and Mangla dams are 40 years old and their storage capacity is falling because of silting and sedimentation. The 30 days of average water demand compared to 220 days for India is available for Pakistan. This has given rise to water scarcity. The construction of new dams and reservoir is the need of the time Like Diamir Basha Dam and Mohmand Dam.

By improving management of existing dams, rehabilitation /remodeling of system of canals and barrages, managing proper existing water resources and attending policy flaws may reduce the risk of water scarcity.

The smaller dams being built not being on the national irrigation grid system, are of little help to alleviate or even minimize the water shortage being felt by the Pakistan's Irrigation System with seventeen barrages and thousands of miles of canal network. The result is acute water shortage and water crisis.

Indus water treaty

Pakistan receives around 145 million acre feet of water every year but can only save 13.7 million acre feet. Pakistan needs 40 million acre feet of water but 29 million acre feet of our floodwater is wasted because we have few dams. Bughlier and Kishenganga Dam on Chenab and Jhelum rivers has started to eat up substantial portion of Pakistan's share of water. India has violated Indus Water Treaty many times by building dams on western rivers. Water crisis has badly affected the agriculture sector of Pakistan. The agriculture sector, according to latest Economic Survey of Pakistan, contributes 21 percent to total GDP of Pakistan. The water scarcity results in severe economic distress to country's economy.

4. Conclusions and recommendations

Following conclusions and recommendations are drawn:

i) The worsening water crisis needs to be resolved for economic stability and development. Far deeper changes are required to mitigate the water scarcity.

ii) Available sufficient water around the year needs to be reserved rather it is left for spoilage and wastage.

iii) Heavy investment in water-saving technology should be given priority to reduce water scarcity.

iv) Implementation of policies like Pakistan Climate Act 2017 and removing bottle-necks in legislation and regulation is important.

v) National Action Plan needs to be prepared and implemented based on PCC 2017.

OPPORTUNITIES OF CONSERVATION AGRICULTURE TO IMPROVE SOIL QUALITY AND MITIGATE CHANGING CLIMATE

By:

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ABSTRACT

Weak quality of soil due to low contents of organic matter and structural instability are major cause of dust pollution in arid/semi-arid regions and also involve in changing climate. Mismanagement of natural resources through clean cultivation, intensive tillage, deforestation and overgrazing are also worsening the situation. Therefore, it is the need of time to search alternative systems that improve soil properties, provide sufficient crop yield and mitigate to climate change. Conservation agriculture (CA) is an emerging technology, which serves as an alternate system to improve soil health by increasing soil organic carbon contents, reduce soil salinity by moderating pH, mitigate climate change by carbon sequestration also reduce fuel, labour and other related input cost by eliminating tillage operations. It has been successfully adopted worldwide for sustainable agriculture, but dryland areas in the South Asia, including Pakistan seem to have missed the opportunity. Most of research studies from dryland areas of Pakistan are short term and they indicate that different forms of CA increase organic matter contents, reduce soil pH, improve soil structure, provide equal yield and economic benefits by decreasing input costs. Particularly chisel plow performed better in comparison with moldboard plow in most of the investigations. There is a need to establish long term, multi-location and collaborative research experiments on different aspects of CA along with the use of computer based models for long term simulations. On farm practice of CA is scarce due to social hindrance, unavailability of local ZT drills, alternative uses of residue, non interest of Government organizations. There are big opportunities of CA in dryland areas of Pakistan as climate, soils and crop diversity are conducive to that. Promotion of CA can be enhanced by encouraging local manufacture of zero tillage drills and on farm trainings of the farming community. CA is the need to improve soil quality, diminish dust storm, mitigate changing climate and reduce input costs of resourceless farmers of Pakistan.

Introduction

Pakistan is situated in the north - western South Asia, between latitudes of 23.5° N to 37° N and longitudes 61° W to 76° W. It is surrounded by India in Southeast, China in the north, Afghanistan in northwest, Iran in the west and Arabian Sea in the south (SOER, 2005).

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The dryland agro-ecosystems of the country encompass variety of landscapes such as Pothwar plateau, upland of Khyber Pakhtunkhwa, Balochistan plateau and desert of Cholistan. The climate of these regions is mostly characterized as arid to semi-arid while a small portion falls in humid and sub-humid categories. Most of the area is very hot in summer and very cold in winter with four common seasons of winter, spring, summer and fall. Rainfall is inadequate, erratic and about 70% of the rain is received during monsoon (July-September) in the form of torrential storms with exception at Balochistan where winter rains dominate. Two most important cropping seasons are *Rabi* (winter) and *Kharif* (summer) with different cropping patterns. In *rabi* wheat and gram and in *Kharif* Millet, sorghum, maize and pulses are grown. The soil textures of these areas are mostly silty loam and sandy loam with Aridisols and Inceptisols as common soil orders.

Pakistan's dryland areas are facing numerous problems such as desertification, land degradation, structural instability and loss of natural resources (Zia *et al*. 2004). Higher evaporation than precipitation, alkaline pH, accumulation of excessive salts and soil surface crusting are other serious problems in these areas (Rafiq 1990). Commonly a hardpan is observed beneath the soil surface due to intensive tillage and continuous plowing at same depth, which restricts the movement of soil water and plant nutrients in the deeper profile layers. The plow-pan also decreases water infiltration and thus encourages runoff losses (Razzaq *et al*. 1989). Soil water conservation in the soil profile is the major challenge in dryland farming systems (Campbell and Akhter 1990).

One of the major reasons for the above cited problems is low organic matter content of these soils. The loss of organic materials in these areas is very fast due to high temperature in summer, over grazing, deforestation, clean cultivation and intensive tillage with moldboard plow. Further the low cropping intensity and lesser biomass of crops due to water stress, inadequate availability of essential nutrients, weed infestation which ultimately results in less return of organic matter to soil. These anthropogenic and natural factors not only degrade the quality of soil but also contribute to green house gas emissions and thus the climate change that ultimately results in flooding, drought, snowfall and some other drastic events. These mismanagements of natural resources and increasing population pressure promote landlessness and small holder land farming systems. The increasing cost of fuel and other farm inputs are also the critical issues for resource poor farmers. All the above cited problems ultimately affect crop production and due to that potential yields are very low in dryland areas of Pakistan than some other countries.

A few years back, the farmers of dryland areas of Pakistan were using tine cultivator as traditional practice, but in the decade of 1980-90 Barani Agriculture and Rural Development Project (BARD) encouraged the adoption of moldboard plow, especially in the uplands of Pothwar. Most of the literature reported by BARD showed that intensive tillage stored higher soil moisture, decreased bulk density and increased crop yield (BARD 1985-89, Campbell et al, 1987). But the long term application of conventional tillage has shown significant economic and environmental drawbacks. From an economic point of view high energy and labour costs ultimately lead to higher cost of production (Košutić *et al*. 2006). From an ecological point of view, disadvantages of intensive tillage systems are increased soil compaction caused by an excessive number of machinery passes, plow pan, systematic reduction of soil organic matter and greater susceptibility to soil erosion

(Birkas 2008). Significant CO_2 emissions from the combustion of large amounts of fuel consumed in the intensive tillage is also an environmental issue (Filipović *et al*. 2006). After a 5 year study (Akhter *et al*. 2002) in Pothwar, northern Punjab dryland found that use of the moldboard plow destroyed soil structure and reduced number of larger pores. As a result of worldwide recognition of huge problems associated with moldboard plow, now it is the need of time to explore alternative systems which not only sustain the quality of soil but also provide sufficient yield by reducing input cost of farmers and help mitigate climate change by carbon sequestration.

Conservation Agriculture (CA) system is being advocated worldwide for sustainable agriculture to improve the health of soil and provide sufficient yield while reducing input cost. Conservation Agriculture (CA) is an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment (FAO 2011). Three main pillars of CA are i) minimum soil disturbance ii) residue cover and iii) crop rotation. It was initiated in the United States of America in 1930 with the theme to overcome dustbowl. New mechanized equipment was developed in 1940 to directly cast seed into soil. It reached Brazil In 1970 where the farmers together with scientists transformed it into a new resource conserving technology now known as CA. It developed exponentially as a revolutionary technology in Argentina and Paraguay. Afterward this advancement was taken up by different world leading organizations like FAO and ICARDA. Through seminars, workshops and research publications, the system has reached the deserts of Africa, central Asia (Khazakhastan) and west Asia (China) **(**Friedrich *et al*. 2012). In 2011 the estimated area under CA was 125 mha. The countries where CA is not practiced have so far missed the opportunity due to research gap, farmer perception and unavailability of locally manufactured zero tillage drill (FAO, 2008; FAO, 2011.

