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(75th Session)

INTRODUCTORY REMARKS

By

ENGR. TARIQ RASHID WATTOO

PRESIDENT

PAKISTAN ENGINEERING CONGRESS

AT

WORLD WATER DAY, COMMEMORATION on Saturday the 31st MARCH 2018

ON THE THEME OF "NATURE FOR WATER"

Distinguished Guests,

Members of Pakistan Engineering Congress,

Fellow Engineers, Ladies and Gentlemen!

Assalam-o-Alaikum!

It gives me immense pleasure to inform that Pakistan Engineering Congress has a unique distinction of commemorating World Water Day since 2005 based on universal themes. Not only this, but the papers presented / discussed and recommendations resulting from these events have been published and disseminated complimentary by the Congress to all concerned, particularly Federal / Provincial Government Agencies.

Ladies and Gentlemen!

As you are aware, the theme of this event is **'Nature for Water'**. This seems to be a very relevant topic for Pakistan, where per capita water availability is approaching the stage of 'acute water stress'.

Water is the free gift of nature. The human beings are required to realize its immense value, make all out efforts to conserve it, use it for its socio-economic operations in a judicious manner and make out maximum benefit out of its use. Pakistan is no exception. It should have visualized importance of water for ensuring "Sustainable Economic Development" / Prosperity and "Food Security" in the context of the volume of its population, Indus Water Treaty of 1960, under which three (3) rivers namely Ravi, Sutlej & Beas, vested with India. Let us analyze whether the "Planners" displayed proper vision in building Mega, Medium and Small water reservoirs / canals; took effective steps to control flood hazards / storage of these waters, proper storage and use of rain water (i.e. harvesting rain waters), controlling water from flash floods, hill torrents etc.

Ladies and Gentlemen!

Water availability in 1951 was 5263 m^3 which now stands reduced to 915 m^3. Pakistan is now a water scarce country. The country has only 30-days water storage capacity, a dismal scenario. India has 220-days potential and is further increasing it.

Non-Construction of Dams:-

After the construction of Mangla & Tarbela Dams, the Country miserably failed to construct any major reservoir. As per the advice given by PIETER LIEFTINCK of World Bank in his study on “Water and Power Resources of West Pakistan-1968”, the Country was mandated to construct at least one major water reservoir every decade. Kalabagh Dam that was to be operative in 1998 was not constructed under the utopian plea of absence of “provincial consensus”. A “Technical Matter” that was to be resolved through domestic / international expertise was made a political issue. Not only Kalabagh Dam was not constructed, no other dam was built. Now belatedly, work on Dasu, Bhasha Dam etc. has been started which would take 6 years to 11 years to complete a long time indeed. In the meantime, the Country suffered huge recurring financial loss of million of rupees. Also, 30 MAF water continued to flow into the sea without being used, in energy generation, agriculture and industrial development.

Ladies and Gentlemen!

Population of the Country that was 34-million stands at the staggering figure of 207.7 million (an understated figure) and is visualized to be 399 million by 2047 rising at an abnormal/galloping growth rate of 2.4%, a catastrophic scenario. It has been characterized by “Economists’ as time bomb. China has controlled its population by enacting 1-child policy. We may go for at the most 2-child policy if drought, hunger, starvation is to be avoided. It is the only sensible course to be adopted.

Ladies and Gentlemen!

The country has not only plundered surface water but has also been playing havoc in the mining of “Groundwater” to the tune of 50-MAF, which is the main source of “Agricultural” development as there is surface water shortfall of 31 MAF. In the absence of regulatory limitations, more than 1.2 million tube-wells are indiscriminately over-mining the “Groundwater” with the water table constantly declining. The aquifer is further suffering due to inadequate recharging. Water Resources specialists have identified numerous areas for recharging the aquifer.

Federal/Provincial Governments should work on groundwater recharge in depleted areas like Bari Doab, Rachna Doab, upstream of Ravi River, Fresh Water Lake needs to established up-stream of River Ravi. Another recharging method is drilling bore holes upto ground water levels in fresh water areas through reverse function of tube wells.

Ladies and Gentlemen!

Rain water Harvesting Techniques in cities of High Rise buildings, Libraries, Museums, Universities etc. is being practiced in several countries for achieving water supply which is clean/potable and can be used in Domestic purposes, gardening, industries and Groundwater recharge. It is the best source of providing low cost decentralized water to urban and Rural House holds where safe treated water is not available. It has been successfully implemented in NUST-Islamabad. It is being effectively practiced in Canada, India, United Kingdom, Sri Lanka, and Malaysia etc.

Ladies and Gentlemen!

Hill torrents in Pakistan drain approximately 65% of the total area of the country. There are 16 large Hill Torrents in 14-major Torrent areas. A study carried out by M/s. NESPAK, 1200 Number water conservation sites have been identified where 18690 MAF of Hill Torrents waters can be conserved and 1.409 million acres of land can be brought under cultivation. Alas, little efforts have been made to tap this valuable potential and to stem the rot of floods etc. that inflict enormous physical and financial losses.

Ladies and Gentlemen!

Pakistan with a fast-rising population cannot adequately meet its domestic agricultural and industrial water demand from surface water and ground water. Like other advanced/emerging economies it also requires proper use of its available waste water resources after their proper treatment as it needs to enhance its food/fibre production by at least 50% to ensure food security. Developed economies use approximately 70% of its waste water after its proper treatment and Pakistan should do the same.

In order to adequately meet the challenges of water shortage following projects need to be completed on Fast track basis.

1. **Diamer Basha Dam Project (6.4 MAF Storage)**

   This is now proposed to be implemented in two stages. In stage I, main Dam and appurtenant structures are going to be constructed through internal resources. PC-I Proforma for this stage is now in the final stage of approval by ECNEC.

2. **Dasu Hydropower Project (0.66 MAF Water Storage)**

   Implementation of this projects also envisaged through 2-stages. Stage 1 to develop 50% of 4320 MW Capacity (2160 MW) is already under implementation through international financing (World Bank) and internal resource mobilization through a consortium of Banks.

3. **Pattan Hydropower Project (0.06 MAF Water Storage)**

   Feasibility study of 2385 MW Pattan Hydropower Project has been already completed. For its implementation, a Chinese consortium has expressed interest on build, operate and transfer (BoT) basis under a lease of about 25-Years.

Thank you all for your patient hearing.

PAKISTAN PAINDABAD

REMARKS BY THE CHAIRMAN, MR. HAMMAD NAQI KHAN, CHIEF EXECUTIVE OFFICER WWF, PAKISTAN

On

World Water Day 2018

Held at Mashhadi Hall of the Congress on

Saturday, 31st March, 2018

On the theme of

"Nature for Water"

Engr. Tariq Rashid Wattoo, President Pakistan Engineering Congress

Fellow Engineers,

Distinguished delegates

Honestly I feel humbled, honoured, to be present in this august gathering and chairing this Session. This issue is very close to my heart not because I am myself water engineer but as an environmentalist, as a Pakistani, I strongly believe that this is one of the most important environmental issue that this Country is facing. Let me first thank all the speakers for sharing their thoughts, I think points those were made, I am not going to repeat those, but I picked up few points that I just shared my thoughts as an engineer and as an environmentalist. I think the message is clear, water is life, but water is not just required for the health, for our well-being, for our life, but it has other dimensions which have other values. It's important for our culture for our social uplift and it's critically important for our economy. I think Pakistan is one country in the world which has a water economy.

Now there were few statements that we tend to make and when I use the word 'we', I include myself as well. Some of these statements I strongly believe, but maybe we do not have substantial data to support those statements, but as I said, we all use those statements. I think one statement is that the economy is running dry, because the water which we have, I think which is true because we are talking about the substantial science behind it, is getting less. Second is about storage and dams that is the solution. We talk about the 30-days of storage, we compare it with the 220-days storage in India, we talk about 900-days storage in Colorado and in other place, but looking at the availability of water in Pakistan and its usage, I haven't seen a single scientific paper which substantiates this argument. Yes, we need storage, that's true, yes, we are losing storage capacity because of sedimentation. But I think the answer is that we need to look into this matter in a very holistic manner. I think in cities, as the first speaker said, that's true. Look at the hospital admissions, look at the number of water borne diseases, look at the quantity and quality of water which we're getting, not only in our capital city, but in every city of this country. Primarily, I strongly believe this is a governance issue. Water resource management in Pakistan is basically governance issue. Another speaker mentioned about "Impacts because of climate change. That's true, the glaciers, most of them if not all, they are melting

on fast pace. We have seen in northern areas, working on different projects, that lakes are being formed where used to be glaciers. We call the phenomena GLOF, which is Glacial Lake Outburst Flood. We are seeing that phenomenon. We're seeing that the frequency and intensity of droughts, rains, and storms is increasing. And we saw the disaster which was created by 2010 floods.

Now as an engineer, I have a belief, I have been trained that all problems have an engineering solution. If you want me to design a project to bring water from K2 to Lahore, give me few weeks, I'll design a project, which will bring water from K2 to Lahore because there is always an engineering solution. But the gap is, and I have witnessed that gap in my professional life, and when I was doing my MS Engineering in Water and Environmental Management or my other fellowship, that even still at this point in time, our engineering universities cover a lot of engineering solutions, but they miss the gap of social and environmental impact of those solutions. We seldom incorporate that what would be the impact on the lives of people all along the route and may be the environment. Such a gap, which I believe that this forum, this platform should continue to advocate and lobby to bridge that gap.

Another thing is that for all our disaster management, a strong belief to have gray structures, whether they are river diversions, whether they are tides, bunds, spurs, dams but a strong belief that there must be a gray structure to address that challenge or to address that problem. And totally ignoring, I'm not against this, as an engineer, I strongly believe that gray infrastructure is critically important but let's not totally ignore the "Green Infrastructure". The "Green Infrastructure" is, just to give you an example, I think Dr. Qazi is present here from Federal Flood Commission, when the national flood protection plan 4 was being prepared at NESPAK and other organizations were working on that, we literally as an organization lobbied and advocated to include the green infrastructure, green solutions in the entire flood protection plan. What is green? The Green solution is the theme "Nature for Water", using nature for water. Water for nature, nature has never been recognized in this country as a water user. 90% for irrigation, 80% for industry or 2 to 4% for domestic. What about nature? Nature has never been recognized. So just forget water for nature, let's just focus on nature for water.

We can start from water detachment areas. Why the dams and storages are being silted, because a highest rate of deforestation is happening in that area, which is a clear link with water resource management. Come down, what about the flood plain management? What about connecting our rivers to the flood plains? Look at the encroachment. People are doing agriculture and have started living there. So that's where the flood plain management doesn't exist. We are using that area. The third is, what about restoring the national wetlands? These were the natural ponds in the depression areas and there was more water, we need to fill those dams and has ecological importance, social importance and it has economic importance. And that's the reason, that with the Federal Flood Commission, we as an organization are working on a project, which is a multi-million dollar project on Flood Plains Management in the Indus Basin. We are submitting that project to the Global Climate Facility, which will be the green infrastructure. Restoring the natural wetlands, restoring some of the lakes which have dried up and wherever there is surplus water. It happens in Europe, it happens in Yangtze River in China and they have managed their rivers through national solutions and we have an opportunity and I'm so happy and excited that the relevant line departments, the ministry of

Water Resources, the ministry of Climate Change, the Irrigation Departments, the Energy Departments, all of them are on board. Initially there was a lot of resistance and opposition, but now 22 departments have endorsed this project and it's growing ahead. And I feel if that project "Nature for Water" goes ahead, that would be, InshaAllah, the game changer for this country.

Lastly, three points will be the crux of listening to the papers. The first point is;

We need to understand water. When I say understand water, i.e. solid scientific data, how much water is available, how much water is needed. Do we need to grow the X quantity of sugarcane, or the X quantity of rice in this country? Do we need to use or to change our cropping pattern? What about the drought in these varieties, so on and so forth. So I think that's critically important. We can understand water if we have solid scientific data.

Second point, which is a very sensitive and important point. Worthy speakers here talked about metering. People talked about abiana is low, cost is low. Honestly, we have to value water. I think we in Lahore are very fortunate. When I go to Quetta, when I go to some of the Southern Punjab districts or some of the upper Sindh districts, the areas are miserable with no water at all. So we should value water. I think people take it for granted; they open the tap and let flow. Every day water is used to wash floors in houses, cars, these small things do matter. So we should value water.

My last point is, we need to have integrated post, and we need to manage water. It's a governance issue. I remember it was 2010 when I first reviewed the draft of National Water Policy and now it is 2018. We were expecting that the first agenda item on the Council of Common Interest was the approval of National Water Policy. All the Planning departments and Provincial Irrigation departments had endorsed it and it had to be signed by the Chief Minister, but sadly didn't happen.

We have policy for literally everything, except the National Water Policy, which is our lifeline!

So, I'm also hopeful, wishful and I pray, for this to happen, but I'm skeptical because I have been listening to it for last 10 years. I pray this happens in this April 2018 because we critically need that.

Let's implement it and if we need to re visit it, we should. No human, no policy is perfect. It doesn't matter. We should first start with it. So the governance issue is very important and I think this is the platform, the prestigious professional association of engineers of this country. We engineers talk about precisions and solutions. We talk about science, we talk about economic development through engineering solutions. Let's have an integrated approach, let's continue to look towards other factors, which are the social factor, the environmental factor and bring these players on board and come up with an integrated approach to address the water challenges of this country.

Thank you very much for listening.