There are numerous benefits of CA for soil health, crop production, water conservation and recently accentuated environment. In CA systems addition of crop residues play a vital role (Loveland and Webb, 2003) that interfere with soil physical, chemical and biological properties (Dexter, 2004). It increases and retains organic carbon in soil (Franzluebbers, 2002; Zibilske *et al*. 2002), improves soil water infiltration, decreases soil surface loss through surface cover and improves soil water and nutrient conservation (Franzluebbers, 2002). The CA also makes the soil stable against the deterioration by water and wind erosion (Madari *et al*. 2005; Chan *et al*. 2002). The crop residues on the soil surface also protect the soil from the impact of rain drop and slow down the intensity of runoff by acting as surface barrier (Franzluebbers 2002b; Zhao *et al*. 2007) thereby increasing intake of water into soil profile and increased *in situ* moisture conservation (Shaver *et al*. 2002). Conservation agriculture system not only improves the quality of soil but also sufficiently increase crop yield. Different researchers have reported that crop yield significantly increases under conservation tillage (Hemmat and Eskandari, 2006; Huang *et al*. 2008). (Ling *et al*. 2011) after a review of CA in China concluded that CA promotes soil and water conservation by reducing evaporation losses, increasing moisture storage and organic matter content, slowing down the impact of rain drop, reducing water and wind erosion, depressing weed population and improving soil structure. They also held that CA improves crop production by providing better nutrient cycling and efficient use of profile water. Furthermore CA has been found to be economically better due to reduced input costs of fuel, labor, fertilizer and

unnecessary plowing. Although CA interferes with all the environment of soil (Huang *et al.* 2008b), however its effects are site specific and depend on the soil and climate of the area.

The Objective of the current study is to highlight soil desertification and its components which increasing due to mismanagement of natural resources also emphasises the potential of CA in comparison with worldwide scenario. However to review the research status of CA in dryland areas of Pakistan and their effect on soil properties, weed intensification, crop production and economics. Also highlight challenges and opportunities of CA to combat desertification, environmental vulnerability and increasing cost of input.

Status of research on CA in Pakistan

Most of the available literature on CA in Pakistan is from the Pothwar Plateau of northern Punjab and uplands of Khyber Pakhtunkhwa while the evidence from other dry land areas is scarce. The Pothwar Plateau consists of near about 2 mha of which more than 1 mha under cultivation. The Plateau has generally gently undulating surface, locally broken gullies and low hills. The rainfall in this area varies from 500-1000 mm annum. More than 70% of the rainfall received during monsoon (July-September). Summer is very high temperature while winter is very cold. The KP falls in the semi-arid zone. The annual rainfall during the last many years ranged between 200 mm to 1057 mm with an average of about 435 mm. The most humid month is August (76.7mm) followed by March (73.7mm) while June (11.6mm) and October (13.4 mm) are the driest months. The evapotranspiration range is narrow during December to March (36-85mm) and highest in June (202mm). The mean monthly maximum temperature ranged from 17.6 to 39.3 C^{o} and the minimum temperature from 1.7 to 24.1C^{o}. The highest monthly temperature is around 43C^{o} in June and the lowest –3oC in December. The average Relative Humidity (R.H) ranges from 54 (June) to 72.6% (August). The research is generally focused on the effects of different forms of conservation tillage on soil properties, crop yield and economic benefits.

Effect on soil properties

As previously mentioned there are multifarious soil related natural and anthropogenic issues in dryland areas of Pakistan that are further aggravated with the use of intensive tillage and clean cultivation. Therefore there is a need to improve the quality of soil by reducing number of plowings, incorporating crop residues and thus increasing organic carbon content. Shah et al. (2010) in uplands of Khyber Pakhtunkhwa after three years of an experiment found that NT improved 16% SOC, 10.44% MBC and 16.87% MBN over the CT tillage. They also reported higher SOC and TN with residue return than residue removal and intensified cropping than fallow based cropping. Among crops legume-cereal rotation promoted SOC than cereal-cereal rotation. (Shafiq *et a*l. 1974) took micrographs of sequential exposures of soil crust perpendicular visual observations suggested that the soil crust taken from conventional and deep tilled plots had fewer and smaller voids than zero tilled plots. The pores were open to the soil surface and their edges were sharp in samples from zero tillage plots. (Anwar-ul-Hassan, 2000) after a comprehensive review about arid and semi-arid areas of Pakistan reported that surface soil crusting is a serious problem over 2.3 mha of dryland areas of Pakistan (Rafiq 1990) due to low organic matter, high silt content and sodicity. He suggested that adoption of

different management practices such as application of surface mulches and increasing organic matter contents would help to overcome the problem. Mulching which part and parcel of CA has been found to control soil crusting. Under rainfed conditions in the Pothwar area (Nizami *et al*. 1995; Nizami and Salim 1997) studies were conducted to evaluate the effect of crusting on crops. In first study, four soil series were investigated. Then six soil series (including these four) namely Gulian (SiCL), Khaur (SiCL), Missa (SiL), Pir Sabak (SiL), Balkassar (SL) and Khair (SL) were selected for the second study. The soil treatments were: Fertilizer without hoeing (A), farmyard manure with no hoeing (B), fertilizer + grass mulching without hoeing (C) and fertilizer with hoeing (D). The applied nutrient status of all the treatments was kept uniform. Soil crust intensity decreased from 6.3 to 1.5 kg cm-2 as the texture changed from SiCL to SL, while increased with an increase in silt and clay contents and was inversely proportional to organic matter and soil water contents. With an increase in soil crust intensity, the plant population decreased. It was concluded that soil structure and aggregate stability can be improved by using organic manures. The highest increase (81- 144%) in grain yield was noted with hoeing on the Guliana, Khaur and Missa soil series. On the Pir Sabak soil, mulching and hoeing showed similar response, and treatment C was the most effective on the Balkassar and Khair (SL) soils. An economic analysis showed that hoeing was the best treatment for managing crust in the Khaur, Guliana and Missa soils; mulching and hoeing were equally good for Pir Sabak soil and mulching was the best for Balkassar and Khair (SL) soil series, i.e. site-specific response to treatments. In rain-fed agriculture, soil, water storage is the main issue due to low rainfall and high evapotranspiration. (Ijaz *et al*. 2007) conducted experiments using different tillage practices with and without application of straw mulch. The MT showed significantly low fallow efficiency and water content at wheat sowing in the two year study than conventional practices (15-23%). However the mulch 4 Mg ha^{-1} and no-mulch plots did not show significant differences for soil moisture storage. They suggested that further research is needed to find out the best rate of wheat straw mulch and ways of residue management to withstand quick decomposition under extreme summer temperatures or the area for a longer period especially for conservation tillage system. (Shafiq *et al*. 1987) compared chisel plow and zero tillage with tine cultivator. They found that chisel plow before the onset of the monsoon had the highest soil moisture content and least bulk density while ZT had the lowest moisture and highest bulk density. A field study was conducted by (Mohammad *et al*. 2010) under the semi arid conditions of Khyber Pakhtunkhwa. The experiment comprised of The experiment comprised of two tillage i) conventional tillage (T_1) and ii) no-tillage (T_0) and two residues i) wheat crop residues retained (+) and ii) wheat crop residues removed (-) treatments. Basal doses of N @ 20: P @ 60 kg ha-1 were applied to mungbean at sowing time in the form of urea and single super phosphate respectively. Labeled urea having 5% 15N atom excess was applied @ 20 kg N ha-1 as aqueous solution in micro plots (1m2) in each treatment plot to assess BNF by mungbean. Similarly, maize and sorghum were grown as reference crops and were fertilized with ^{15}N labeled urea as aqueous solution having 1% ^{15}N atom excess @ 90 kg N ha-1. They observed that zero tillage with residue retention improved biological nitrogen fixation and water use efficiency under rain fed condition. The maximum amount of N_2 fixed by mungbean (82%) was derived in no-tillage with wheat residue retained treatment. These results suggest that BNF and WUE in the rain-fed environment can be improved with minimum tillage and crop residue

retention. Further evidence came from the field study carried out by (Ali *et al*. 2013) during 2005 through 2007 at two locations (Rawalpindi and Fatehjang) in Pothwar, Pakistan to compare minimum tillage with conventional tillage practices for yield performance and nitrogen fixation in mungbean (*Vigna radiata*). The treatments including Minimum Tillage (MT), Conventional Cultivator (CC) and Moldboard Plow (MP) were laid out in a randomized complete block design. All the tillage treatments had equivalent profile moisture content at mungbean sowing. The results on %Ndfa (nitrogen derived from the atmosphere) and total N_2-fixed varied with sites. At Rawalpindi site, though total nitrogen fixation slightly decreased with a decrease in tillage intensity, the differences were statistically nonsignificant. The average values were 24, 34, 32 percent for %Ndfa and 15, 19, 21 kg ha^{-1} for total N_2-fixed under MT, CC and MP, respectively. At Fatehjang site, CC had a significantly lower nitrogen fixation than MT and MP. The average values were 40, 12, 49 percent for %Ndfa and 24, 6, 32 kg ha^{-1} for total N_2-fixed under MT, CC and MP, respectively. The results of study indicate that comparable mungbean nitrogen fixation can be achieved by minimum tillage while avoiding current intensive tillage practices in semi arid Pothwar, Pakistan. In the uplands of Pothwar (Nizami *et al*. 1990) compared three tillage practices, i.e. moldboard plow, chisel plow and tine cultivator in different soil series. They reported that influence of different tillage practices was site specific. Chisel plow conserved more moisture in Missa and Balkassar soils while MB plow in Guliana. Chiseling was efficient in moisture conservation where a pan existed in the profile or the soil texture was coarse. In another study at the rainfed area of Khyber Pakhtunkhwa (Mohammad *et al*. 2006) concluded under different tillage practices with the addition, removal of crop residues through crop rotation with different fertilizer levels. The soil moisture contents data recorded with neutron at different growth stages of wheat indicated that similar moisture content in 0-30 cm upper soil was recorded in the tillage and no-tillage treatments. However, at lower depths 30-90 cm the ZT treatment at seedling 1^{st} tillering, 2^{nd} tillering, booting, anthesis, milk development and maturity stages contained 30.4, 24.15, 25.73, 13.81, 44.2, 32.0 and 9.65 mm more water in soil profile than tillage treatments, respectively. Working in the highlands of Pothwar by (Shafiq *et al*. 1994) contrasted direct drilling with two farmer conventional practiced i.e. conventional cultivator, Moldboard. Who found that soil moisture content measured in June, August and December were similar under conventional and no-till treatments. However the infiltration rates measured in the same months were significantly higher under no-till. They also explained the reason that surface vegetation encouraged the breakdown of soil crusting which ultimately reduced the surface runoff and increased vertical flow of water in soil profile. (Hussain *et al*. 2013) compared different tillage practices at the time of wheat sowing and reported that there was no difference in soil moisture content at different stages during wheat crop. In an effort to reduce fallowing in Pothwar, Pakistan, 3 year field experiments were carried out from 2005 through 2008 at three locations (Rawalpindi, Chakwal and Fateh Jang). The tillage treatments; conventional cultivator, moldboard plow and minimum tillage were applied in main plots; fallow, legume (mungbean, *Vigna radiata*) and mulch of wheat straw were used in sub plots. Wheat (*Triticum aestivum*) was planted in all the subplots during winter. The results showed that all the treatment plots had equivalent volumetric water content upto 90cm profile at the time of wheat planting. In a five year study (2004 through 2009) (Mohammad *et al*. 2012) reported maximum N fertilizer utilization 24.1%, 62.7% and 38.0% in wheat were obtained under no-tillage + residues treatment

during 2006, 2007 and 2008 respectively. The SOC in surface soil (0-15 cm) was higher in wheat-fallow-wheat and wheat-legume-wheat rotation under no-tillage + residues treatment. (Ijaz *et al*. 2010) and Ali et al. (2013) reported in Pothwar that volumetric water content was equal under Moldboard plow (MB), Minimum tillage (MT) and Conventional tine cultivator (CT).

Effect on weed population

Weed infestation is also a serious threat in dryland agro ecosystems and involve reduction of crop production. They not only reduce crop yield, but also deteriorate the quality of product and hence the market value of the crop decrease (Arif *et al*. 2007). They compete with crops for uptake of nutrient, soil water, depress crop and ultimately yield upto 80% (Khan et al., 2004). Tillage plays a critical role in weed management strategies (Mohler and Galford 1997). In the rainfed area of Pothwar (Shafiq *et al*. 1994) in a study reported that the weeds population was remained same under different tillage treatments but the weed biomass was higher in zero tillage plots in fallow as well cropping season. However, (Arif *et al*. 2007) evaluated in a one season study from the rainfed area of Khyber Pakhtunkhwa that weed population was higher under no-till followed by reduced tillage and Chisel plow. They also reported that soil disturbance depress the weed population. Also (Khattak *et al*. 2005) evaluated the effect of different tillage practices i.e. no-till, chisel plow, tine cultivator, moldboard plow and disc harrow in chickpea-fallow rotation on weed population under rainfed conditions of district Karak of Khayber Pakhtunkhwa. After three years of study they reported that chisel plow depressed weed population followed by moldboard plow. The NT had the highest weed density.

Effect on crop production

With increasing population and decreasing land owners the rainfed lands have great potential for contributing to national food productions to meet the food and fiber demand of resource poor masses of country. Crop yield can vary from year to year and are influenced by different factors including soil type, climate and management practices. (Mohammad *et al*. 2006) conducted a study for comparison of farmer's conventional tillage and no-tillage both with residue retention and removal of wheat and oat crops. They reported that there was no significant difference in crop yields and related attributes in tilled and no-till plots. Further, more in the uplands of Pothwar Plateau (Ijaz *et al*. 2007) conducted a two year experiment in which the main treatments were moldboard plow, sub-soiler and conventional cultivator with the addition and removal of straw mulch. The treatments were applied at the start of fallow period and wheat crop was sown during winter. They reported that the minimum tillage and moldboard plow gave averagely 30% higher grain yields of wheat than tine cultivator during both the experimental years. Grain yield was 33% higher in mulch than no mulch. In Khyber Pakhtunkhwa at rainfed conditions of Lukimarwet (Khan *et al*. 2011) conducted an experiment in which zero, reduced, conventional and maximum tillage with different doses of fertilizer N were applied at the time of wheat sowing. The one season study indicated that germination count, grain per spike and 1000 grain weight were similar under all tillage treatments. However the productive tillers and wheat yield were significantly higher with maximum tillage. Also (Khattak *et al*. 2005) in a sandy loam soil of rainfed area of Khyber Pakhtunkhwa compared the effects of no-tillage, chisel plow, moldboard plow, cultivator and disk harrow on chickpea yields. They reported that maximum chickpea yield was obtained under the chisel plow that was 19% higher than the NT

that was attributed to better weed control. In a long term field study (2004-09) carried out by (Mohammad *et al*. 2012) in north-west Pakistan the treatments consisted of three rotations: i) Wheat-fallow-wheat (farmers' practice) ii) Wheat- summer legume-wheat and iii) Wheat-summer cereal-wheat with two tillage and crop residues management treatments: i) Tillage (crop residues removed) and Tillage (crop residues retained) and ii) No-tillage (crop residues removed) and No-tillage (crop residues retained). The results revealed that the wheat grain and straw yield in tilled and no till treatments were equal in all the five years. However, every year, crop residues retention significantly enhanced the wheat grain and straw yield. Crop residues with no-tillage resulted in 520 kg ha^{-1} greater wheat grain yield than residues removed treatment. Similarly WUE, N yield and fertilizer N utilization by wheat was increased significantly by crop residues under no-tillage compared to the tillage treatment. The results of the long term study showed that no-tillage + crop residues and legume based rotation treatment were beneficial under the rainfed (dry) conditions. (Shafiq *et al*. 1987) conducted an experiment under the environmental condition of Pothwar to evaluate the effect of zero tillage, cultivator and chisel plow on the yield of wheat crop. They reported that yield was higher under chisel plow than other treatments.

Also (Khan *et al*. 2011) compared the effect of cultivator with moldboard on mungbean yield under the rainfed conditions of Dera Ismail Khan, Khyber Pakhtunkhwa. After a two year study they concluded that yield was higher under tine cultivator than moldboard plow. Also (Razzaq *et al*. 2002) in a three year study at farmer's fields of Islamabad evaluated the effect of moldboard plow, direct drilling and tine cultivator. They reported that yield was higher with moldboard than direct drilling and tine cultivator. Moreover (Mohammad *et al*. 2010) found the effect of conventional tillage and no-tillage with and without residue on mungbean (*Vigna radiata*) yield under the rainfed conditions of Khyber Pakhtunkhwa. Maximum mungbean yield (1224 kg ha^{-1}) was obtained under no-tillage with addition of crop residues. Also (Arif *et al*. 2007) contrasted three tillage treatments i.e. no-tillage, reduced tillage and chisel plow in a rainfed valley of Peshawar, Khyber Pakhtunkhwa. They concluded that the fodder maize yield was significantly higher under reduced tillage. However in case of groundnut yield has been found to be better with moldboard plow than chisel plow by (Akhtar *et al*. 2005) under rainfed condition of Chakwal, Pothwar. Also (Ijaz *et al*. 2010) were carried out field experiments from 2005 through 2008 at three locations (Rawalpindi, Chakwal and Fateh Jang). The experimental design was split–plot and treatments were applied as follows: conventional cultivator, moldboard plow and minimum tillage in main plots; fallow, legume (mungbean, *Vigna radiata)* and mulch of wheat straw were used in sub plots. Wheat *(Triticum aestivum)* was planted in all the subplots during winter. The wheat biomass and grain yields were statistically equivalent under all the applied treatments. The average yields were 7.37, 6.19 and 4.27 Mg ha^{-1} for wheat biomass and 3.06, 3.56 and 1.6 Mg ha^{-1} for wheat grain yield at Rawalpindi, Chakwal and Fateh Jang sites. Also (Ali *et al*. 2013) conducted a field study during 2005 through 2007 at two locations (Rawalpindi and Fatehjang) in Pothwar, Pakistan to compare minimum tillage with conventional tillage practices for yield performance of mungbean (*Vigna radiata*). The treatments including Minimum Tillage (MT), Conventional Cultivator (CC) and Moldboard Plow (MP) were laid out in a randomized complete block design. The biomass and grain yields were generally equivalent under all the tillage treatments. The average values were 3.10, 3.19, 3.64

Mg ha^{-1} for biomass and 0.59, 0.58, 0.60 Mg ha^{-1} for grain yield under MT, CC and MP respectively.