World Water Day held on 31st March 2018

on the theme of

“NATURE FOR WATER”



(From Left) Engr. Tariq Rashid Wattoo, President-PEC, Engr. Hammad Naqi Khan, Chief Executive Officer, WWF, Pakistan/Chairman of the Session, Engr. Najam Waheed, Secretary-PEC



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



Engr. Tariq Rashid Wattoo, President-PEC presenting the Welcome Address



(From Right) Engr. Tariq Rashid Wattoo, President-PEC presenting shield to Engr. Hammad Naqi Khan,Chief Executive Officer, WWF, Pakistan/Chairman of the Inaugural Session, for chairing the Inaugural Session



(From Left) Engr. Tariq Rashid Wattoo, President-PEC and Engr. Hammad Naqi Khan,Chief Executive Officer, WWF, Pakistan awarding Shield to Engr. Abdul Khaliq Khan for presenting his paper on the topic of **"Water Needs of Capital Cities in Pakistan"**



Engr. Dr. Muhammad Nawaz Bhutta presenting his paper on the topic of **"Groundwater Use and Management Experience in Punjab"**



(From Left) Engr. Tariq Rashid Wattoo, President-PEC and Engr. Hammad Naqi Khan,Chief Executive Officer, WWF, Pakistan awarding shield to Engr. Dr. Allah Bakhsh Sufi for presenting his paper on the topic of **"Water: A Natural Resource of Sustainable Development for Pakistan`s Economy"**



(From Left) Engr. Tariq Rashid Wattoo, President-PEC and Engr. Hammad Naqi Khan,Chief Executive Officer, WWF, Pakistan awarding Shield to Engr. S. Laraib Zadi for presenting their paper on the topic of **"Water: A Natural Resource of Sustainable Development for Pakistan`s Economy"**



(From Left) Engr. Tariq Rashid Wattoo, President-PEC and Engr. Hammad Naqi Khan, Chief Executive Officer, WWF, Pakistan awarding Shield to Dr. Qazi Talat Mahmood Siddiqui for presenting his paper on the topic of **"Impacts of Climate Change on Water Resources of Pakistan"**



(From Left) Engr. Tariq Rashid Wattoo, President-PEC and Engr. Hammad Naqi Khan, Chief Executive Officer, WWF, Pakistan awarding Shield to Engr. Saba Tasaduk for presenting their paper on the topic of **"Are we drinking Quality and Safe Water in Pakistan"**



(From Left) Engr. Tariq Rashid Wattoo, President-PEC, Dr. Shahzad Alam**,** Chairman, PCSIR/Chairman of the Technical Session, Engr. Najam Waheed, Secretary-PEC



(From Right) Engr. Tariq Rashid Wattoo, President-PEC presenting Shield to Dr. Shahzad Alam**,** Chairman, PCSIR for Chairing the Technical Session



(From Left) Dr. Shahzad Alam**,** Chairman, PCSIR awarding Shield to Engr. Dr. Muhammad Saeed for presenting their paper on the topic of **"A Review on: Water Saving Techniques for Domestic, Agricultural and Industrial Water Usage"**



(From Left) Dr. Shahzad Alam**,** Chairman, PCSIR awarding Shield to Engr. Faiz Raza Hassan for presenting their paper on the topic of **"Flood Water Storage in Aquifer through Natural Recharge- A Case Study of Rechna Doab, Punjab, Pakistan"**



(From Left) Engr. Tariq Rashid Wattoo, President-PEC, Dr. Shahzad Alam**,** Chairman, PCSIR awarding Shield to Engr. Amrah Qureshi for presenting their paper on the topic of **"Monitoring Microbial Regrowth and Inactivation Potential of Chlorine in a Lab-scale Water Distribution Network"**



(From Left) Engr. Tariq Rashid Wattoo, President-PEC, Dr. Shahzad Alam**,** Chairman, PCSIR awarding Shield to Engr. Mumtaz Hussain for presenting his paper on the topic of **"Nature- Water Nexus: Managing Current Water Challenges"**



(From Left) Engr. Tariq Rashid Wattoo, President-PEC, Dr. Shahzad Alam**,** Chairman, PCSIR awarding Shield to Engr. Sameen Salman for presenting their paper on the topic of **"Microbial Fuel Cell for the Treatment of Industrial Waste Water"**



(From Left) Engr. Tariq Rashid Wattoo, President-PEC, Dr. Shahzad Alam**,** Chairman, PCSIR awarding Shield to Engr. Rabia Shaukat for presenting their paper on the topic of **"Microbial Fuel Cell for the Treatment of Industrial Waste Water"**



(From Left) Engr. Tariq Rashid Wattoo, President-PEC, Dr. Shahzad Alam**,** Chairman, PCSIR awarding Shield to Engr. Fizza Tahir for presenting their paper on the topic of **"Efficiency of Grass Species for the removal of Heavy Metals from Waste Water"**



(From Left) Engr. Tariq Rashid Wattoo, President-PEC, Dr. Shahzad Alam**,** Chairman, PCSIR awarding Shield to Engr. Laraib Fatima for presenting their paper on the topic of **"Efficiency of Grass Species for the removal of Heavy Metals from Waste Water"**

Glimpses of the Audience



Engr. Husnain Ahmad Past President/Vice-President-PEC in conversation with Engr. Tariq Rashid Wattoo President-PEC



(From Right) Engr. Husnain Ahmad Vice-President-PEC in Deep Conversation with. Also seen in the picture is Engr. Tariq Rasheed Wattoo President-PEC, Dr. Muhammad Nawaz Bhutta, Engr. Iftikhar Ahmad, Past President / Member Executive Council.

Glimpses of the Audiences



(From Right) Engr. Husnain Ahmad Past President/Vice-President-PEC, Mr. Abdul Hafeez Siddiqui Senior Manager-PEC, Engr. Anwar Ahmad Member Executive Council



(From Right) Engr. Ch. M. Aamir Ali Vice-President-PEC, Engr. Tariq Rashid Wattoo President-PEC, Engr. Anwar Ahmad Member Executive Council, Engr. Iftikhar ul Haq Member Executive Council

Glimpses of the Audiences



(From Left) Engr. Tariq Rashid Wattoo President-PEC, Engr. Dr. Shahzad Alam, Engr. Riaz Ahmad Khan Past President/Member Executive Council



(From left) Engr. M. Amin Former Vice-President, Engr. Riaz Ahmad Khan Past President/ Member Executive Council, Engr. Ch. Ghulam Hussain Immediate Past President, Engr. Abdul Khaliq Khan, Engr. Riaz Nazir Tarar, Engr. Anwar ul Hassan, Engr. Husnain Ahmad Past President/Vice-President-PEC, Engr. S.M.A Zaidi former Secretary/Vice-President-PEC

Glimpses of the Audiences



(From left) Engr. Ch. Ghulam Hussain Immediate Past President, Engr. Abdul Khaliq Khan, Engr. Riaz Nazir Tarar



(From left) Engr. M. Amin Former Vice-President, Engr. Riaz Ahmad Khan Past President/Member Executive Council, Engr. Ch. Ghulam Hussain Immediate Past President, Engr. Abdul Khaliq Khan, Engr. Riaz Nazir Tarar, Engr. Anwar ul Hassan

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





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

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

Tue 7 Aug 2018 07.21 BST



Polar bears on sea ice: the loss of the Greenland ice sheet could disrupt the Gulf Stream, which would in turn raise sea levels and accelerate Antarctic ice loss. Photograph: Paul Goldstein/Cover Images

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.”

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 **(WAPDA Photo)**



A view of Power House-Neelum Jhelum Hydropower Project **(WAPDA Photo)**

GOLEN GOL HYDROPOWER PROJECT

- Golen Gol Hydropower Project has been constructed on River Golen Gol, a tributary of River Mastuj in Chitral district of Khyber Pakhtunkhwa province.
- Generation capacity of Golen Gol Hydropower Project is 108 MW.
- The project has three generating units. Generation capacity of each unit is 36 MW.
- The first unit of the project has started generation and provided electricity to Chitral on January 24, 2018.
- Electricity generated by the first unit i.e. 36 MW is exclusively meant for Chitral, which is three times more than the existing electricity requirements of the area.
- The second unit of the project is scheduled to be completed in March 2018.
- The third unit will come on line in May 2018.
- Golen Gol Hydropower Project will contribute 436 million units of low-cost hydel electricity to the National Grid every year.
- Annual revenue of the project is estimated at Rs. 3.76 billion.

Salient Features

- Weir Height 12 m
- Head Race Tunnel Length 3.8 km
- Gross Head 436 m
- Design Discharge 30 m3/sec
- Installed Capacity 108 MW
- Objectives to Generate Electricity

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Weir and intake structure of Golen Gol Hydropower Project constructed by WAPDA near Chitral



A view of switchyard of Golen Gol Hydropower Project



A view of Grid Station of Golen Gol Hydropower Project

MILLIONS OF CHINESE FARMERS REAP BENEFITS OF HUGE CROP EXPERIMENT

Decade-long study involving 21 million smallholders shows how evidence-based approaches could improve food security.

David Cyranoski



Rice farmers in China increased their crop yields when they adopted new evidence-based farming practices.Credit: KeystoneUSA-ZUMA/REX/Shutterstock

A landmark project to make agriculture more sustainable in China has significantly cut fertilizer use while boosting crop yields on millions of small farms across the country, researchers report in *Nature*.

As part of a decade-long study, scientists analysed vast amounts of agricultural data to develop improved practices, which they then passed on to smallholders. Through a national campaign, about 20.9 million farmers adopted the recommendations, which increased productivity and reduced environmental impacts. As a result of the intervention, farmers were together US$12.2 billion better off.

The scale of the project has stunned international scientists. With the global demand for food expected to double between 2005 and 2050, they hope that the study's lessons can be applied to other countries. "This is an astonishing project of a scale way beyond anything I am familiar with," says Leslie Firbank, who studies sustainable intensification of agriculture at the University of Leeds, UK.

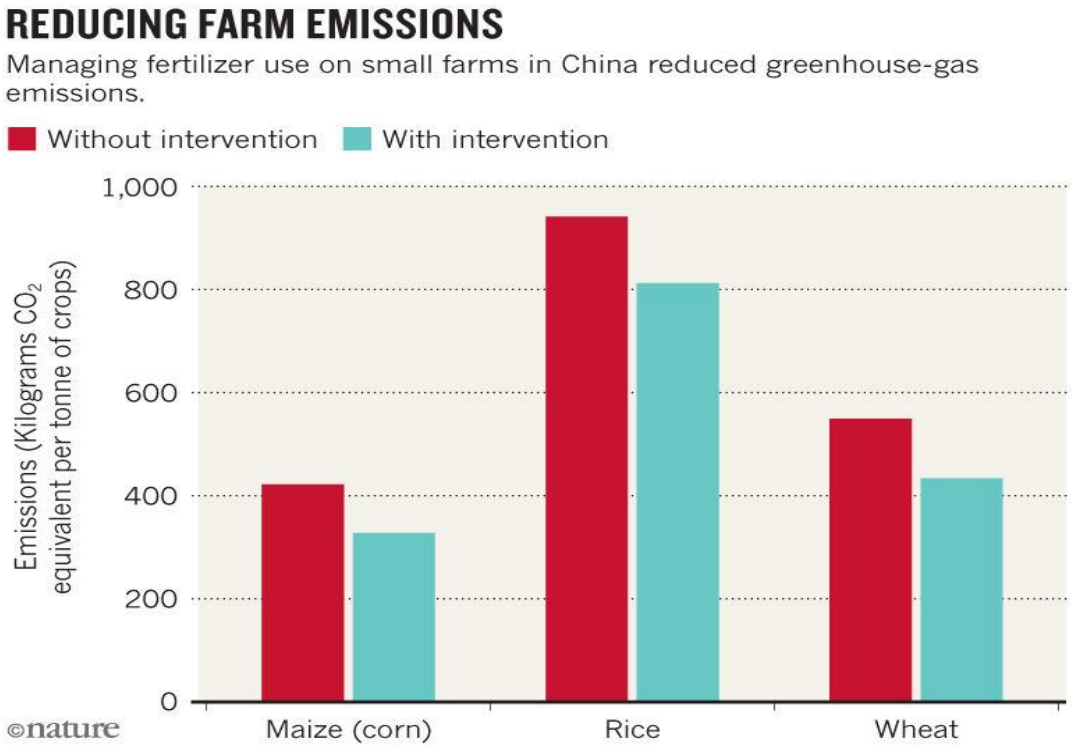
Charles Godfray, a population biologist at the University of Oxford, UK, says that, over the past 30 years, China has achieved an agricultural miracle by producing enough food to feed the vast majority of its 1.4 billion people. But this feat has come

at a tremendous cost to the environment, he says. Fertilizers, such as nitrogen, have increased crop production but have also acidified soil, polluted water and contributed to global warming. Godfray says the latest study demonstrates that it is possible to reduce fertilizer use while increasing economic returns on a large scale.

Tailored advice

Chinese farmers use about 305 kilograms of nitrogen per hectare a year, which is more than four times the global average. Project leader Cui Zhenling at the China Agricultural University in Beijing and his collaborators took up the challenge to cut that use without lessening farmers' yields.

From 2005 to 2015, the project team conducted 13,123 field studies at maize (corn), rice and wheat farms across the country, from the subtropical south to the frigid north. The researchers tested how yields varied with different crop varieties, planting times, planting densities, fertilizer and water use. They also measured sunlight and the effect of the climate on farm production.



Source: Z. Cui et al. Nature http://dx.doi.org/10.1038/nature25785 (2018)

With data from the field trials, Cui and his colleagues developed evidence-based advice that was given to farmers on the basis of their local conditions. For example, the team recommended that rice farmers in northeast China reduce their overall nitrogen use by 20% on average, while increasing the nitrogen applied late in the growing season and planting the seeds closer together.

Almost 21 million farmers adopted the group's recommendations between 2006 and 2015. In that period, crop production for each grain increased by an average of around 11%. The study's collaborators also recorded a surprising drop in fertilizer use — about 15% per crop — saving 1.2 million tonnes of nitrogen. "The

demonstration that reducing inputs can actually boost agricultural, environmental and economic performance at scale is very important," says Godfray.

Management success

A combination of outreach programmes and workshops — about 14,000 over 10 years — helped to convince the farmers to adopt the recommendations. "The [farmers] were sceptical, but we gained their trust, and then they depended on us — that was our greatest reward," says Cui. The project, which also provided on-site demonstrations and high-quality seeds and fertilizers at some sites, cost around $54 million.

To enrol and educate the farmers, more than 1,000 researchers across China worked with 65,000 bureaucrats and technicians at provincial or county agricultural agencies and with 140,000 representatives from agriculture businesses. The project's success highlights the importance of the vast social networks, says Jules Pretty, who researches the environment and society at the University of Essex in Colchester, UK.

David Tilman, an ecologist at the University of Minnesota in St Paul, says the study is a rare example of scientific knowledge being properly implemented in farming. "The greatest barrier to sustainable agricultural is getting farmers to adopt more efficient practices," he says, adding that the project offers a path for other nations to follow.

But some researchers think the project's lessons may be difficult to translate to other regions. China's improved yields resulted from reducing fertilizer overuse, but many farmers in low- and middle-income countries don't have access to enough fertilizer, says Godfray. He says that China's centrally controlled government is uniquely capable of implementing policies across the country, which is not the case in other regions. "It would clearly have benefits across sub-Saharan Africa, but an approach is needed that crosses borders, organizations and funders," says Firbank.

These challenges shouldn't stop other countries from trialling a similar experiment, says Tilman, but improving farm productivity is not enough. "The China study proves that nations do not have to pollute lakes, rivers and the ocean in order to feed themselves," he says. "A great remaining challenge that all nations face is adopting healthier, low-meat diets that prevent disease and preserve the environment."

WATER WOES: TIME TO ACT NOW

By:

Naveed Iftikhar and Maha Ahmad[1]

Once a water-affluent country, Pakistan is new in the midst of a severe water crisis. Between 1990 and 2015, water availability almost halved from 2,172 cubic metres per citizen to 1,306 cubic metres per dozen. The Pakistan Council of Research in Water Resources (PCRWR) has warned that unless the government takes action, the country may run dry by 2025. The imminent water crisis has received some media attention recently, however, the dialogue remains narrowly focused on public investment for reservoirs and moral appeals to save water. There is a dire need to change the fundamental workings of water governance in the country.

This article focuses on governance issues in the water sector. However, there are many other challenges relating to international and provincial water distribution, water storage, impact of excessive water extraction from natural resources on climate change, water-associated disasters, deforestation and recharge of aquifer which need a separate discussion.

With water scarcity becoming an increasing constraint, the pricing mechanism for water-use by all sectors requires reappraisal. Pricing must recover at least operational and maintenance costs. Even the elite of the country pays a meagre amount for massive use of water at home, industry and vast agricultural farms; only a tiny fraction of the population pays for metered use of water. For households, water charges are based on the size of the plot. Any common resource, when consumed on the basis of fixed rather than marginal cost, is bound to be overly exploited. For agriculture, there are no charges for pumping water from the ground and canal irrigation charges are also minimal, both of which have led to flood irrigation and wastage of water.

Research shows that appropriate pricing of water along with clearly defined and legally enforceable water regulations are the key underlying factors that motivate water conservation. Moral appeals are not enough! Politicians don't want to hold dialogue about improving water pricing in order to avoid resentment by the constituencies. They fail to acknowledge that inefficient use of available water supplies is playing a major role to exacerbate the impending water crisis. Indeed, even most lower income families would be willing to pay for efficient water provision services, given that they are already paying a high proportion of their incomes either in the form of excessive charges imposed by water vendors (case in point: Karachi), or in time lost due to collecting water from far-flung sources. A survey of residents of Lahore in 2011 found that people were willing to pay S7-50-S9 per month for clean, piped drinking water, which is comparable to the monthly expenditures on in-house water treatment and is about three to four times the average monthly water bill being paid.

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[1] The former is a public policy adviser and research fellow having interest in public-sector governance, cities, and entrepreneurship. He tweets @navift. The latter is an Assistant Professor of economics at the National University of Science and Technology, Islamabad

Second, there is a need to enhance participation and partnerships in the water sector. Water, being a collective resource available to society, needs a collective response. The public sector must realise that without mobilising and involving all the stakeholders, the crisis will remain unresolved. Communities residing in small cities, towns, slums and villages need to be mobilised to participate in water financing and maintenance. A home-grown model named 'Changa Pani' (Clean Water) in Bhalwal has proved that it is possible for communities to work with the government to construct and maintain water supply systems. Other cities, social entrepreneurs and community groups have much to learn from such community participation models and may benefit by customising the approach according to their own circumstances. For big cities the complexity of governance requires public-private partnerships (PPPs) for water availability, quality and distribution. All provinces have already developed PPP frameworks and are pursuing projects in many sectors. However, PPPs in the water sector are almost non-existent. Karachi and other coastal cities need desalination plants to supply drinking water. Almost every city needs water-filtration and treatment plants. But it would be hard to finance and operate them under the public sector. Sindh water commission formed by the Supreme Court of Pakistan, for example, found that all water-purifying systems in Sindh are either dysfunctional or redundant. The public sector is agile to build new schemes, but it lacks capacity to maintain filtration plants and distribution system. This is where communities and the private sector can play their part. The recently announced national water policy has specifically emphasised to foster partnerships and participations, but provinces would carefully have to plan appropriate execution of these partnerships at the local level. We have recently started a research initiative with the US-Pakistan Centre for Advanced Studies in Water at the Mehran University of Engineering and Technology (MUET) to assess the possibilities of such partnerships and collective action in Sindh. We hope that this research will provide valuable insights to improve drinking-water governance.

Third, the regulatory regime for water pumping, distribution and usage needs special attention. There is a need to introduce radical measures to regulate the use of water starting from our homes to agricultural fields. Overall regulatory quality is weak in Pakistan but in the context of social and environmental aspects of the society, regulation is generally non-existent. The most wasteful practices are observed in the agriculture sector, where farmers continue to rely on surface rather than drip irrigation, the latter using substantially less water than traditional surface irrigation systems. Other than areas plagued with salinity, drip irrigation is a more efficient and sustainable option. The effective use of water in the agriculture sector is imperative given that it consumes around 90% of water resources in the country.

Fourth, a wave of entrepreneurship and technology development can be witnessed across Pakistan. Many of the entrepreneurs and technologists are working on water issues, starting from water filtration to distribution to irrigation and treatment. The public sector needs to give some space and funding to such startups to further develop and refine their technologies and solutions. We recently met a few experts and faculty members at the Lahore University of Management Sciences who have formed the Centre for Water Informatics and Technology that is leading research on a range of water-related issues. There is an urgent need to engage such water centres at LUMS and MUET to not only provide technological and governance solutions but also to carry out independent monitoring of water management in the

country. Such research and engagement of academia can directly feed into policy and regulatory decisions.

Fifth, there is only marginal improvement in the understanding of the importance of clean drinking water in Pakistan. Public investment is still deficient and communities are also unaware about the impact of clean water. Some international research studies have found that poor quality of water is indeed a bigger factor leading to childhood stunting as compared to poverty. There is a need to organise a mass campaign to highlight the importance of water quality and conservation. The purpose of such awareness should be how society at large can act to address water woes faced by the country.

WORLD WIDE FUND PAKISTAN AIMS TO WORK ON SDGS, REAFFIRMS COMMITMENT

LAHORE: World Wide Fund-(WWF) Pakistan reaffirms its commitment to advancing the Sustainable Development Goals (SDGs) and achieving Agenda 2030.

The global WWF Network has always highlighted nature's contribution to social and economic development and helped develop an integrated Agenda 2030 with a strong environment dimension. Most of the 17 SDGs are directly or indirectly linked to environmental sustainability, particularly those that address poverty, hunger, health and well-being, water and sanitation, clean energy, sustainable cities and communities, responsible consumption and production, climate action, life below water and life on land. WWF, thus, aims to drive national action on SDGs implementation around the world.

Unfortunately, Pakistan's performance on these goals is comparatively low. The country was ranked 147 out of 188 on the Human Development Index and 106 among 119 developing countries in the Global Hunger Index. With an annual per capita availability of water at around 1,000 cubic metres, Pakistan is fast becoming a water scarce country; many areas, including metropolises like Karachi, are in the grips of acute water crises already. Pakistan has one of the lowest forest covers and one of the highest rates of deforestation in the world. In addition, climate change impacts, such as the recent melting of a glacier in Ghizer district in Gilgit-Baltistan that has damaged infrastructure and rendered many families insecure, exacerbate these issues.

Without healthy ecosystems, which can be measured by the richness of biodiversity and various other indicators outlined for the SDGs, there can be no integrated sustainable development.

Commenting on this, WWF Pakistan Director General Hammad Naqi Khan shared that the country is home to rich biodiversity and unique ecosystems, from mountains in the north to mangroves along the coast. The organisation works closely with local communities living in important ecoregions, protected conservation areas and fragile ecosystems.

"Raising awareness about important environmental challenges is key for WWF-Pakistan and advocating for responsible voting is a crucial step towards ensuring environmental sustainability in country," he added.

It is the responsibility of the citizens of Pakistan to elect leaders who are committed to building a future where clean air and water, livelihood opportunities, adequate nutrition, clean energy, sustainable and equitable access to natural resources, among other necessities, are provided for everyone across the country. WWF-Pakistan urges all citizens, those working in the public and private sectors, civil society organizations, academia, and others to take collective action aimed at bringing together the agendas for sustainable development, climate change adaptation and biodiversity conservation.

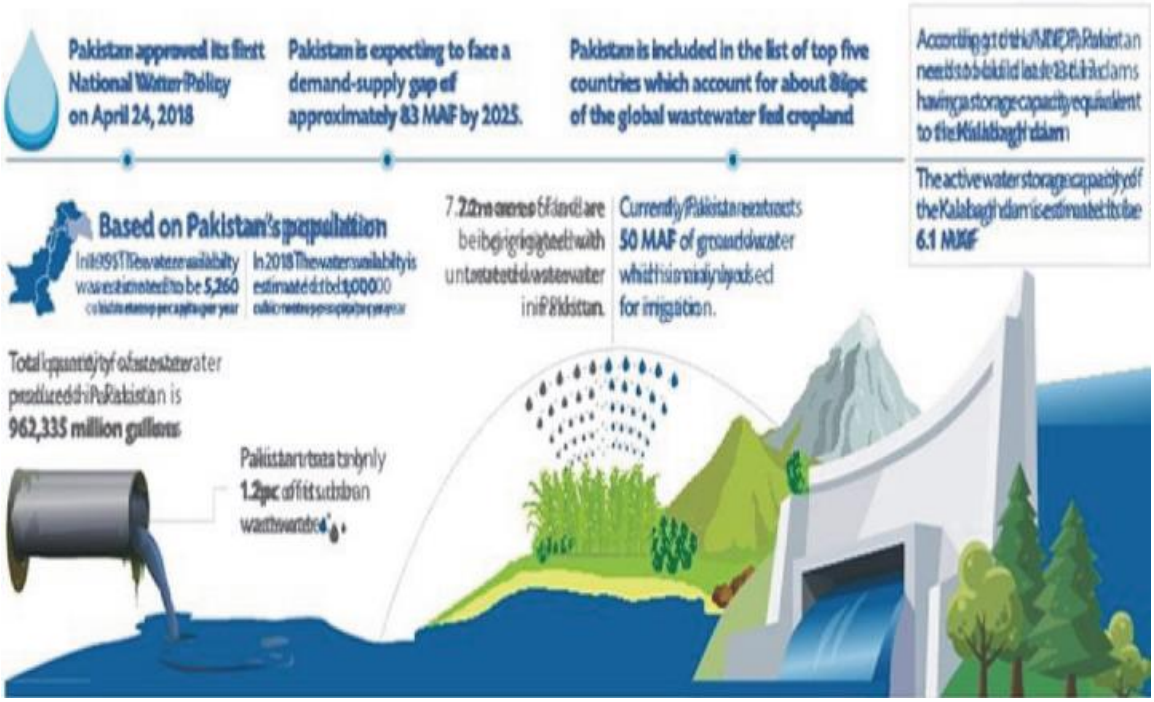
Therefore, WWF-Pakistan in collaboration with a non-partisan voter platform operating since January 2012, Pakistan Votes, released a short video of WWF's project community members demanding citizens vote responsibly in the upcoming general elections to be held on July 25, 2018 across Pakistan. Local communities now realise the importance of environment conservation for sustainable development as a result of various awareness raising initiatives by WWF-Pakistan.

(Courtesy Daily Times 22 July 2018)

RE-THINKING THE NATIONAL WATER POLICY

By:

Muhammad Arif Watto



Design by Rohail Safdar

PAKISTAN approved its first National Water Policy on April 24, 2018. Following this, a recent wave of discussions on social media seems to have brought the water crisis back to the forefront.

Many believe that the construction of the Kalabagh dam will solve Pakistan's water crisis. The active water storage capacity of the Kalabagh dam is estimated to be 6.1 million acre-feet (MAF),whereas Pakistan is expected to face a demand-supply gap of approximately 83 MAF by 2025.

According to the United Nations Development Programme's report, "The Vulnerability of Pakistan's Water Sector to the Impacts of Climate Change", Pakistan needs to build at least 13 dams having a water storage capacity equivalent to the Kalabagh dam.

Keeping this in mind, the National Water Policy is inadequate to address the country's water issue as it is vague on many key aspects, technically unsound, and does not contain updated information about the state and quality of water resources.

The per capita water availability estimates, presented in the policy document, are derived from the old estimates of water availability in the country. Based on Pakistan's total renewable water resources and population in 1951, the water availabilty was estimated to be 5,260 cubic metres per capita per year.

The policy is inadequate for addressing the water issue as it is vague on many key aspects, technically unsound, and does not contain updated information about the state and quality of water resources

The current per capita water availability estimates are about 1,000 cubic metres. However, Pakistan's renewable water resources have decreased significantly. There has been a gradual decline in surface water flows and our groundwater depletion rate is one of the highest in the world.

Even the estimates of the total renewable water resources at 138.4 MAF suggest a water availiabity of 823 cubic metres per capita per year which is significantly lower than 1,000 cubic metres.

The situation is much worse than these estimates if we distinguish between water availability and water accessibility. The reason to do so is that the majority of the fresh water (both canal water and groundwater) is being polluted by wastewater.

According to an estimate, the total quantity of wastewater produced in Pakistan is 962,335 million gallons which ultimately finds its way to freshwater bodies and groundwater aquifers. Untreated wastewater makes much of the fresh water in eastern rivers and canals (especially in Ravi) inaccessible.

Pakistan is included in the list of top five countries which account for about 86 per cent of the global wastewater fed cropland, says a study published in IOPscience, a leading scientific research journal.

Of these countries China, Mexico and India treat 71pc, 54pc and 22pc of their urban wastewater, respectively, but Pakistan treats only 1.2pc of its urban wastewater. About 7.2m acres of land are being irrigated with untreated wastewater in Pakistan.

Currently, Pakistan extracts 50 MAF of groundwater which is mainly used for irrigation. Due to excessive pumping Pakistan's groundwater abstraction rates have exceeded the annual recharge rate of 55 cubic kilometres per year.

Consequently, the groundwater tables are lowering rapidly in different parts of the country. Some hydrologists think that there could be a decline of 10-20 metres in the groundwater tables in the upper and the lower regions of the Rachna Doab in north-east Pakistan by 2025.

Despite this, Pakistan continues to exploit groundwater resources to grow and export water-intensive crops such as rice. Pakistan's rice water productivity- at 0.45kg per cubic metre — is 55pc lower than the average water productivity of 1kg per cubic metre for rice in Asian countries.