Economic efficiency

Increasing costs of inputs such as fuel, fertilizer and seed have rendered the dryland farming a profitless business for small landholders. Therefore, lowering the input cost of dryland agriculture is the need of the time. (Arif *et al*. 2007) compared economics of no-till, tine cultivator and chisel plow. They reported that the no-till with an efficiency coefficient of 1:4 was found to be economically more feasible for resource less farmers although gross margins and gross income were higher with tine cultivator. Also (Ahmed *et al*. 2007) evaluated bed planting, zero tillage and conventional tillage in rainfed area of Islamabad and reported that zero tillage gave maximum net income by decreasing input cost.

Challenge to CA in Pakistan

The above review clearly show the possibility of successful use of CA in Pakistan. However, there are big challenges which hinder quick adoption of CA by farmers which can be summarized as follows:Social hindrance: Farmer's perception is one of the major problems for the adoption of conservation agriculture. Farmers of this area traditionally believe that maximum plowing is useful for utmost crop production. The farmers that do not plow very often are called as lazy and inactive in local community.Residue retention is the 2nd most important principal for successful conservation agriculture but our farmers do not leave any residue for soil surface cover. They use straw for feeding their animals and use fallow fields for grazing purposes. The livestock is another important sector for rural people to meet their food requirement.CA systems require a specific seed drill e.g. zero-tillage drill, which are not available in the local market. Also the pulling of heavy drill may require a powerful tractor which is not affordable.There is no technical experience of farmers for initiation of CA. This new advancement needs expertise for shifting from traditional farmer practice to the new system. Also the extension system in the country is not so strong that can help farmers to understand the basics of CA.The chemical herbicides used for control of weeds in CA during fallow and crop periods are costly and generally adulterated. The farmers of dryland areas lack knowledge about preparation and proper use of these chemicals.The Government lacks clear policy for promoting conservation agriculture. Also there is no independent research institute about CA to bridge the research gap between Pakistan and other pioneer countries in CA. There is need of long term, comprehensive and collaborative research on CA that involves soil scientists, agronomists, plant breeders, agricultural engineers and extension workers together.The benefits of CA to soil and crop production take at least five years to appear therefore it is difficult for resource poor farmers to wait and visualize the benefits of CA.

Opportunities

Already successfully practiced in vast arid-semi and arid regions, Worldwide and Pakistani climate is also mostly arid and semi-arid.There are big opportunities for successful adoption of CA in steep slope topographic areas. As the soils of dry land areas of Pakistan are silty loam and sandy loam there is big chance for CA adaptation.In the dry land of Pakistan there is a big chance for adaptation of crop diversification is the third main principal of CA.Optimum soil temperature in different areas promotes soil biodiversity.

Conclusion: Most of research studies from dryland areas of Pakistan are short term and they indicate that different forms of CA increase organic matter contents, improve soil structure, provide equal yield and economic benefits by decreasing input cost. Particularly chisel plow performed better in comparison with moldboard plow in most of the investigations. However, there is a need to establish long term, multi-location and collaborative research experiments on different aspects of CA that use computer based models for long term simulations to draw clear conclusions.

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RESIDUAL EFFECTS OF LONG-TERM LAND APPLICATION OF WASTEWATER TO EDIBLE PLANTS AND THEIR HEALTH RISK ASSESSMENT

By:

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Novelty statement

The selected topic is very important to be investigated and reported due to serious health hazards to consumers in urban areas across the world where vegetables are being grown on untreated municipal sewage discharge. As literate has revealed that concentration of metals has increased in soil as well as in food commodities over period of time causing potential health risk to consumers. The information and results of this study disseminated among growers, researchers may significantly help manage irrigations which can restrict/decrease heavy metal translocation into the food chain.

Abstract:

The present study was carried out to access the transfer and accumulation of essential metals (Zn, Cu, Fe and Mn) in different part of common vegetables (Fenugreek, Spinach, Radish) and crop (wild oat) irrigated on a land which has been under sewage irrigation from unknown time period and health problems caused by their consumption. The quantitative analysis through Flame Atomic Absorption spectrophotometer (Varian 220FS) showed considerable build-up of essential metals in vegetables. Translocation from shoot to leaves was found highest in fenugreek leaves with transfer factor of 2.492 followed by spinach, radish and wild oat respectively. Accumulation factor AF > 1 was recorded in spinach for all metals making it a hyper accumulator while the lowest AF for copper was found in wild oat's leaf. The detrimental potential effects by consumption of these metals were also determined by calculating daily metal intake (DIM) and Target hazard quotient (THQ) values. DIM of most metals for men and women were under UL while iron concentration was found near to UL for children and adult. The combined THQ values for male and female was determined and concluded that they are below the safe level of THQ < 1 for all vegetables and wild oat. Two all-Pairwise Comparison test (Tukey HSD) were used and it was concluded from test that means are not significantly different from each other at $P < 0.05$. The vegetables were found to be safe for human consumption, but subjected to portion size as it can increase the per day limit described by joint FAO/WHO committee.

Key words: Accumulation, translocation, Accumulation Factor, Transfer Factor, Target Hazard Quotient, Daily Intake Metal.

Introduction:

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Essential metals are natural component of Earth's crust. They can't reverse back once they have entered in our ecosystem cycle via natural (Volcanos, earth quake, erosion) and anthropogenic sources (Mining, burning of fossil fuel, industrialization). Their non-biodegradable behavior makes them harmful and debatable (Chen wang and wang 2005; Gupta et al. 2010; Chopra and Pathak 2012).

It is believed from ages that the use of organic waste can improve soil's characteristic and hence crop yield (Al Zoubi et al. 2008). During recent years application of sewage sludge has become a widely accepted practice in periurban ecosystem due to use of less or no fertilizer, its easy availability and most importantly scarcity of fresh water (Naggar and El-Ghamry 2001; Besalatpour et al. 2008). However negative impact of sewage sludge in the form of metal toxicity, phyto toxicity and soil contamination cannot be neglected (Khan et al. 2007).

Not only humans, animals are equally at the risk of metal toxicity through food and water as they are the main source which exposes them to various toxic metals. Vegetables grown in sewage sludge tends to accumulate more quantities of metals in their edible part making them hazardous for human and animal consumption (Alam *et al.,* 2003). Different diseases like hemochromatosis, neurosensory disorders, Parkinson's disease, muscle weakness and nerve damage are associated with Fe, Zn, Mn and Cu toxicity respectively. Synergism and antagonism of metals are not only confined with soil-plant or water-soil-plant eco-system, consumption of these contaminated vegetable can lead to serious health risk in human body by depleting one or more essential metals from the body causing chronic diseases. (David Watts 1990; Robert and prem2012; K. Madhavan Naira and Little Flower Augustine 2016)

The present study was conducted to compare the translocation and accumulation of essential metal (Cu, Fe, Mn, Zn) in common leafy vegetable, root vegetable and fodder grown on sewage amended soil in Karachi, Pakistan. Target hazard quotient (THQ) and daily intake (DIM) of these metals were also calculated for children, adults, male and female.

Materials and Methods

Study Area

Samples of wild oat (Avena fatua), Radish (Raphanus sativus L.), Spinach (Spinacia oleracea) and fenugreek leaves (Trigonella foenum-graecum L.) were collected from agricultural land of Malir, Karachi (24° 56' 46.3848" N and 67° 0' 20.2140" E), during the period of January 2017-Febuary 2017. This land receives industrial and domestic effluent from Landhi and Korangi zones and is under sewage cultivation for an indefinite period of time.

All the experiments were performed at the laboratory of Food Quality & Safety Research Institute, Karachi.

Sample Preparation

Collected samples were washed with double distilled water and air dried for a day. Method described in (AOAC 2000) was used for sample preparation. All parts of vegetables (Root, Shoot, Leaf) were separated and tagged accordingly. All the samples were dried in oven (Memmert) at a temperature of 80-85°C for 24 hours.

After drying samples were crushed by mortar and pestle and sieved through muslin cloth.

Determination of essential metal content

Approximately 0.5g of each sample (triplicate) were weighed accurately in digestion tubes. 20 mL of (65%) concentrated HNO_3 and 3.0mL (70%) $HCLO_4$ were added in each tube and allowed for pre digestion in fuming hood for half an hour. Sampling tubes were then sealed and samples were digested following heating program as given in Table-1. The concentration of Copper (Cu), Iron (Fe), Manganese (Mn) and Zinc (Zn) were determined by Flame Atomic Absorption Spectrophotometer (Varian 220FS, Australia) following methods of (AOAC 2000) and manufacturer's operational Manual. All the Analytical grade reagents and standards (Merck, 1000mg/L) were used throughout experiment.