Pakistan also exports rice at competitive prices in the international export market. A recent study reported that about 11pc of the global groundwater depletion is due to the international food trade.

The National Water Policy does not address the issue of growing and exporting water-intensive crops such as rice, cotton and sugarcane. Pakistan's water resources face a number of challenges including over-extraction, contamination, and vulnerability to the impacts of climate change and population growth, etc.

Population growth will worsen the crisis as on an average, we use 350 billion litres of surface water daily, which translates to 1,684 litres per capita per day. In less than

half a month, we extract about 8.5 cubic kilometre of groundwater, which is higher than the active storage capacity of the Kalabagh dam.

Each Pakistani produces daily about 65 litres of wastewater which is not being recycled. This requires a massive public awareness campaign in the country on an immediate basis to create awareness about conservation measures and more comprehensive policies to address the water crisis effectively.

INTRODUCTORY REMARKS

By

ENGR. TARIQ RASHID WATTOO

PRESIDENT

PAKISTAN ENGINEERING CONGRESS

at

WORLD ENVIRONMENT DAY on Saturday, the 23rd June 2018

ON THE THEME OF "Beat the Plastic Pollution"

Distinguished Guests,

Members of Pakistan Engineering Congress,

Fellow Engineers, Ladies and Gentlemen!

Assalam-o-Alaikum!

The Plastic(s) products are made in different sizes and shapes and its use is increasing with the increase in population of the world.

- One-time use, non-biodegradable bags especially Black Plastic Bags
- Bottles
- Jars
- Electric Goods-Switches etc.
- Soft Drink Bottles
- Packaging Materials
- Polyester Fibre- used in cloth
- Re-useable Shopping Bags

The use of plastic products is a result of its numerous characteristics

- Durability
- Corrosion Resistance
- Light Weight- ease in Transportation of Goods etc.
- Conversion in different shapes
- Energy generation through incineration along with other waste materials
- Recyclable it's a good quality which appears to be the only solution to control its increasing production

Ladies & Gentlemen!

The very characteristics of Durability/ non-biodegradable is causing immense harm to environment and public health. Roughly 8.3 billion metric tons of plastics produced worldwide since the 1950s, about 6.3 billion have been thrown away, according to 2017 study in the Journal “Science Advances”.

- Towers of trash engulf Delhi-a Land-Fill storeys high crashes and kills a young man
- A UN report on International Environment Day cautions the world that at present plastic consumption level, the world will be awash with 12 billion tons of plastic trash by the end of the century
- The plastic enjoys a 450 years span of existence but gets shredded into pieces and gets ingested by Marine, Birds etc.

A pilot whale that washed ashore in Southern Thailand in critical condition and with a belly full of black plastic bags, becomes a cause of World Wide concern. And its death a few days later was a reminder of a staggering global problem: plastics in the oceans and seas.

Ladies & Gentlemen!

Plastic bags and products are a source of huge environmental degradation in following ways;

- A great Patch of plastics has appeared (like an island) in the Pacific Ocean
- Drains
- Streets
- Major Water Resources
- Streams
- Clog Sewers
- Habitat of Animals
- Marine Creatures
- Birds Entanglement

The immense harm caused using plastic bags, bottles etc. has forced a number of countries to ban its use some of which are;

- China
- India
- Bangladesh
- Taiwan
- Kenya
- Macedonia
- Rwanda

- Morocco

The only solution to avert the Plastic invasion is;

- Production/use of one-time plastic bags to be totally banned
- Recycling of the Plastic Products especially plastic bottles to check un-controlled production
- Energy generation through incineration of the Plastic Products along with other waste materials

Thank you all for your patient hearing.

PAKISTAN PAINDABAD

WORLD ENVIRONMENT DAY – 2018

on the topic of

"BEAT THE PLASTIC POLLUTION"

held on

Saturday, 23rd June 2018



(From right) Engr. Husnain Ahmad Former President/Vice President-PEC, Engr. Tariq Rashid Wattoo President-PEC Welcoming the Chief Guest, Mr. Jehan Zeb Khan. Also seen in the Picture is Engr. Iftikhar Ahmad and Engr. Najam Waheed



(From Left) Engr. Tariq Rashid Wattoo, President-PEC, Mr. JehanZeb Khan, the Chief Guest of the Session, Engr. Najam Waheed, Secretary-PEC



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



Engr. Tariq Rashid Wattoo, President-PEC presenting the Welcome Address



(From Left) Engr. Tariq Rashid Wattoo, President-PEC presenting Shield to Mr. JehanZeb Khan, the Chief Guest -Inaugural Session



(From Right) Mr. JehanZeb Khan, the Chief Guest and Engr. Tariq Rashid Wattoo, President-PEC presenting Shield to Dr. Abdul Majeed of IUCN, Pakistan for Presenting Key Note Address on the topic of **"BEAT THE PLASTIC POLLUTION"**



(From Right) Mr. Jehan Zeb Khan, the Chief Guest and Engr. Tariq Rashid Wattoo, President-PEC presenting Shield to Dr. S. E. Benjamin for Presenting her Paper on the topic of **"PLASTICS: ENVIRONMENTAL ISSUES AND REMEDIAL SOLUTIONS"**



(From Left) Engr. Tariq Rashid Wattoo, President-PEC and Engr. Najam Waheed, Secretary-PEC presenting shield to Dr. Javed Iqbal for Chairing the Second Technical Session



(From Right) Dr. Javed Iqbal, Chairman Technical Session, and Engr. Tariq Rashid Wattoo, President-PEC presenting Shield to Engr. Dr. Muhammad Saeed for Presenting their Paper on the topic of "**IMPACT OF DOMESTIC AND INDUSTRIAL EFFLUENT OF LAHORE CITY ON GROUNDWATER"**



(From Right) Dr. Javed Iqbal, Chairman Technical Session, and Engr. Tariq Rashid Wattoo, President-PEC presenting Shield to Prof. Dr. Asif Ali Qaiser for Presenting their Paper on the topic of **"REDUCING PLASTIC WASTE POLLUTION: CHALLENGES AND KEY SOLUTION STRATEGIES"**



(From Right) Dr. Javed Iqbal, Chairman Technical Session, and Engr. Tariq Rashid Wattoo, President-PEC presenting Shield to Engr. Ghulam Zakir Hassan Sial for Presenting their Paper on the topic of "**PLASTIC POLLUTION AND ITS IMPACT ON WATER RESOURCES"**



(From Right) Dr. Javed Iqbal, Chairman Technical Session, and Engr. Tariq Rashid Wattoo, President-PEC presenting Shield to Mr. Syed Laraib Zaidi for Presenting their Paper on the topic of **"NEED FOR INTELLIGENT TRANSPORTATION SYSTEM FOR REDUCING TRAFFIC CARBON POLLUTION IN LAHORE"**



(From Right) Dr. Javed Iqbal, Chairman Technical Session, and Engr. Tariq Rashid Wattoo, President-PEC presenting Shield to Dr. Nasir M. Ahmad for Presenting their Paper on the topic of **"NEED FOR INTELLIGENT TRANSPORTATION SYSTEM FOR REDUCING TRAFFIC CARBON POLLUTION IN LAHORE"**

Glimpses of the Audiences



(From Left) Engr. Ch. Ghulam Hussain, Engr. Akhtar Abbas Khawaja, Engr. Riaz Ahmad Khan, Prof. Dr. Asif Ali Qaiser and Engr. Husnain Ahmad Khan



(From Right) Engr. S.M.A Zaidi, Dr. Javed Iqbal, Engr. Husnain Ahmad, Prof. Dr. Asif Ali Qaiser, Engr. Riaz Ahmad Khan, Engr. Akhtar Abbas Khawaja, and Engr. Ch. Ghulam Hussain

Glimpses of the Audiences





(From Right) Engr. S.M.A Zaidi, Dr. Javed Iqbal, Engr. Husnain Ahmad, Prof. Dr. Asif Ali Qaiser, Engr. Riaz Ahmad Khan, Engr. Akhtar Abbas Khawaja, and Engr. Ch. Ghulam Hussain

Glimpses of the Audiences



(From Left) In the Middle Engr. Iftikhar Ahmad Former President-PEC



Glimpses of the Audiences





Glimpses of the Audiences





Glimpses of the Audiences



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/4th Meeting of Executive C9ouncil held on 26 May, 2018.

1 Engr. Shahzad Hafeez
2 Engr. Rooha Masroor
3 Engr. Muhammad Noman
4 Engr. Ahsan Razzaq
5 Engr. Usman Khalid
6 Engr. Jarrar Farooq
7 Engr. Azhar Ali
8 Engr. Subiyal Abbas
9 Engr. Zubair Abdul Ghafoor
10 Engr. Abdul Basit Mansoor
11 Engr. Hafiz Syed Mahmood Arshad
12 Engr. Muhammad Naveed
13 Engr. Muhammad Waqas Sial
14 Engr. Faisal Riaz Randhawa
15 Engr. Muhammad Qasim Raza
16 Engr. Ahmed Fazeel Khan
17 Engr. Hafiz Ali Raza
18 Engr. Shahzad Ali
19 Engr. Muhammad Ali Syed
20 Engr. Muhammad Faizan Ameer
21 Engr. Muhammad Irfan Gohar
22 Engr. Syed Ahmad Bilal
23 Engr. Nabeela
24 Engr. Haroon Ahmed Chaudhry
25 Engr. Syed Imran Ali Shah
26 Engr. Saqib Ashraf
27 Engr. Muhammad Abdullah
28 Engr. Waqas Akhtar
29 Engr. Muhammad Arif Shamim
30 Engr. Waqar Arshad
31 Engr. Sajjad Ahmed
32 Engr. Syed Muhammad Suqlan
33 Engr. Saeed Anwar
34 Engr. Abdul Majid
35 Engr. Mubashir Ali
36 Engr. Faisal Raza
37 Engr. Muhammad Hamza
38 Engr. Muhammad Iqbal
39 Engr. Saifullah Bhutto
40 Engr. Tayyab Iqbal
41 Engr. Syed Iftikhar Hussain
42 Engr. Muhammad Taqi
43 Engr. Faraz Ahmed Shaikh
44 Engr. Arshman Khalid
45 Engr. Ahsen Ahmed Shaikh
46 Engr. Nabeel Hafeez Shaikh
47 Engr. Hassam-ul-Haq
48 Engr. Abdus Subhan
49 Engr. Kazim Raza
50 Engr. Muhammad Aziz
51 Engr. Fazli Rabi
52 Engr. Mehran
53 Engr. Zaraq Naseer Khan
54 Engr. Wasif Nawab
55 Engr. Muhammad Zubair Sarwar
56 Engr. Muhammad Usman Saleem
57 Engr. Abdul Hannan
58 Engr. Shahzad Ali
59 Engr. Tayaba Jawed
60 Engr. Shafiya Qadeer
61 Engr. Pir Muhammad Saand
62 Engr. Tehseen Furqan
63 Engr. Syed Muhammad Ammar
64 Engr. Syed Ali Akbar
65 Engr. Faisal Farhad
66 Engr. Rai Ali Hassan Raza
67 Engr. Faisal Ayaz Khan Sherwani
68 Engr. Mahmood Saleem
69 Engr. Muhammad Zeeshan
70 Engr. Afif Ahmed
71 Engr. Idrees Gul
72 Engr. Syed Waqar Ali Shah
73 Engr. Abdul Haseeb Baloch
74 Engr. Fahad Hussain

KEY RECOMMENDATIONS

World Water Day held on 31st March 2018 on the theme of

"NATURE FOR WATER"

Pakistan Engineering Congress has been celebrating World Water Day since the year 2005. Papers presented at the event are printed in a book form and distributed to concerned Public / Private Sectors complimentary.

This year also the World Water Day, on the theme of **"Nature for Water"**, was celebrated on 31st March 2018. The Welcome address was presented by Engr. Tariq Rashid Wattoo, President Pakistan Engineering Congress. It was chaired by Mr. Hammad Naqi Khan, Chief Executive Officer, WWF-Pakistan. 6-Technical Papers were presented in the Session by renowned authors on different water related topics. The post-lunch Technical Session was chaired by Dr. Shahzad Alam, Chairman PCSIR. 8-Technical Papers were presented in this Session, followed by Question / Answers Session of about half an hour.

Given below are the recommendations made by the Speakers:-

1. Paper: Developing Sukh-Beas As Potential Recharge Site During Wet Years for Bari Doab

Author: Engr. Dr. Muhammad Basharat

Recommendations:

50% exceedance probability is more dependable and a volume of 10.28 MAF is available at Punjnad Barrage which can be utilized for groundwater recharge subject to its appropriate management during its routing in the river system. Also, the results show that extra releases going downstream of Kotri Barrage were 78600 cfs and 17100 cfs at 50% and 75% exceedance probability, with corresponding flow volumes being 22.64 and 24.75 MAF, respectively. Thus, flood flows released from Punjab through Punjnad River remain excess to the irrigation demand of Lower Indus due to extra water flowing in Indus River during July to September.

However, thousands of acres of farmland of tehsils of Kabirwala (Khanewal), Shorkot (Jhang) and Pirmahal (Toba Tek Singh) area covering almost 200 villages are already waterlogged from the seepage occurring due to Trimu-Sidhnai (TS) and Haveli canals. The farmers of the area already demand that the TS link canal should not be operated for more than 4000 cfs discharge; otherwise underground water level rises and severely damages the crop production in the area. Therefore, conveying extra water through the TS Link without its lining is out of question. Therefore, the only option of diversion of this extra flood water to the Ravi River remains through the QB Link, UCC Link or MR Link canals. Once conveyed into the Ravi River, it can then be diverted to the SB Channel through the Balloki-Suleimanki and Sidhnai-Mailsi Link canals. However, capacity enhancement of these link canals

might be required, in coherence with the maximum discharge capacity of SB channel which can be accommodated for conveyance and recharge to the groundwater.

At Balloki Barrage, discharge at 50% probability of exceedance (during July to September) was 9300 cfs and the corresponding volume going downstream was 2.53 MAF. Also, the corresponding figures for Sidhnai downstream were 5700 cfs and 1.89 MAF. Thus, substantial volume of water is available at these two barrages which can be diverted to Sukh-Beas channel during July to September. Even excluding half of the discharge flowing d/s of the Balloki Barrage for diversion to Cholistan area, through BS Link canal (currently being planned by the Punjab Irrigation Department), half of this volume i.e. 1.26 MAF would still be available for diversion to Sukh-Beas channel. However, these meager flood flows available in Ravi River can be substantiated by diverting extra flood flows available in Chenab and Jhelum rivers.

The flood flows to the Sukh-Beas channel can be released from Balloki-Sulemanki (BS) and Sidhnai-Mailsi-Bahawal (SMB) link canals, for recharge purpose. Therefore, it is concluded that stopping and reversing the declining groundwater tables in Bari Doab would be possible by diverting flood flows to Sukh-Beas channel. Equity amongst the farmers regarding groundwater availability will be improved, resulting in improved agricultural yields in the area. Specific conclusions regarding diversion of flood flow and recharge are as follows:

- Operation of the escape gates would have to be rehabilitated, especially electric motors would have to be installed for their easy and frequent operations;
- Kasur Nallah entering from India should be diverted to its old route i.e. Sukh-Beas channel after its rehabilitation for surface water use by the adjoining lands and groundwater recharge;
- Link Canals, particularly the QB Link, Marala Ravi and UCC link to Balloki mechanism Barrage should be remodeled for diversion of extra flood water available in Chenab River to Balloki and Sidhni barrages;
- All the three reaches of Sukh-Beas channel should be rehabilitated to the maximum possible level for accommodating extra flood water during wet season;
- All the three reaches of Sukh-Beas channel should be used for groundwater recharge with flood water conveyed through BS Link and SMB Link canals;
- Most of the bridges and other structures have enough capacity for passing this flood water,though very newly built bridges like the one near Muhammad Pura would need widening in order to avoid flooding of a few acres of land on upstream side;
- The SB channel crosses as level crossing with abandoned Mailsi Canal. Thus, water released in SB channel can also be ponded in Mailsi canal;

However, capacity of the SB channel has been reduced with passage of time due to encroachment of fields by the farmers towards the channel itself. Reach wise specific conclusions and recommendations regarding the channel capacity are as follows:

- 5 to 10 km of the BS Link to Sutlej River reach of the channel would have to be widened and its section made equivalent to the existing section of the rest of the channel;
- Trimming of the existing full section may also be needed at a few places to remove any obstacles in the channel for easy accommodation of the released flood water;

2. Paper: **Water Needs of Capital Cities in Pakistan**
Author: Engr. Abdul Khaliq Khan

Recommendations:

1. The roles and responsibilities of different organizations need to be clearly defined to avoid overlapping and to ensure effective management of water resources at all levels. The capacity of institutions needs to be developed to undertake systematic sets of legislations and organizational changes to solve the water supplies, distribution, pricing and regulatory issues.
2. Keeping in view the growing problems of groundwater and its consequences on the future of water supply particularly for Lahore and Quetta, the regulatory organizations need to enhance the monitoring of groundwater abstraction and lay restrictions on the abstraction of groundwater in critical areas. In Lahore, for example, central parts of the city where a groundwater depression zone is being developed should be defined as a “groundwater protection zone” and pumping should be regulated. In Quetta the further expansion of tubewells should be stopped. Since groundwater plays an important role in economic development, the government needs to develop a strategy for long-term sustainability of this resource.
3. The importance of groundwater resources and the potential impacts of climate change on them should be discussed with all water users. Providing education and training to local communities about rainwater and runoff water harvesting for domestic use, agricultural use and for groundwater recharge will enhance the adaptation options to cope with current and anticipated future problems.
4. For long-term sustainability of drinking water supplies, the possibility of supplementing groundwater supplies with surface water supplies should be explored, wherever possible. For Lahore, provision of surface water supply from the River Chenab or BRBD canal system may be considered after addressing quality concerns. Similarly, detailed designs and implementation of surface water supply schemes for Karachi, Islamabad, Peshawar, Quetta and Gwadar need to be expedited.
5. Further work should urgently be carried out on Dotara Dam, Jabba Dam, Bara Dam and the Water Supply Link from Tarbela Reservoir to Islamabad.
6. To increase recharge to groundwater, rainwater harvesting should be encouraged in all new and old housing schemes and in areas currently under WASA jurisdiction. For this purpose, special recharge zones may be developed to facilitate groundwater recharge.

7. In order to promote the culture of water conservation, a metering system should be introduced to charge water on a volumetric basis.

8. Water should be treated as an economic good and its exploitation rights be given through a proper permit system and compatible prices especially to the industrial sector. Industries can invest in treating wastewater at source and reuse it. To promote water conservation in the industrial sector, attention must be given to water intensive sectors such as textile processing, paper and pulp, leather and tanneries, sugar etc. because this is by far the most water consuming industries in the region.

3. Paper: Groundwater Use and Management Experience in Punjab

Author: Engr. Dr. Muhammad Nawaz Bhutta

Recommendations:

Irrigation System

Re-examining water allocation for different canal commands, keeping in mind official irrigation duties, actual deliveries, cropping patterns, groundwater quality, current groundwater use and over- or under-exploitation. This needs to be complemented by an extensive information campaign to opinion makers to avoid the discussion becoming captive to politicization.

Promote skimming wells in areas with saline groundwater to exploit the fresh water lens on top of the saline layers

Institutional Measures

Initiate an awareness campaign that familiarize groundwater user on the local aquifer conditions, risk of over exploitation, legal provisions, water conservation measures and importance of local management

Initiate a social mobilization programme to develop local groundwater regulation, focused on participatory hydrological monitoring and micro-planning. Engage tehsil administration in these efforts. Strengthen capacity of Farmer Organizations to manage water resources through training programmes and local water budgeting. Punitive and physical measures be taken to stop contamination of groundwater.

Technical Measures

There are several meaningful programs and policies that can be pursued to counter the perceived threats. The actions are to be taken at expert level are: (i) Prepare/update hydro-geological maps & groundwater atlases for the benefit of decision makers and farmers. (ii) Investigate and reverse groundwater contamination. (iii) Sample design of tubewells for different depths of water tables and different aquifer characteristics. (iv) Prepare a groundwater recharge manual for different conditions in Pakistan. (v) Preparation of groundwater recharge schemes for agriculture and urban areas. Perfect methods for groundwater recharge shall be propagated. (vi) Prepare guidelines for local use of saline water for different regions and crops. (vii) Avoid groundwater disasters at hot spots – using regulatory and investment measures. (v) Extract undisturbed and skim fresh groundwater layers overlying saline water and ensure/ initiate development of improved technologies.

Policy Measures

The actions required at policy level are: (i) Planning and Development Division to prioritize groundwater recharge projects. In case of groundwater recharge a broad range of recharge options – from water harvesting to spate irrigation – should be developed and used. (ii) To minimize the use of groundwater for irrigation, there is a need to construct dams with substantial storage capacity. In addition, small dam, mini dams and delay action dams shall be constructed. (iii) Stop financing overuse, as now occurs through reduced electricity tariffs for agricultural use, flat rates and non-essential operation of public sector wells in fresh groundwater zones. (iv) Punjab Government to setup Groundwater Boards with clear tasks and capacities in monitoring, data dissemination, rule setting and enforcement. Also rationalize canal water allowances, design & approve groundwater recharge schemes/projects. (v) Provincial Agriculture Departments to educate farmers about aquifer characteristics and water quality issues. (vi) EPA to enforce regulation against disposal of untreated toxic effluents into surface drains. Waste water must be treated by individual industrial unit. (vii) Encourage and enforce rainwater harvesting and prepare and implement groundwater recharge schemes.

4. Paper: Groundwater Prospectus, Challenges and Management Strategies in Indus Basin

Author: Dr. Habib ur Rehman, Dr. Ghulam Nabi, Muhammad Waseem, Muhammad Ijaz

Recommendations:

There should be integrated effort of research and implementing institutions to find the solutions to groundwater issues by comprehensive studies in respect of the followings.

1. Trends in groundwater pollution; trends in loss of groundwater quality and related aquifers services.
2. Conjunctive use and management of groundwater and surface water.
3. Urban-rural tensions; opportunities for co-management.
4. Management of recharge / discharge processes and aquifer equilibrium states
5. Groundwater policy and governance.
6. Legal framework for sustainable groundwater governance.
7. Trends in local groundwater management institutions / user partnerships.
8. Social adoption of groundwater pumping technology and the development of groundwater cultures: governance at the point of abstraction.
9. Macro-economic trends that influence demand for groundwater and related aquifer services.
10. Governance of the subsurface and groundwater frontier.
11. Political economy of groundwater governance.
12. Groundwater and climate change adaptation

5. Paper: Hydraulic Performance Evaluation of Long Inverted Siphons for Irrigation Conveyance System - A Case Study

Author: M. Mohsin Munir, Irfan Mahmood, Kamran Ahmed, Javed Munir

Recommendations:

In the light of hydraulic design carried out for the irrigation conveyance system, following conclusions and recommendations are suggested:

1. Total head loss calculated in the main irrigation conveyance system is 31.62 ft which is less than total head available i.e. 50.69 ft. It indicates that the system can carry design discharge of 12 ft^3/s from dam body to last sump at RD 33+185 under NPL of 1470 ft amsl.
2. Pipe material at siphon locations has been changed from PRCC to HDPE pipe which can sustain the pressure for head more than 50 ft.
3. Computed flow velocity of 2.86 ft/s in all HDPE siphons are sufficient for self-cleansing. This is due to adopted size of siphons and improved roughness coefficient.
4. Invert levels of siphon at inlets have been lowered for better hydraulic performance and siphoning action.
5. Total head loss is calculated with comparison to available head at each siphon to estimate required water seal. This indicates appropriate size of siphons have been selected.
6. Maximum efforts have been made to retain existing gravity pipes and open channels subject to their physical conditions and verification of designed hydraulic parameters at site otherwise will be reconstructed.
7. To ensure the safety and suitable functioning of open channels, proper arrangements of water crossings at different locations must be provided.

6. Paper: Water: A Natural Resource of Sustainable Development for Pakistan`s Economy

Author: Muhammad Munir Ch., Maqsood Shafique Qureshi, Dr. Allah Bakhsh Sufi, S. Laraib Zadi

Recommendations:

Campaign on efficient use of water in domestic, industrial and agricultural sectors have been launched to disseminate knowledge and information to the water users especially farmers. Rain water harvesting and use of treated water are also being adopted. Water is key factor for agro-socio-economic uplift in the country. Additional storages and other relevant developments of efficient water use in the country would not only be able to sustain food security but also would export more agricultural products to sustain the economy.

7. Paper: Impacts of Climate Change on Water Resources of Pakistan

Author: Dr. Qazi Talat Mahmood Siddiqui

Recommendations:

Global warming is now an established phenomenon and effects are very clear in most parts of the world in the form of variability and intensity taking place in the climate system. Climate change has visible impacts on water, agriculture, forestry, biodiversity and ultimately the socio-economic sectors. It is predicted that there will be more droughts and floods in future due to climate change. In the wake of such changes, it is imperative to formulate a response strategy for short, medium and long terms. National Policy on Climate Change is an endeavor to face the adverse impacts of Climate Change.

The main objective of Climate Change policy relating to water sector is to assess the likely impact on water resources and to formulate a well-thought-out adaptative strategy for various sub-sectors of water to face the future challenges of Global Climate Changes. Also, draft National Water Policy submitted to CCI for final approval addresses the climate change impacts in a holistic manner. Following are the salient actions to be taken:

- Development of infrastructure to store more water for utilization in lean flow periods. To that end there is a greater need than even before to develop and forge national consensus on a cascading system of dams on river Indus utilizing all the available sites to discharge our liability to coming generations.
- Expedite work on construction of Mega dams, Small dams, and water harvesting projects. The financing factor retarding construction of mega dams may be addressed on war footings, exploring all the available avenues of funding.
- Stop wastage of water and resort to efficient water use
- Develop appropriate rainwater harvesting system commensurate with local needs.
- Construct series of water storages for retention of floodwaters for their effective utility.
- Protect life, property and infrastructure from floods, through a comprehensive and long-term flood protection plan. Develop a flood response plan and make sure that general public is aware of this plan and if necessary public awareness level be raised through electronic and print media.
- Develop and implement regulatory framework for ground water use. Encourage to employ latest techniques for the extraction and skimming of fresh groundwater without disturbing the underlying saline water.
- Establish an institution to carryout research into the future availability of water especially in Climate Change conditions. As the climate change phenomenon is slow and long term, it requires a long-term commitment.
- Establish linkages between different water sector organizations for data and knowledge sharing.

- Ensure the water rights of the provinces in accordance with the 1991 Water Accord.
- Establish a database system on water sector information.
- Develop public awareness about importance of water

The array of potential adaptive responses available to human societies is very large. With too much uncertainties about the future water availability the best preparation for managing unpredictable future changes is to put in place a water resource infrastructure and management system which is driven to a much greater degree by knowledge (including but not limited to hydrologic knowledge), and which is designed and operated to be much more flexible and adaptive.

8. Paper: A Review on: Water Saving Techniques for Domestic, Agricultural and Industrial Water Usage

Author: Engr. Dr. Muhammad Saeed, Engr. Rahmat Ullah Sheikh, Engr. Muhammad Shoaib

Recommendations:

- Landscape with water-wise landscaping principles may be adopted.
- Install water efficient fixtures in restrooms and showering areas.
- Replace water-cooled equipment with air-cooled equipment when feasible.
- Make sure all hoses are equipped with an automatic shut-off nozzle.
- Dry sweep or use a water broom when possible, instead of using a hose to clean floors, sidewalks, and other hard surfaces.

9. Paper: Flood Water Storage in Aquifer through Natural Recharge- A Case Study of Rechna Doab, Punjab, Pakistan

Author: Ghulam Zakir Hassan Sial, Ghulam Shabir, Faiz Raza Hassan, Saleem Akhtar

Recommendations:

1. Development of Structures like dams, reservoir, and pond to store flood water.
2. Construction of flood channels to divert flood water in desert areas like Cholistan, Thal etc.
3. Allow flood waters to spread overland through pre-planned breaches
4. Artificial recharge of aquifer from flood water
5. Detailed program of groundwater monitoring to prepare groundwater potential maps for further hydro-geological investigations is direly needed.
6. An Integrated Flood Management approach embedded within IWRM is to be adopted.