Transfer Factor and Accumulation Factor (TF and AF)

The ratio of metal concentration in plants to soil's extractable mineral is called transfer factor. It can be calculated through TF=Metal concentration in Vegetables part / Metal concentration in root. (Chuck *et al.,* 2016) Bio-accumulation factor or Accumulation factor (AF) is a way to calculate accumulation of a specific metal in part of a crop (Likar et al. 2010)

Determination of Daily Intake of Mineral (DIM)

The daily intake of mineral was estimated by the equation

DIM=[m].CF.I/W

Where [M] represents the concentration of mineral in vegetable (mg/kg), C.F conversion factor used to convert fresh vegetable weight to dry weight is 0.085 as reported by (Arora *et al.,* 2008) I is average intake of vegetables (Kg/person/day) and W is average body weight (Kg). The average intake of vegetables in children, adults, men and women were considered to be 0.232, 0.345, 0.15, 0.12 (Kg/person/day) respectively as narrated by Wang *et al.,* 2005(Wang *et al.,* 2005, Rattan *et al.,* 2005, Ge 1992) while average body weights for children, adults, men and women were considered to be 32.7, 55.9, 81, 67 Kg respectively.

DIM for a Galloway cow was calculated through following equation (Roggeman *et al.,* 2013)

$DIM = 12.5\ Kg * \sum (V_p [M]) * V_t$

Where;

12.5 is average dry matter $day^{-1}Kg^{-1}$

Vp= vegetation proportion

Vt= Vegetation type

Target Hazard Quotient (THQ)

The complex THQ parameter provides a better health risk assessment cause by metals. Long term exposure to chemical pollutants can lead to potential health risk hazards. Target Hazard Quotient parameter was used for estimation of risk associated with the consumption of vegetables in men and women which was developed by Environmental Protection Agency (EPA) in the United States (US, 1989).

$$THQ = E_f \cdot F_d \cdot DIM / R_{od} \cdot W \cdot T$$

Where E_f is exposure frequency; F_d is exposure duration; DIM is daily intake of mineral (mg/person/day); R_{od} is reference oral dose (mg/Kg/day); W is average body weight (Kg); 81 for male and 67 for female while T is average exposure time for noncarcinogens (365days/year * exposure years). E_f was assumed 183.5days/year, based on average life expectancy F_d for male was set 63 while for female 70 years. (Harmanescu *et al.,* 2011)

Data Analysis

Microsoft Excel (ver. 2013) and Statistix10 was used for statistical analysis. Tukey HSD test was applied for comparison of means.

Results

Determination of essential metal content.

The essential metal accumulation (Zn, Cu, Fe, Mn) in root soil, root, shoot and leaves of vegetables are shown in (Table 1). It was observed that the crops have the highest concentration of iron as compared to other metals ranging within 3923.7-10449 mg/Kg while the lowest concentration of Cu was found in a range of 520.7-1602.8 mg/kg throughout samples. Synergistic effect between Cu and Zn was observed in fenugreek root. All vegetables and wild oat was found to accumulate higher level of Zn and Cu than the maximum permissible limit of 60 mg/Kg and 40mg/kg. (Codex Alimentarius commission, 1984). Translocation pattern of these metals were also recorded, concentration of metals in vegetables' and wild oat's Root, Shoot, Leaf showed Fe > Zn ≈ Mn > Cu pattern while in edible part of all vegetable and wild oat a pattern of Fe > Mn > Zn > Cu (Fig. 1) was found. Through translocation pattern it was observed that Mn and Zn have some antagonist behavior in many part of crops.

Accumulation Factor and Transfer Factor (AF and TF)

Maximum AF (1.790) was found in radish root for iron metal among all metals while minimum AF (0.7318) of Cu was found in wildoat leaves (Table 2). Spinach was found to have an AF >1 for all metals followed by Radish Root, Wild oat leaves and Fenugreek leaves. The essential metal Transfer factor (TF) of leaves and shoots for Fenugreek, Spinach, Radish and Wild oat is shown in (Table 3). TF >1 means plant translocates metals very effectively from root to shoot and leaves; TF < 1 shows uniformity in distribution of metals (Fig. 3) Relative order of TF for (Zn, Cu, Fe and Mn) was found in order of;

Zn: Fenugreek leaves <Fenugreek shoot < wild oat leaves < Spinach Leaves < Radish Leaves < Spinach shoot < wild oat shoot < Radish Shoot.

Cu: Fenugreek shoot < Fenugreek leaves < Radish Leaves < wild oat shoot < Radish Shoot < Spinach leaves < spinach shoot < Radish leaves.

Fe: Fenugreek leaves <Fenugreek shoot < wild oat leaves < Radish leaves < wild oat shoot < Spinach leaves < Radish Shoot < Spinach Shoot.

Mn: Radish Shoot < Spinach shoot < wild oat shoot < wild oat leaves < Radish leaves < Spinach leaves < Fenugreek shoot < Fenugreek leaves.

Phytoremediation capacity

TF and AF values are primary indicators to evaluate phytoremediation capacity of a plant. When TF and AF values are greater than 1 for a particular metal, the plant is said to be sink or accumulators (Nazir *et al.,* 2011). It can be said that fenugreek leaves are sinks of Mn (TF 2.49; AF 1.21) Spinach Shoot is a sink for Zn (TF=1.305; AF=1.10), whereas spinach leaves are sink of Mn (TF= 1.14; AF= 1.97), wild oat leaves are sinks of Mn (TF=1.021; AF= 1.391) and shoots are sinks of Zn.(TF= 1.160; AF= 1.099)

Daily Intake of Mineral (DIM) and Target Hazard Quotient (THQ)

Daily intake for four metals (Zn, Cu, Fe, Mn) were estimated in edible part of each vegetable is shown in (Fig. 4). The daily intake rate for Fe was found highest in all vegetable's edible part among other metals having a range (0.659 - 4.47 mg-metal/person/day) for children, adult, men and women. It was found that values of DIM for Zn, Fe, Mn were below upper recommended daily limit of metal except for Radish Fe in children. DIM for cows by consuming Avena Fatua was also estimated. (Fig. 5).

Statistical analysis.

In Tukey test three way interaction was opted for the analysis through Statistix 10. Where probability level was set to 0.05, Standard Error for Comparison 344.06, Critical Q Value 5.809, Critical Value for Comparison 1413.2 found. There were 14 groups in which the means are not significantly different from one another.

Discussion:

It is evident that the waste-water application can change the physicochemical properties of soil and metals uptake by plants. In the study iron showed maximum concentration while copper showed least among all the metals. A land which is receiving sewage water for a longer period of time can be the reason of iron accumulation in soil, while presence of aluminosilicates in soil which binds with iron can also be the reason of iron accumulation in soil (Maria and Silvia 2014). Yousufzai *et al.,* 2000 has reported maximum amount of Fe in sewage water, (Yousufzai *et al.,* 2000) and continuous use of this sewage water can ultimately increase iron content in soil and in plants. Maria and Silvia 2014 have also reported highest amount of iron in sewage water and plants growing with that sewage water (Maria and Silvia 2014). While less absorption of copper could be a natural protective behavior of plant or could be due to antagonist behavior of iron with Cu (Hiroaki, *et al.,* 2008) (Brar and Sekhon, *1978*). (Zarcinas *et al.,* 2004) reported that uptake of copper and iron is strongly co-related with organic matters present in sewage water. Nature of plant, human interactions, environmental effects, nature of soil , absorption capacity of each plant for specific metals are some factors which effect the concentration of metal in plant (Zurera, *et al*., 1989). (Fageria, 2001) has also reported this behavior. Results from previous studies (Liu *et al.,* 2005, Muchuweti *et al.,* 2006, Sharma *et al.,* 2007) is in agreement with the present study which demonstrates that the vegetables grown on sewage sludge can lead to accumulation of metals.

Plants which have AF more than 1 are considered hyper accumulating while AF < 1 plant are considered excluder (Cluis 2004). Almost all the crops are found to be a hyper accumulator of metals except Fenugreek leaves for Zn, Radish Root and

Wild oat leaves for Copper (Fig. 2). (Zhuang *et al.,* 2009) has also reported that leafy vegetables have significantly higher AF average than non-leafy vegetables. Difference in accumulation factor is depended on type of soil and effluent, its concentration, nutrient management ability of soil and crop (Mishra *et al.,* 2009).

Long term exposure to chemical pollutants can lead to potential health issue and estimation of these risks are done through a complex parameter Target Hazard Quotients (THQ) (Khan *et al.,* 2009). The THQ is a dimension less value if the THQ <1 is considered safe while THQ >1 reflects that population is at the risk of toxicity. THQ values for male and female is given in (Table 4). Combined THQ for comparison of male and female is shown in (Fig. 6) and is found that female has more THQ value as compared to male due to difference in life span and average body weight (Hague 2008).

Conclusion:

It can be concluded that irrigation with sewage on a land which is previously being irrigated with sewage has significantly increased the (Zn, Fe, Cu, Mn) concentration in plants. The discoveries of this examination in regards to metals concentration in vegetables, TF, AF, DIM and THQ recommend that the consumption of these vegetables irrigated in these zones isn't totally free of dangers. DIM of metal Iron and Manganese for children and adult were near the border line value prescribed by Joint FAO/WHO committee so an intake of Fe and Mn should be monitored as consumption of large quantities of these vegetables can lead to chronic diseases. Still more considerations ought to be paid to youngsters because of their higher affectability to metal exposure than that of grown-ups. Consistent checking of these metals in sewage, soil, vegetables and in other food commodities is fundamental, to keep their immoderate expansion in food chain.

Conflict of Interest.

Authors have no conflicts of interest

Acknowledgement

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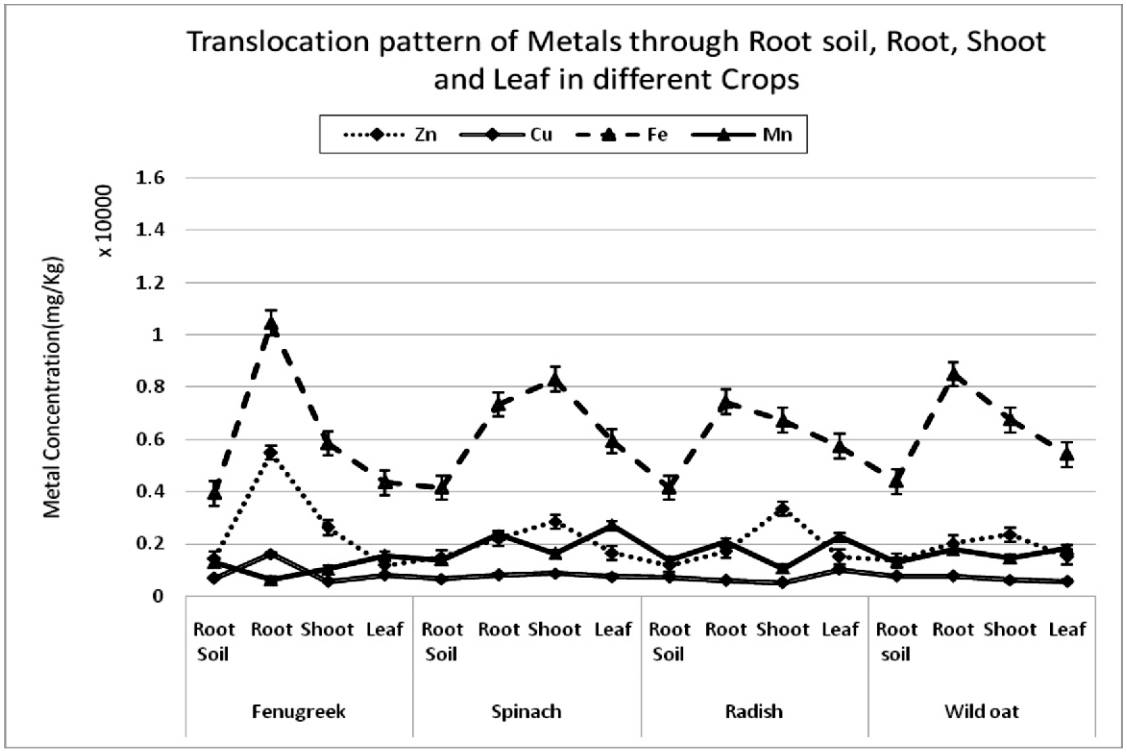


Fig. 1: Translocation pattern of Metals through Root soil, Root, Shoot and Leaf in different Crop

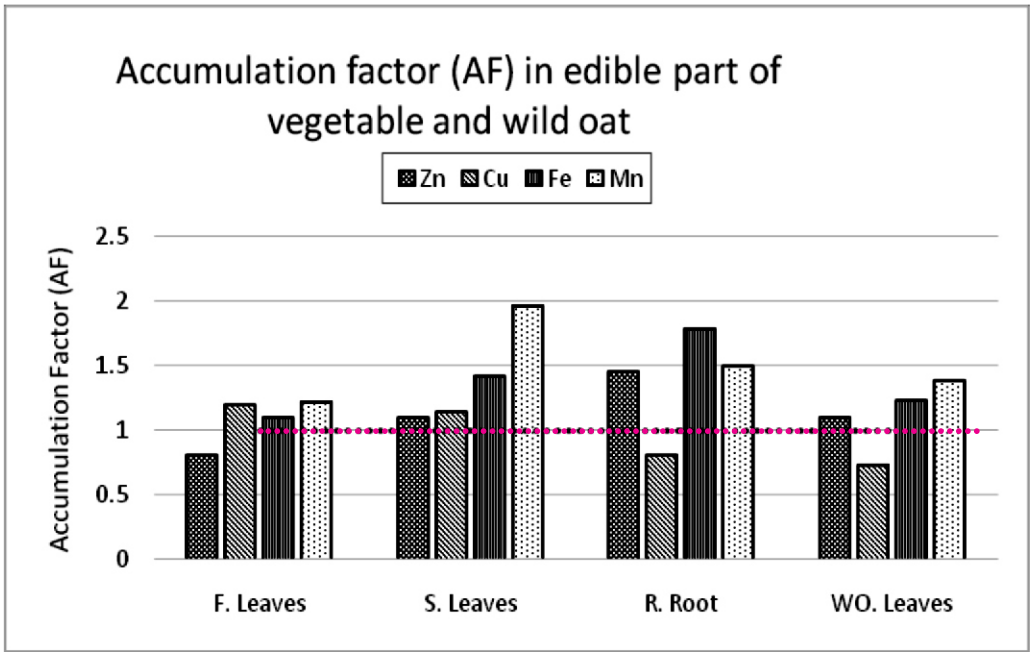


Fig. 2: Accumulation Factor (AF) in edible part of Vegetables and wild oat

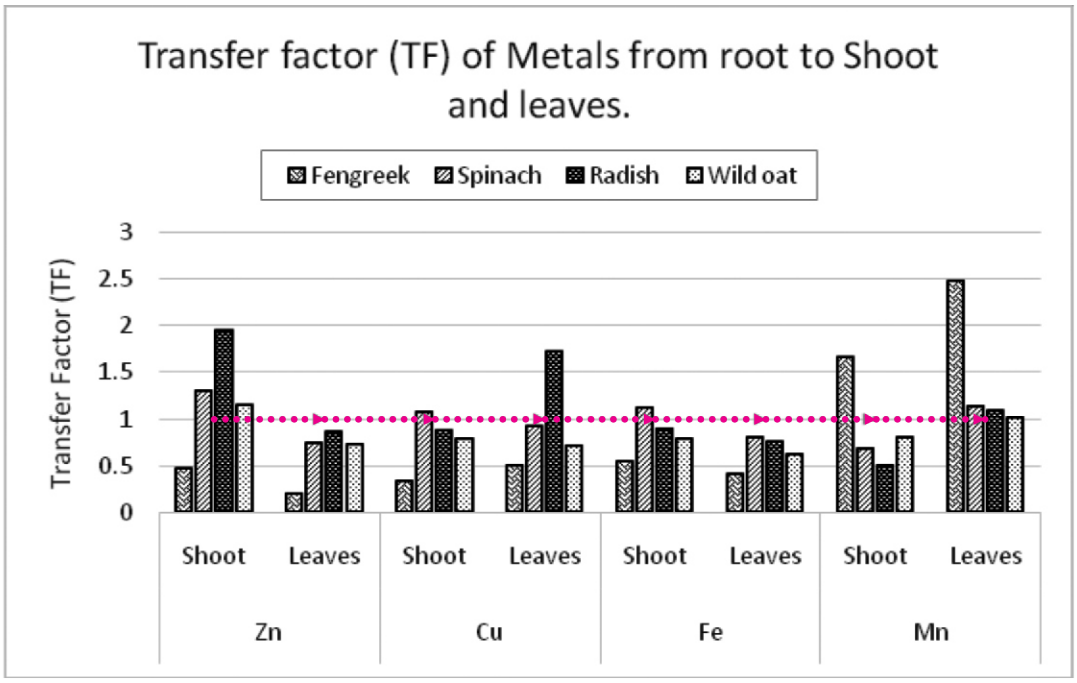


Fig. 3: Transfer factor (TF) of Metals from root to Shoot and leaves.