7. Design, maintenance standards and operation rules for barrages should be reviewed and updated
8. Flood Plain Maps and Flood Protection Plans should be updated regularly
9. Coordination be enhanced with WAPDA for reservoir operation of Mangla Dam.
10. Adaptive measures be worked out to mitigate impacts of floods and Climate Change
11. Strengthen the capacity of research Institutes to study storage of flood, Climate Change and collaborate actively with national and international organizations
12. Urban groundwater pumpage in major cities e.g. Lahore, Gujranwala etc. should be managed and supplemented by surface water.
13. Encourage rainfall harvesting in Urban and Rural areas.
14. Formulation of long-term policy and special legal framework for comprehensive master planning to guard against fast depleting groundwater resources to ensure sustainable use of groundwater in rural and urban areas.
15. Awareness raising, and capacity building of the stakeholders must be ensured

10. Paper: Monitoring Microbial Regrowth and Inactivation Potential of Chlorine in a Lab-scale Water Distribution Network

Author: Amrah Qureshi, Dr. Imran Hashmi, Romana Khan

Recommendations:

P. aeruginosa becomes less susceptible to conditions when they act in a consortium. *K. pneumoniae* was fittest to survive in consortium of bacteria therefore it is a commonly detected pathogen in drinking water networks. *S. aureus* being gram-positive does not survive among gram-negative bacteria. The results further showed a negative correlation between bacterial regrowth and disinfectant residual. At longer contact times, free chlorine diminishes from the system thus suggesting a key factor in regrowth of bacteria.

11. Paper: Are we drinking Quality and Safe Water in Pakistan?

Author: Dr. Muhammad Anwar Baig, Mr. Muhammad Adnan Baig

Recommendations:

As given by the Results of five years National Water Quality Monitoring Programme which covered 23 major cities, 8 Rivers, 9 lakes and many reservoirs showed widespread bacteriological contaminants in the drinking water. Chemical contaminants in drinking water such as arsenic, fluoride and nitrate are discovered at various locations. Arsenic contamination was found in southern Punjab and central Sindh.

Similarly, bottled water companies have used marketing tacts to convince the public but unfortunately, bottled water is not only hazardous to our health, but it is also equally disastrous to the environment. As described by Pakistan Council of Research in Water Resources (PCRWR) which has found 27 brands of bottled water being sold in Pakistan to be unsafe for drinking due to contamination against water quality standards set by the Pakistan Standard Quality Control Authority (PSQCA).

12. Paper: Nature- Water Nexus: Managing Current Water Challenges

Author: Engr. Mumtaz Hussain

Recommendations:

Basing on the above discourse following recommendations are made:

1. Natural principles of water development, exploitation and consumption should be applied at all levels for ensuring its equitable and just provision to human beings and other biodiversity occupying the Planet Earth.
2. Nexus between Nature and water should never be weakened.
3. Centers should be established at global, regional and national levels for carrying out research and development studies for optimum utilization of water in light of natural injunctions.
4. There is necessity of revisiting existing water treaties, regulations and contracts. These should be reformed to conform to natural laws.
5. Global bodies such as United Nations, Organisation of Islamic Cooperation, SAARC & ECO and National Institutions need to revisit the water related protocols, conventions & respective national legislation for improving their efficiency & effectiveness in the backdrop of natural solutions for addressing current water crisis in the world.
6. All divine religions advocate equality & respect for utilization of natural resources including water. In this connection Inter-Faith Dialogue may be initiated for improving performance of water sector to incorporate morals and ethics.

13. Paper: Microbial Fuel Cell for the Treatment of Industrial Waste Water

Author: Sameen Salman, Abdullah Yasar, Amtul Bari Tabinda, Rabia Shaukat, Naveed Anwar, Ahmad Iqbal

Recommendations:

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 a potential source for the removal of pollutants.

14. Paper: Efficiency of Grass Species for the removal of Heavy Metals from Waste Water

Author: Fizza Tahir, Abdullah Yasar, Amtul Bari Tabinda, Rizwan Rasheed and Laraib Fatima

Recommendations:

Different modifications have been used with the microbial fuel cell technique. The modifications are Single Chambered Microbial Fuel cell, flat plate microbial fuel cell, dual chambered microbial fuel cell, mediator less microbial fuel cell etc. They have shown different efficiencies with different parameters. This technique has shown best results when it is combined in series or integrate it with other treatment techniques. The advantage of using microbial fuel cell is that we can treat waste water along with the generation of few volts of electricity. It shows efficiency of COD removal, nutrients removal like phosphorous and nitrogen and carbon compounds as well. This energy generated in this process can be stored in capacitors or in batteries for further use

Microbes present in the anodic chamber break down the organic matter present in the wastewater and treat the water with simultaneous production of electric potential, and this study confirms it. The highest voltage produced in one of the municipal waste treatment MFC was from 2.4V to 5V.

As we know that Pakistan is energy scarce country, so we can apply microbial fuel cell technology to overcome the shortage of energy along with the treatment of waste water. This is a very recent technology which is very helpful in the current scenario in Pakistan, where there is shortage of energy and excess of wastewater. The microbial fuel cell can be made on a very basic level that is at domestic level, so it should be introduced in the country. These cells can be used in areas where there is problem of wastewater treatment. The areas which are less privileged by energy and water can use this method for treatment of wastewater for energy production and conservation of water at the same time. The microbial fuel cell is a source of green energy. It should be introduced in the Northern as well as in the remote areas of Pakistan because shortage of electricity in these areas is common. The energy which is produced by the cells can be stored in the capacitors and batteries, or different technologies can be used to increase the electric potential, so it can be used for daily use. This can generate revenue for energy generation as well as for wastewater treatment plant. Studies should be carried out at advance level to make this technology closer to real world.

BUILDING CODE OF PAKISTAN (SEISMIC PROVISIONS-2007), ITS ENFORCEMENT, COGNIZANCE, IMPORTANCE AND MAINTENANCE IN PAKISTAN:

By:

Engr. Abdul Qayyum[1]

A. Introduction

Codes are technical documents and every word, term and punctuation mark can impact the meaning of the code text and the intended results. A code often uses terms that have a unique meaning in the code and the code meaning can differ substantially from the ordinarily understood meaning of the term as used outside of the code. Understanding of a term's definition is especially a key to or necessary for understanding a particular code provision. Definitions of key terms are provided at adequate locations in bold italic format and the first letter is capital of all worlds.

The building codes have becomes law of a particular jurisdiction when formally enacted by the appropriate governmental or private authority. The building code, in every country is intended to be adopted as a legally enforceable document and it cannot be effective without adequate provisions for its administration and enforcement. Cognizance/compliance by the people and implementation by the governments, of the provisions of buildings codes, comes in established best practices in the world.

Pakistan Building Code was first published in 1986 by Ministry of Housing and Works, Govt. of Pakistan. It was used as a reference by the engineers; however, it was not enforced as a mandatory requirement.

After the 8th October 2005 earthquake, Ministry of Housing and Works Government of Pakistan, with the collaboration of International Code Council (ICC), American Society of Civil Engineers (ASCE), American Concrete Institute (ACI), uniform Building Code (1997), NESPAK, Pakistan Engineering Council, decided to revise and update the Building Code. Within the overall scope of development of the Building Code, priority was assigned to the preparation of provisions for seismic design of buildings.

Building Code of Pakistan (Seismic Provisions-2007) has therefore been developed. An attempt, to materialize/realize the importance of its enforcement, cognizance, implementation and maintenance, has been made through this paper.

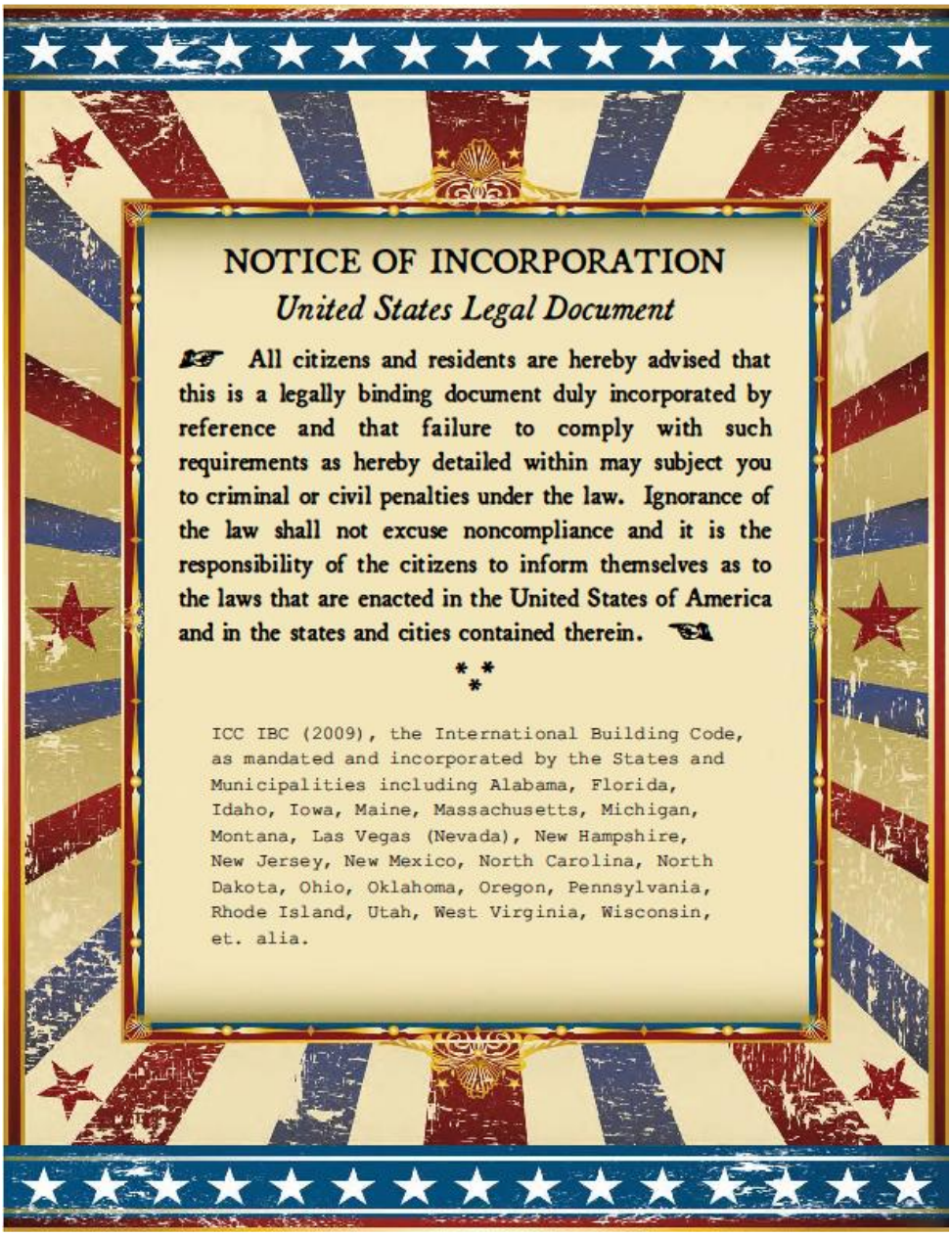
B. Legal Enforcement/Implementation.

- The building code, in every country is intended to be adopted as a legally enforceable document and it cannot be effective without adequate provisions for its administration and enforcement, i.e., a **building code, in general,** is a set of rules that specify the minimum standards for design and construction of objects such as buildings and Non-building structures or Codes are technical

[1] Team Leader, (Techno-Consult International (Pvt.) Ltd.)

documents and every word, term and punctuation mark can impact the meaning of the code text and the intended results.

- We in Pakistan should circulate the Building Code 2007 with the same zeal and its implementation should also be ensured through government of Pakistan by all organizations, whether public or government and /or private entities, being beneficial to all communities, large or small.
- First page of IBC-2009 is indicated as below:



We, in Pakistan also, to save the lives of the general public at large as well as our economics should make the implementation of BCP (Seismic Provision-2007) as a legal enforcement and Pakistan Engineering Council through this forum (Pakistan Engineering Congress) is requested to initiate the prerequisites.

C. Cognizance:

1. Seismic hazard Determination.

Chapters 1 to 4 provide the information, requirements and activities for this task as follows;

a. Chapter-1 lays out the “Scope” under the Sub-Headings as ‘Objectives and General Principles’ and, ‘Scope’.

b. Chapter-2 is “Seismic Hazard” and it defines the minimum seismic hazard that has to be considered for the design of reinforced concrete, steel and masonry building and building like structures. It also provides the seismic zones of all tehsils in Pakistan, in Tabular as well as graphical modes/seismic zoning maps.

c. Chapter-3 is “Site Considerations” and provides the prerequisite activities/information, to be considered / gathered, for the selection of suitable site. It also provides the criteria/ general arrangement for location of Buildings in or near sloping terrains, in accordance with UBC and IBC.

d. Chapter-4 is “Soils and Foundations” and describes the standards including the ways of determining of soil conditions/profiles for buildings to be constructed in such soils in seismic areas. It also guides as how to take care of the construction in seismic zones 3 & 4.

It is prudent to mention that all the four chapters mentioned as above are commensurate with the relevant/counterpart chapters of UBD- 1997 as well as IBC-2009 and *provide the methods and measures that must be exercised in the planning and design of foundation systems based on obtaining sufficient soil/strata information, the use of accepted engineering procedures, experience and good technical judgment. If adopted properly, these can save the overrun of time and money almost in all types of projects.*

2. Design Criteria and Analysis

5th Chapter of this code contains 4 divisions, mentioned as below:

i. Division-1: This part deals with general design requirements and provides Symbols and Notations, Scope, Definitions, Design Loads, Load Combinations including exceptions acceptable types of design methods, Standards, Design/Construction Rationality, Distribution of Horizontal Shear Wind, Earthquake, torsion due to eccentricity, Criteria of Stability against Overturning, Anchorage Requirements of the components of a buildings and building like structures to foundation and then the anchorage of foundation to competent strata to resist the uplift and sliding forces that result from the application of the prescribed forces. This division also provides Special Seismic Load Combinations permissible to use under both Allowable Stress Design and Strength Design, Deflection Criteria and details of faults existing in 4th Zone of Pakistan.

ii. Division-2: Deals with Snow Loads and describes the provisions of reduction factor, where the snow loads are in excess of 1.0 Kilo-Newton per square meter.

iii. Division-3: is regarding Wind Design and contains Symbols and Notations, application, Definitions, Types of Exposure, Basic Wind Speed, and Design Wind Pressures.

iv. Division-4: This division deals with Earthquake Design and contains Symbols and Notations, General (purpose, minimum Seismic Design parameters, Seismic and Wind Design criteria), Definitions, Criteria Selection, Minimum Design Lateral Forces and Related Effects, Dynamic Analysis Procedures, Ground Motion, Mathematical Model and Detailed Systems Design Requirements. It provides the importance of Soil Profile and Seismic zone and how to interpolate different soil profile and zones to calculate the seismic coefficient Cv, Near Source factor Na and seismic source type Source documents of these chapters are UBC-1997 and International Code Council's document IBC 1997-2007

3. Structural Tests and Inspections

6th Chapter deals with Structural Tests, Inspections and provides the information regarding masonry, reinforcement, concrete and Standards, applicable to structures prone to high seismicity (zones 3 and 4). It also discusses the acceptability criteria of inspections by competent officials. Contents of this chapter are mainly based on UBC 97.