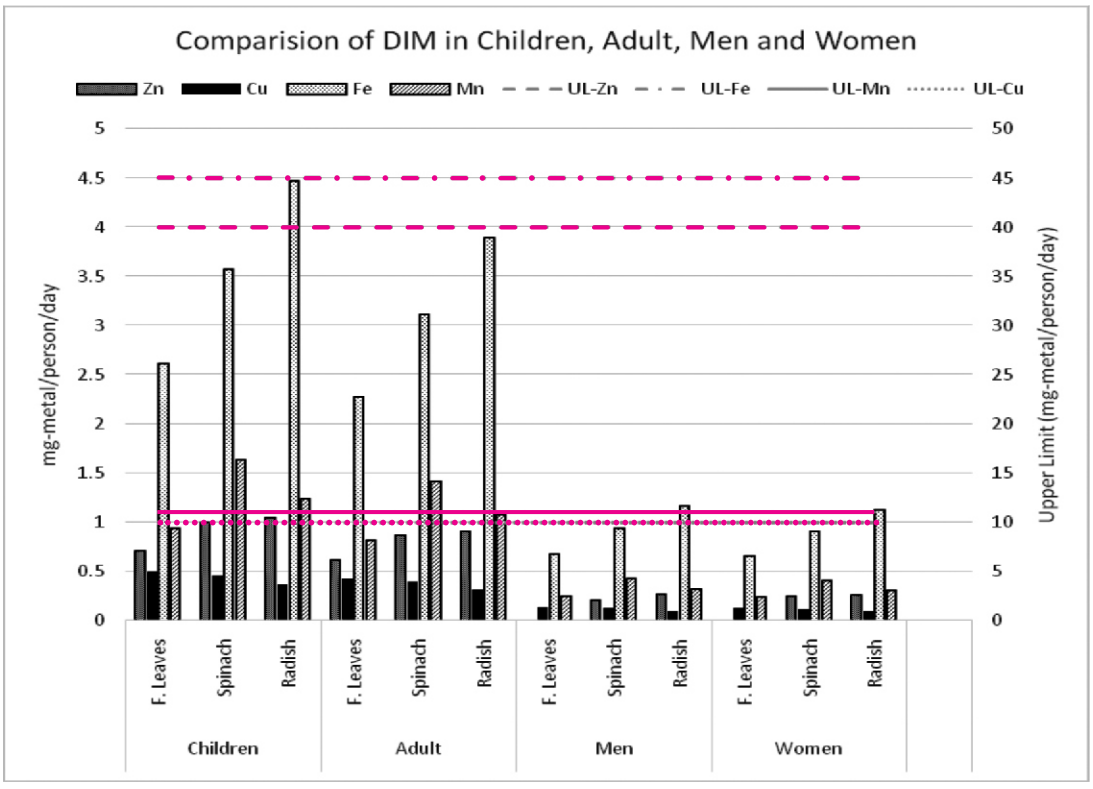


Fig. 4: Comparison of DIM in Children, Adult, Men and Women

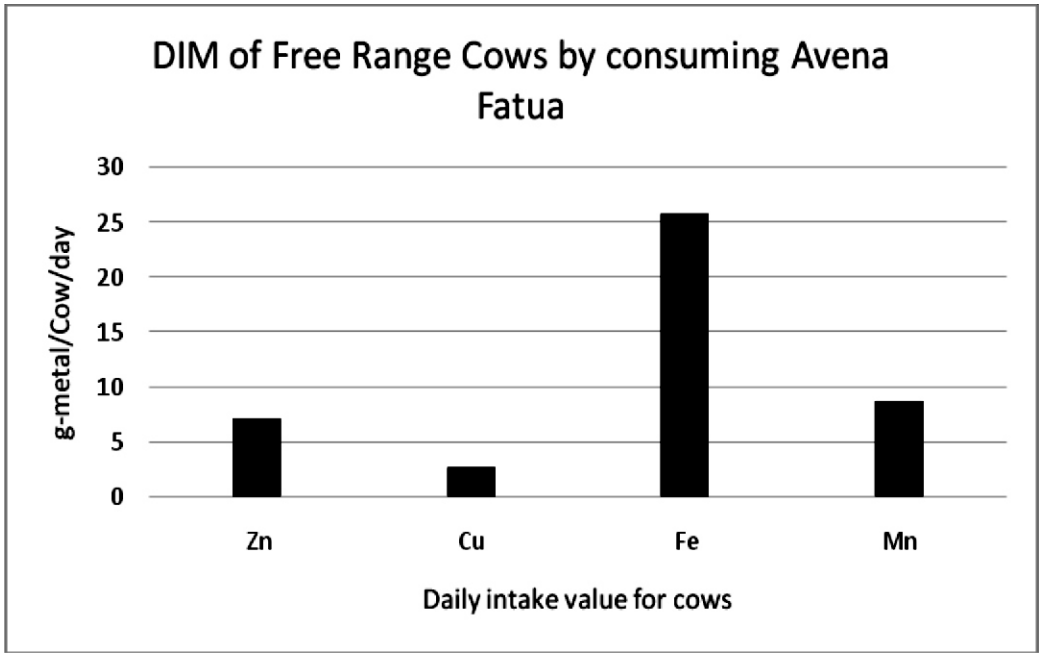


Fig. 5: DIM of Free Range Cows by consuming Avena Fatua

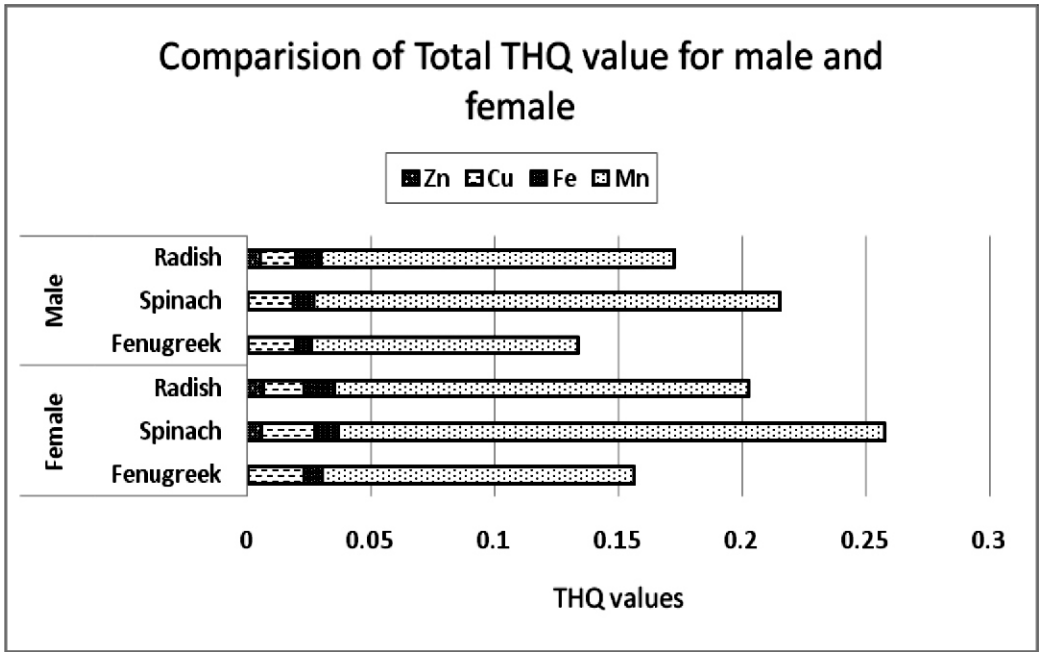


Fig. 6: Comparison of total THQ value for male and female

Table 1: Concentration of Metals (mg/Kg)

		Zn	Cu	Fe	Mn
[a] **UL (mg day^{-1} person $^{-1}$**		40	10	45	11
[b,c] **Recommended Daily Intake (mg day^{-1} person $^{-1}$)**		11(8)	0.9	8(18)	2.3(1.8)
[d] **Oral reference doses (mg Kg^{-1}day^{-1})**		0.300	0.040	0.700	0.014
Fenugreek	Root Soil	1442.7 ± .009	672.4 ± 0.045	3923.7 ± 0.076	1274.95 ± 0.072
	Root	5476.4 ± 0.05	1602.8 ± 0.067	10449.1 ± 0.056	623.33 ± 0.054
	Shoot	2618.95 ± 0.045	559.77 ± 0.034	5839.7 ± 0.066	1039.5 ± 0.042
	Leaf	1169.9 ± 0.08	805.5 ± 0.067	4334.48 ± 0.037	1553.5 ± 0.063
Spinach	Root Soil	1491.7 ± 0.087	657.9 ± 0.012	4250.94 ± 0.056	1373.97 ± 0.099
	Root	2183.07 ± 0.067	804.2 ± 0.021	7334.3 ± 0.063	2355.4 ± 0.024
	Shoot	2851.04 ± 0.057	872.7 ± 0.088	8301.01 ± 0.036	1629.1 ± 0.078
	Leaf	1647.72 ± 0.097	750.7 ± 0.091	5926.91 ± 0.012	2707.8 ± 0.087
Radish	Root Soil	1180.1 ± 0.034	725.1 ± 0.017	4150.8 ± 0.046	1371.8 ± 0.0423
	Root	1718.39 ± 0.062	590.7 ± 0.041	7430.4 ± 0.073	2062.5 ± 0.024
	Shoot	3353.5 ± 0.084	520.7 ± 0.042	6725.2 ± 0.063	1061.7 ± 0.084
	Leaf	1501.1 ± 0.055	1019.9 ± 0.076	5730.5 ± 0.073	2271.5 ± 0.023
Wild oat	Root soil	1364.17 ± 0.099	755.1 ± 0.056	4376.8 ± 0.098	1305.2 ± 0.044
	Root	2031.64 ± 0.021	761.8 ± 0.098	8497.7 ± 0.054	1777.6 ± 0.099
	Shoot	2358.31± 0.089	608.5 ± 0.033	6732.59 ± 0.024	1445.41 ± 0.076
	Leaf	1499.9 ± 0.059	552.59 ± 0.055	5409.53 ± 0.075	1815.6 ± 0.099

a. FDA (Food and Drug Administration): Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc. Report of the Panel on Micronutrients. National Academy Press, Washington, DC, Food and Drug Administration. Dietary supplements. Center for Food Safety and Applied Nutrition; 2001

b. Dietary reference intakes tables and application. Institute of Medicine of the National Academy of Sciences, 2010.

c. Daily values from FDA food labeling: Revision of the nutrition and supplement facts labels. 2016

d. US EPA Human Health Risk Assessment: Risk-Based Concentration Table. [http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm]

Table 2: Accumulation factor of Metals from root to Shoot and leaves.