4. Structural Concrete/Steel and Masonry

Chapters 7, 8 and 9 are regarding structural concrete, structural steel and masonry and provides the key precautions, methods including special requirements for design and construction in regions of low seismic risk (Zone 1), moderate seismic risk (Zones 2A, 2B) and high seismic risks (Zones 3, 4). Recommended Dimensions of Openings and Piers, strengthening of masonry around openings, overall arrangements of reinforcing masonry buildings including overall arrangements of reinforcing buildings having pitched roofs are provided here. Contents of these chapters are based on ACI- 318-05, ANSI/AISC 341-05 UBC-1997

5. Architectural Elements

Seismic handling of architectural elements regarding design, i.e. the methodology of determining the seismic forces on such elements and the 'performance criteria factor P' with reference to 'Occupancy Category' are provided in Chapter 10 of the Code. Source of information provided in this chapter is based on ASCE (1993/2005 and ANSI etc.

6. Mechanical and Electrical Systems

Like Architectural Elements, handled in Chapter 10, Mechanical and Electrical Systems with Symbols/Notations, Seismic Loads applied to Mechanical and Electrical Components, loads calculations and the 'performance criteria factor P' with reference to 'Occupancy Category' are provided in Chapter-11 of the Code. The contents of this Chapter are based on ASCE (1993/2005, SEI and ANSI etc.

7. Background for Seismic Zoning Map

APPENDIX 'A' contains 3 sub appendixes (A1, A2 and A3) including maps, indicating PGAs with 10% probability of Exceedance in 50 years of the areas of Pakistan and discusses the seismic orientation and inter alia states, "Being located close to the collision boundary of the Indian and Eurasian plates, Pakistan lies in a seismically active zone. Owing to high population density near seismically active areas, it is imperative that buildings should withstand the seismic hazard to which these may be exposed during their life time.

This appendix is based on a rigorous exercise based on compilation of geological, tectonic and seismicity data from Pakistan and its immediate surroundings. Only a brief account of salient seismo-tectonic features, seismicity and methodology adopted for seismic hazard zonation is included in this appendix. A separate document titled "Building Code of Pakistan, Seismic Hazard Evaluation Studies (2007)" contains details of geodynamics, tectonic zones, major faults, historical and instrumental seismicity catalogue, and procedures adopted for seismic hazard evaluation".

D. The Importance of implementation of Building Codes in Earthquake-Prone Localities;

As mentioned in paragraph C-7 above Pakistan is extremely prone to earthquakes and although we can't control the seismic hazard in the community where we live or work, we can influence the most important factor in saving lives and reducing losses from an earthquake through the adoption and enforcement of up-to-date building codes. Evaluating older buildings and retrofitting structural and non-structural components also are critical steps. To survive and remain resilient, communities should also strengthen their core infrastructure and critical facilities so that these can withstand an earthquake or other disaster and continue to provide essential services. Implementation, in letter and spirit, in Pakistan of the updated building code is basic and fundamental requirement (Please refer to the loss of human lives/infrastructure during the earthquake of 2005).

E. Maintenance;

- Internationally, code officials recognize the need for a modern, up-to-date building code addressing the design and installation of building systems through requirements emphasizing performance.
- The Building Code of Pakistan, in its 2007 edition, was designed to meet these needs through model code regulations (ASCE 7-05, ACI 318-2005, UBC 1997 and IBC-2005 etc.) that safeguard the public health and safety in all communities, large and small.
- The documents relied upon have been updated into their new editions and therefore, BCP- 2007 also needs revision so that it is fully compatible with all the *International Codes.*
- It is further added that in the Preface of BCP-07, it is promised that the revisions to these provisions will be made every five years or as and when deemed necessary, which will allow updating the provisions of this code continually.

- It is further pointed out that Section 5.31.2 of BCP-07 defines 'Ground Motion' as, "The ground motion representation shall, as a minimum, be one having a 10-percent probability of being exceeded in 50 years". This provision also dictates the revision periodically and continuously.
- Moreover the code should also encourage international consistency in the application of its provisions.

Above in view, it is requested that the Pakistan Building Code – Seismic provisions 2007 be updated so that it is compatible with the documents, relied upon while its development.

F. Recommendations;

BCP 1986 is completely irrelevant/deficit regarding the requirements of seismic provisions, without legal enforcement and, after the Earthquake of 2005, Ministry of Housing and Works Government of Pakistan (MOHW), with close coordination/assistance of ICC, ASCE, ANSI/AISC in 2007, published BCP- Seismic Provisions 2007, which in itself are relevant and extremely competent but without its requisite cognizance among the engineers/consultants/contractors as well as in general public and also without its legal enforcement, therefore:

- Building Code of Pakistan (Seismic Provisions- 2007) be circulated to Ministry of Housing and Works Government of Pakistan as well as to provinces including all engineering forums and lectures for its cognizance be managed at large and then its legal implementation be ensured on urgent basis, i.e. its implementation should be ensured through government of Pakistan by all organizations, whether public or government and /or private entities, being beneficial to all communities, large or small.
- Earthquake induced responses in building and all other structures are well determined by dynamic analysis procedures (BCP section 5.31), therefore, especially in zones 3 & 4, this procedure of analysis be encouraged in tender documents and detail design.
- Cognizance, of BCP may be enhanced through frequent seminars in Pakistan.
- As promised in preface, a continuous process of developing and maintenance is required to be mechanized permanently, as exercised regarding other well reputed building codes of the world.
- Being located close to the collision boundary of the Indian and Eurasian plates, Pakistan lies in a seismically active zone. Our all hydro-power potential is concentrated in northern areas, extremely vulnerable to extreme seismicity. Further owing to high population density near seismically active areas, it is imperative that buildings should withstand the seismic hazard to which these may be exposed during their life time. Building Code 2007 is prepared by the collaboration of ICC, ASCE, ACI and UBC-1997 and local experts and can help a lot to mitigate the adverse effects of earthquake, if complied properly. Therefore, as in other countries, its compliance is needed to be enforced as a mandatory requirement.

EFFECT OF DIFFERENT IRRIGATION REGIMES ON THE YIELD, YIELD PARAMETERS AND WATER PRODUCTIVITY OF BANANA IN THE LOWER INDUS BASIN

By:

Ashfaq Ahmed Sheikh[1], Muhammad Ishtiaque Rao[2] and Nazar Gul[2]

Abstract

A field study was conducted to assess the effect of different irrigation regimes on the yield, yield parameters and water productivity of Banana during the year 2013-2016 at Drainage and Reclamation Institute of Pakistan (DRIP), Tandojam. The experiment was arranged as per the principles of randomized complete block design with four treatments and three replications. The treatments; viz. T_1, T_2, T_3, T_4 consisted of farmers practices, irrigation regimes of 75, 100 and 125 % of crop water requirements. The good quality irrigation water having the EC = 0.50 dS m^{-1} used throughout the study period. The results of the study showed that the banana produced maximum yield of 59817 kg ha^{-1} with the treatment T_3 followed by 53340 with T_2, 53132 kg ha^{-1} with T_4 and the lowest of 51867 kg ha^{-1} with T_1 treatment. Under the treatment T_3, the yield of the banana increased 10.8, 11.1 and 13.2 % over T2, T4 and T1 treatments, correspondingly. Similarly, the banana yield parameters such as plant height, bunch weight, number of leaves $plant^{-1}$ and length of leaves were found to be superior with the treatment T_3 followed by the treatments T_2, T_4 and T_1, respectively. The highest water productivity of 3.26 kg m^{-3} was attained with the treatment T_2 followed by 2.85 kg m^{-3} with treatment T_3, 2.07 kg m^{-3} with the treatment T_4 and the lowest of 1.42 kg m^{-3} with the treatment T_1. Under the treatment T_2, the water productivity increased 12.5, 36.5 and 56.4 % over the treatments T_3, T_4 and T_1, correspondingly. The soil chemical properties such as EC, pH, SAR and ESP decreased with the all designed treatments; however maximum decrease in such chemical properties was occurred with T_1 followed by T_4, T_3 and T_2 treatments, respectively. The statistical analysis showed that the water used, water productivity, plant height, bunch weight, length of leaves, soil EC, soil pH, soil SAR and Soil ESP were differed significantly ($p < 0.05$), whereas the yield and number of leaves $plant^{-1}$ differed non-significantly ($p > 0.05$) under different irrigation regimes. Therefore, it can be concluded that the irrigation regime of 75 % of the crop water requirement has the potential to obtain the significantly higher water productivity, maintain the soil fertility, saves 25 % of irrigation water with the non-significantly banana yield decrease of 10 % as compared to farmers practices, 100 and 125 % irrigation regime of the crop water requirement.

Key words: Irrigation regimes, yield, yield parameters, water productivity, banana

1. Introduction

Pakistan is falling in the arid to semi arid climatic region of South Asia, wherever the annual rainfall ranges from fewer than 100 mm to more than 1050 mm; whereas the

[1] Pakistan Council of Research in Water Resources, PCRWR, Islamabad

[2] Drainage and Reclamation Institute of Pakistan, DRIP Tando Jam

mean annual evapotranspiration (ET_0) is near to 1778 mm. The vast difference exists between the rainfall and evapotranspiration (ET_0). Therefore, for the optimum crop production and crop water productivity, the crop water demands are fulfilled by irrigation practices. In Pakistan, with the passage of time, the stresses on the available fresh water resources are increasing due to the increase in population, industrialization and urbanization. The population of the country has increased from 32.4 to 168 Million during the year 1948 to 2010 and probably it will increase to 221 Million by the year 2025 (Qureshi *et al*., 2011).

In the era of 1951, the availability of fresh water was 5260 m^3 $capita^{-1}$ that has decreased manifold and currently it is below 1000 m^3 $capita^{-1}$, hence enlisted the country in water stressed countries (Raheel, 2013). Thus, it is imperative to manage the irrigation water judiciously. The irrigation management under water scarcity conditions includes practices and management that result in reduction in irrigation requirements, water saving, and conservation, and an increase in crop yield and income per unit of water used (Capra *et al*., 2008).

The deficit irrigation can be used as an alternate strategy to reduce irrigation water use as well as improve irrigation water efficiency. According to Exposito and Berbel (2017), the deficit irrigation is the application of irrigation water below crop water requirement throughout the cropping period to enhance the crop water productivity. The deficit irrigation strategies are the potential ways to increase water savings in agriculture by allowing crops to withstand mild water stress with no or only marginal decreases of yield and quality (Costa *et al.*, 2007). Many researchers have evaluated the effect of deficit irrigation practices on the yield, water productivity and soil health.

Ayas *et al*. (2011) found the significant difference in yield and yield parameters of broccoli under various deficit irrigation strategies (100, 75, 50, 25 and 0% of crop water requirement). The highest crop water use efficiency (671 kg m^{-3}) they were found with 75 % deficit irrigation strategy as compared to 100, 50, 25 and 0 %. Karrou *et al*. (2012) obtained the highest crop water use efficiency of 1.83 and 1.86 kg m^{-3} under deficit irrigation and the lowest of 1.53 and 1.30 kg m^{-3} under farmers practices for maize and wheat crops. Bozkurt *et al*. (2011) reported that the crop water use efficiency increases with the increase in deficit irrigation level. Fu and Huang (2007) while conducting research on turf grass (Tall Fescue Falcon-II variety) found the highest agronomical parameters with 80% deficit irrigation as compared to 100 and 60% deficit irrigation strategies. Hamed *et al*. (2015) found the highest water use efficiency of wheat with 70% deficit irrigation as compared to 100 and rain fed irrigation strategies. El Baroudy et al. (2014) while conducting research on rice cultivated on beds found that the dry bulk density and the soil chemical parameters decreased with the deficit irrigation practices.

The limitation of water is a universal phenomenon and represents great obstacle in the production of banana (Ravi *et al*., 2013). The average banana yield of Pakistan is 29.3 tons ha^{-1} whereas it has the potential to produce the yield up to 60-80 tons ha^{-1} (Memon *et al*., 2010). Hence, huge gap subsist amid the average and potential yield of banana. Therefore, under the present scenario of water shortage and having much not water resources, the studies to grow the banana under different irrigation regimes need to be conducted to ascertain the best irrigation regime for optimum yield, water saving and to enhance the banana crop water productivity.

Banana (*Musa Paradidica L.*) belongs to the family of Musaceae. In Pakistan, It is the cultivated extensively after mango. It contains the vitamin B6, soluble fiber, vitamin C, manganese and potassium (Irfana *et al*., 2015). The total area under banana in the year 2011-2012 estimated at 27200 ha with the total production of 140, 600 tons (GOP, 2013). Sindh province has 87% share of banana cultivation in Pakistan and 95% of the banana area in Sindh comprised of variety (Dwarf Cavendish) locally known as Basrai variety (Rajput et al., 2017).

2. Materials and methods

2.1 Site Description and Experimental Design

The experiment was conducted at the research farm of Drainage and Reclamation Institute of Pakistan Tandojam (25^0 $25'$ $10.6''$, 68^0 $31'$ $35.2''$), Sindh. The experiment was setup as per the principles of Randomized Complete Block Design (RCBD) with four treatments, viz. T_1 = Farmers practices (75 mm weekly in summer and fortnightly in winter), T_2 = 75 % of the CWR, T_3 = 100 % of CWR and T_4 = 125 % of CWR. Each treatment replicated thrice. The equivalent plot size was maintained for each treatment (20m × 13m). The experimental plots possessing the Sultanpur soil series (Silt loam texture). The canal water used for irrigation purpose throughout the cropping period having the EC = 0.50 dS m^{-1}.