Metals	F. Leaves	S. Leaves	R. Root	WO. Leaves
Zn	0.81091	**1.104592**	1.45613	**1.09949**
Cu	1.1979	1.141055	0.814646	0.73181
Fe	1.10469	1.42784	1.790113	1.235955
Mn	**1.2184**	**1.970785**	1.503499	**1.391051**

Bold values are indicating Phytoremediation capacity (TF and AF >1)

Parts	Crops	Zn	Cu	Fe	Mn
Leaves	Fenugreek	0.21362574	0.502558	0.414819	**2.49225**
	Spinach	0.75477195	0.933474	0.808108	**1.149614**
	Radish	0.873550242	1.726596	0.771224	1.101333
	Wild Oat	0.73827056	0.725374	0.636588	**1.021377**
Shoots	Fenugreek	0.478224746	0.349245	0.558871	1.6676
	Spinach	**1.305977362**	1.085178	1.131807	0.691645
	Radish	1.951536031	0.881497	0.905093	0.514764
	Wild Oat	**1.160791282**	0.798766	0.792284	0.813124

Table 3: Transfer factor of Metals from root to Shoot and leaves.

Bold values are indicating Phytoremediation capacity (TF and AF >1)

Table 4: Target Hazard Quotient (THQ) for male and female.

Gender	Crops	Zn	Cu	Fe	Mn
Female	Fenugreek	0.000445212	0.022998467	0.00706	0.1264
	Spinach	0.006252982	0.021422715	0.00961	0.22082
	Radish	0.006578137	0.016695461	0.01213	0.16722
Male	Fenugreek	0.000380675	0.019550989	0.006047063	0.108173
	Spinach	0.000368262	0.018325173	0.008271709	0.18886
	Radish	0.005627375	0.014275326	0.010356261	0.1427

Source	DF	SS	MS	F	P
Replication	2	329489	164744		
Metals	3	8.784E+08	2.928E+08	1648.89	0.0000
Parts	2	3.952E+07	1.976E+07	111.29	0.0000
Vegetable	3	6023162	2007721	11.31	0.0000
Metal*Part	6	7.289E+07	1.215E+07	68.42	0.0000
Metal*Veg	9	1.688E+07	1875097	10.56	0.0000
Part*Veg	6	5.010E+07	8349332	47.02	0.0000
Metal*Part*Veg	18	6.710E+07	3727942	20.99	0.0000
Error	94	1.669E+07	177564		
Total	143	1.148E+09			
Grand Mean	3003.3				
CV	14.03				

Table 5: Factorial Analysis of variance (AOV) Table for Concentration.

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SOLUTION TO SOIL POLLUTION

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ABSTRACT:

Soil pollution adds to environment pollution which is the major threat to all living beings today. As we all are aware of the causes of soil pollution i.e., contamination of soil due to harmful substances, over irrigation, usage of pesticide, dumping of sewage & garbage, deforestation, chemical & biological agent, urban waste & many more unnatural human practices are degrading the soil. Kaimtech is delighted to reveal its successful contribution to resolve this monstrous threat through natural means. Kaimtech has introduced the most proficient, efficient, economical and result oriented technology to provide solution to soil pollution in general and help in waste management (sewage water & solid waste treatment) as well as economical & durable construction in particular. Our years of research is substantiated by result oriented ground performance of our product by clients and confirmed by laboratory reports. Kaimtech is awaiting to disseminate its finding to the world.

BACKGROUND OF THE INVENTION

Pakistan stands amongst 10 worst affected countries of the world by climate change. Untreated sewage water, solid waste and massive cement production further aggravates environment pollution. Paucity of water for drinking & irrigation is threatening our very existence as healthy nation, more than 80% of our population is deprived of clean drinking water whereas major part of available water is used for irrigation purposes.

Extensive researches are focused on water preservation, water, economy, recycling used / waste water to cop-up with water deficiency. Most advance countries are successfully recycling sewage/waste water whereas developing countries including Pakistan are either ignorant of best practices to recycle this valuable commodity. Heaps of solid waste and untreated sewage water is causing worst environment pollution causing health hazards to human as well as animals besides polluting underground water. Mass production of cement to meet population demand for housing is another major cause of air pollution. According to World health organization (WHO) 22% deaths are caused due to air pollution only.

SPECIFICATION

Biological treatment of concrete, water, sewage, waste water and solid waste.

DETAILED DESCRIPTION OF B-PYLE

- Our product relates to a process to preserve and enhance the properties of concrete by inserting B-Pyle solvent to make the subject concrete into efficiently modified concrete (EMC).
- Thus the EMC improves the work ability of concrete making it durable many fold.

- Biological treatment of concrete eliminates voids from concrete to make it resistant to external environmental affects which helps EMC to resist salinity and heat.
- Surprisingly it was revealed that B-Pyle efficiently recycle the sewage water successfully eliminating odor and gradually reducing chemical oxygen demand (COD) and biological oxygen demand (BOD) bringing it at permissible level of National Environment Quality Standards (NEQS).
- It is also observed that B-Pyle bacterial treatment effectively converts organic waste into animal feed and bio-fertilizer such as soil conditioning agent of fertilizer grade, culture grade and soil grade.

TEST REPORTS COMPARISON OF SEWAGE WATER

Test Parameter	Limits as per NEQS	Before Treatment	After Treatment 90 x days	After Treatment 180 x days
COD	150	1110	219	202
BOD	80	480	87	78
TSS	200	-	20	-

Results are provided by SGS laboratories Pvt. Ltd.

COD: Chemical Oxygen Demand

BOD: Biological Oxygen Demand

NEQS: National Environment Quality Standard

TEST REPORTS OF B-PYLE IN CONSTRUCTION

BLOCK COMPRESSIVE STRENGTH RESULT

GEOTECHNICAL SERVICES LABORATORY

Test Parameter	Size (inch)	Sample Date	Compressive Strength (psi)
B-Pyle Block	6 x 8 x 12	01-10-14	667
B-Pyle Block	6 x 8 x 12	01-10-14	722
With Out B-Pyle Block	6 x 8 x 12	01-10-14	556
With Out B-Pyle Block	6 x 8 x 12	01-10-14	528

FARHAD MATERIAL TESTING LABORATORY

(WITH EMC)

Test Parameter	Size (inch)	Test Date	Compressive Strength KG	PSI
Solid	6 x 8 x 12	30-09-14	53750	1232
Solid	6 x 8 x 12	01-10-14	56250	1291
Solid	6 x 8 x 12	01-10-14	51250	1175
Average Psi				1233

(WITHOUT EMC)

Test Parameter	Size (inch)	Test Date	Comprehensive Strength KG	PSI
Solid	6 x 8 x 12	30-09-14	40000	917
Solid	6 x 8 x 12	01-10-14	42500	974
Solid	6 x 8 x 12	01-10-14	40000	917
Average Psi				936

Inter Laboratory Comparison (ILC): GEOTECHNICAL SERVICES LABORATORY and FARHAD MATERIAL TESTING LABORATORY

Area of each block 48mm^2

Each sample was analyzed triplicate; Average results are reported.

OSMANI Engineering - Architecture - Planning - Mapping - Technology

COMPRESSIVE STRENGTH AND LOAD

Test Parameter	Area	Test Date	Compressive Strength Load(lbs)	Strength(PSI)
With B-Pyle	28.28	06-02-15	42000	1485
With B-Pyle	28.28	06-02-15	50,000	1768
With B-Pyle	28.28	06-02-15	62,000	2192
In seven (7) days			Average PSI 1815 19% more than without admixture	
With B-Pyle	28.28	27-02-15	91,000	3218
With B-Pyle	28.28	27-02-15	98,000	3465

With B-Pyle	28.28	27-02-15	90,000	3183
In twenty eight (28) days			Average PSI 3287 39% more than without admixture	

Test Parameter	Area	Test Date	Comprehensive Strength	
			Load(lbs)	Strength(PSI)
Control	28.28	06-01-15	43000	1521
Control	28.28	06-01-15	47000	1662
Control	28.28	06-01-15	45000	1591
Control	28.28	27-02-15	67000	2369
Control	28.28	27-02-15	71000	2511
Control	28.28	27-02-15	62,000	2192

Results are collected by Osmani & Company Pvt. ltd.

Area of each block 28.28mm2

Each sample was analyzed triplicate; Average results are reported.

Note: All above claims are verified by SGS laboratory & Council For Works & Housing Research reports beside completed ground project.

CONCLUSION

No single product provides multiple beneficial properties to resolve major issues in waste management confronted by Pakistan and across the world. The B-Pyle product is indigenous, organic & affordable. It is expected that its use shall reduce cement use in concrete, and helps in provision of clean water beside preservation of sewage and waste water for further use in parks, plants and agriculture.