2.2 Preparation of land and transplantation of suckers

In order to eradicate the weeds and to plow the soil, the land was prepared by the disc harrow followed by cultivator and then leveled using laser land leveler. After plowing, the pits (having the dimensions L = 0.61m, W = 0.61m and D = 0.61m) for the transplantation of banana suckers were dug manually using spade. The farm yard manure (0.50 kg $hole^{-1}$) were mixed with the soils obtained from the pits, thereafter one healthy banana sucker was transplanted in each hole (09-04-2013) and then filled by soils. The field was irrigated immediately after transplanting the suckers (100 mm) under each treatment. The plants and rows spacing were kept the same for each treatment i.e. 2.13m × 2.13 m.

2.3 Hoeing, fertilization and de-suckering practices

The hoeing practices were carried out on monthly basis in each treatment. The fertilizer was applied at the rate of 544-227-494 kg ha^{-1} $year^{-1}$ NPK (Memon *et al.,* 2010). The N was applied in the form of Nitrophous (NP), P in the form of Di-ammonium Phosphate (DAP) and K in the form of Sulphate of Potash (SOP). The NPK fertilizers were applied after every two months followed by irrigation. To remove the unwanted suckers and to maintain the 1:2 banana mother plant and suckers ratio, the de-suckering practices were carried out on quarterly basis.

2.4 Irrigation application

The actual water requirement of banana under the climatic condition of Lower Indus Basin is 1996 mm (Yaseen and Samo, 2000). The irrigation was applied as per the designed treatments as discussed in the section 2.1. Any rainfall take place during the banana growing period was measured using rain gauge installed at the Agro-Meteorological Observatory of DRIP Campus Tandojam. After measuring rainfall, its effectiveness was determined using the FAO CROPWAT software and included in the water used data of each treatment. In order to apply the required depth of irrigation water as per treatment, how long to irrigate the crop was determined by the following equation;

$$T = \frac{A \times D}{Q}$$

Whereas; T = how long to irrigate the crop (seconds), A = area occupied by each treatment (ft^2), D = required depth of water (ft) and Q = discharge of the field channel (ft^3 sec^{-1}). To determine the discharge of the field channel, a cut-throat flume was installed at the centre of field channel.

2.5 Yield, yield parameters and water productivity

The main harvesting time of banana bunches are September and April. Depending on the market preference, the banana bunches were harvested 18 months after transplanting (04-09-2013). The bunch yield was weighed in kg replications^{-1} and then converted to kg ha^{-1}. The percent increase in yield was computed using the following relation:

$$\text{Increase in Yield (\%)} = \frac{Y_{max} - Y_{min}}{Y_{max}} \times 100$$

Whereas; Y_{max} = Maximum bunch yield (kg ha^{-1}) and Y_{min} = Minimum bunch yield (kg ha^{-1}). Twelve plants were selected out of each treatment and the yield parameters such as plant height, bunch weight, number of leaves plant^{-1} and length of leaves were measured. The water productivity of the banana was computed using the following relation:

$$WP = \frac{Y}{WU}$$

Whereas; WP = Water productivity (kg m^{-3}), Y = Bunch yield (kg ha^{-1}) and WU = Water used (m^3 ha^{-1}).

2.6 Soil chemical properties

The total 18 soil samples were collected from each treatment plots at the time of sucker transplantation (09-04-2013) and at the end of experiment (15-05-2016). These soil samples were analyzed for the determination of EC, pH, SAR and ESP. The soil EC and pH was determined by 1:5 soil water extract method. The soil ESP and SAR were determined using the equation given below:

$$SAR = \frac{Na^+}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}}$$

$$ESP = \frac{100\left(-0.0126 + 0.01475 \times SAR\right)}{1 + \left(-0.0126 + 0.01475 \times SAR\right)}$$

The soil Soluble Ca^{2+} and Mg^{2+} were determined by EDTA titration method, while Na^+ was analyzed by the EEL-Flame photometer.

2.7 Statistical analysis

The collected data were analyzed using the statistix software version 8.1.

3. Results and discussion

3.1 Banana plants water used

The irrigation water depths of 76.2, 31.2, 41.6 and 52 mm was applied weekly in summer and fortnightly in winter under the treatments T_1, T_2, T_3 and T_4, correspondingly. Consequently, the banana plants consumed 36521, 16302, 20942 and 25631 m^3 ha^{-1} of irrigation water under the treatments T_1, T_2, T_3 and T_4, respectively (Figure 1). Obviously, higher amount of irrigation water is used by T_1 treatment than its complement. Hence, the water saving of 55.3, 42.6 and 29.8 % was achieved under the treatments T_2, T_3 and T_4 over T_1 treatment. Moreover, the maximum water saved under the treatment T_3 as compared to T_2 and T_4 treatments, respectively. These results are in close agreement of Costa *et al*. (2007); they reported that deficit strategies conserve the irrigation water. The statistical analysis showed that there was significant difference ($P < 0.05$) in banana plants water used under the treatments T_1, T_2, T_3 and T_4, respectively.

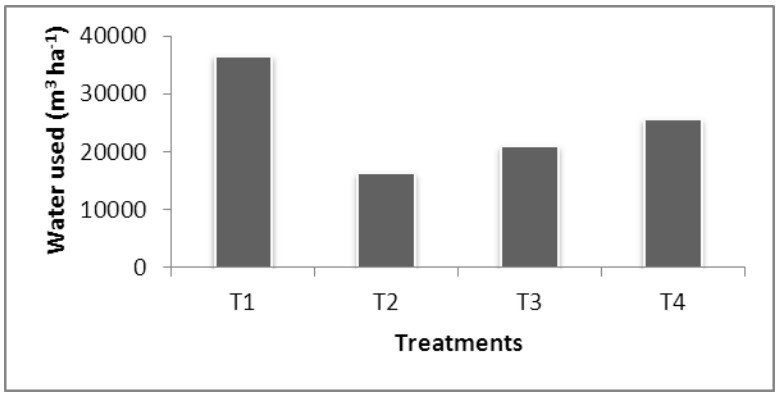


Figure 1: Banana plants water used under different irrigation regimes

3.2 Banana fruit yield

The highest total banana fruit yield was obtained from T_3 treatment as 59817 kg ha^{-1} followed by T_2 treatment 53340 kg ha^{-1}, 53132 kg ha^{-1} under T_4 and the lowest of 51867 kg ha^{-1} under T_1 treatment (Figure 2). Total banana fruit yield obtained from T_1, T_2 and T_4 treatments were 13.3, 10.8 and 11.2 % lower than the T_3 treatment, respectively. Since, the irrigation under T_3 was applied based on 100% CWR, therefore the banana produced maximum fruit yield under this treatment as compared to other treatments. The decrease in banana fruit yield under T_2 treatment might possibly be due to the water stress as a result of 75% application of CWR that could not fulfilled the banana water demand. The statement is in line with Costa *et al.* (2007), they reported that the crop yield decreases insignificantly with the deficit crop irrigation. As well the banana fruit yield decreased under T_1 and T_4 because of suffocation in the crop root zone as a result of application of 125% of CWR under the treatment T_4 and the wild flooding under T_1 treatment. The statistical analysis showed that there exist non-significant ($p > 0.05$) difference in banana fruit yield under the treatments T_1, T_2, T_3 and T_4, respectively.

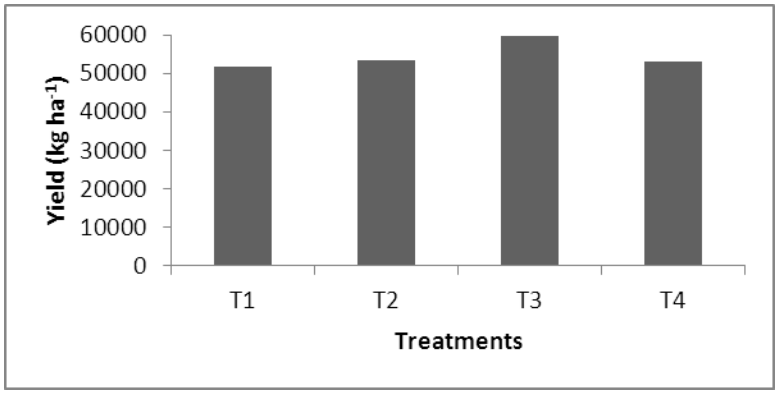


Figure 2: Banana fruit yield under different irrigation regimes

3.3 Banana yield parameters

The banana yield parameters such as plant height, bunch weight, number of leaves plant^{-1} and length of leaves are the key variable for the diagnosis and prediction of crop growth and yield. This makes the irrigation systems critical for effective understanding of the biophysical processes of plant canopies and the prediction of plant growth and productivity. The values for the all yield parameters of the banana were found to be higher under the treatment T_3 followed by T_2, T_4 and T_1 treatments, respectively (Table 1). The higher values for the yield parameters under the treatment T_3 may attribute to the irrigation as per the crop water requirement as compared to the treatment T_2 caused water stress and T_1 and T_4 caused suffocation in crop root zone. The different irrigation regimes affected significantly ($p < 0.05$) the banana plant height, bunch weight and length of leaves whereas the number of leaves plant^{-1} differed non-significantly ($p > 0.05$). Ayas *et al*. (2011) found the significant difference in yield parameters of broccoli under various deficit irrigation strategies. Fu and Huang (2007) found the highest agronomical parameters with 80% deficit irrigation.

Table 1: Banana yield parameters under different irrigation regimes

Treatments	Banana yield parameters			
	Plant height	Bunch weight	Number of leaves plant^{-1}	Length of leaves
T_1	146.6	19.5	10	150.3
T_2	162.6	20.5	11	161.6
T_3	164.6	22	12	175
T_4	150.3	20.3	11	153.3

3.4 Water productivity

The water productivity is the ratio of yield to the total water used by the crop throughout its cropping cycle. The water productivity of the banana was found 1.42, 3.26, 2.85 and 2.07 kg m^{-3} with the treatments T_1, T_2, T_3 and T_4, respectively. Obviously, the treatment T_2 attained the highest value of water productivity than the other treatments. Hence, the water productivity of 56.4, 12.6 and 36.5 % was lower under the treatments T_1, T_3 and T_4 correspondingly (Figure 3). Since, the minimum water used with insignificant yield difference under T_2 treatment, therefore its water productivity increased and due to the maximum water used with insignificant yield difference under T_1, T_3 and T_4 treatments, their water productivities were found to be lowest. These statements are advocating by (Exposito and Berbel, 2017) and Costa et al. (2007), they reported that the deficit irrigation has the potential to increase the

water productivity. Ayas *et al*. (2011), Karrou *et al*. (2012), Bozkurt *et al*. (2011) and Hamed *et al*. (2015) found the same results while studying the water productivity under different irrigation regimes. The statistical analysis showed that there was significant difference ($P < 0.05$) in banana water productivity under the treatments T_1, T_2, T_3 and T_4, respectively.

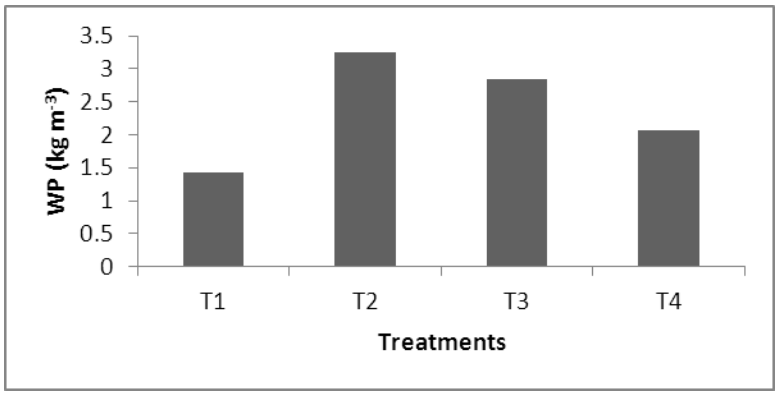


Figure 3: Water productivity of banana under different irrigation regimes

3.5 Soil chemical properties

The result of soil chemical properties such as EC, pH, SAR and ESP for samples taken before transplanting the suckers and after the completion of the study are presented in table 2. The results showing the decreasing trend in chemical properties under all treatments, however maximum decreased under T_1 treatment as compared to T_2, T_3 and T_4 treatments, respectively. Since, under T_1 treatment, the maximum water was applied that leached out maximum salts from the crop root zone and under the treatments T_2, T_3 and T_4, minimum water was applied that leached minimum salts. These results are in close agreement of El Baroudy *et al*. (2014). They found that the soil chemical parameters decreased with the deficit irrigation practices. Statistically, the EC, pH, SAR and ESP of the soil differed significantly ($p < 0.05$) under the treatments T_1, T_2, T_3 and T_4, respectively.

Table 2: Soil chemical properties under different irrigation regimes

Treatments	Soil chemical properties			
	EC (dS m^{-1})	pH	SAR	ESP
Before transplanting of suckers				
T_1	2.75	7.40	3.08	3.21
T_2	2.59	7.20	2.99	3.20
T_3	2.79	7.20	3.27	3.43
T_4	2.94	7.20	3.58	3.79
After completion of study				
T_1	2.25	7.15	2.89	3.04
T_2	2.48	7.12	2.98	3.16
T_3	2.63	7.08	3.23	3.36
T_4	2.59	7.02	3.50	3.68

4. Conclusions

The results of the study concluding that the banana was found to be water sensitive crop whose yield was decreased with both deficit and excessive irrigation. The water productivity decreased with the increasing irrigation and vice versa. The soil salinity parameters decreased with the all interventions but remained under the safe limit. The T_2 treatment (75 % CWR) was superior to the treatments T_1, T_3 and T_4, since it attained significantly highest crop water productivity with the insignificantly minor yield loss. Therefore, under the water shortage situation, the banana may successfully be grown under T_2 treatment.

Acknowledgements

The field staff of the DRIP Campus Tandojam is highly acknowledged for the collection of data.

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DESIGN, FABRICATION AND ANALYSIS OF POSITIVE DISPLACEMENT MUD MOTORS

By:

Waqas Rauf[1], Dr Nadeem Ahsan, Raja Amer Azim

***Abstract*—**. The aim of the this research paper is to design, fabricate and analyse a prototype of power section of Mud Motor using indigenous resources and to prove that it can be manufactured in Pakistan using the resources available. The Mud Motors are designed on the principle of Moineau Pumps but operate in reverse of that. Mud motor is a positive displacement motor. It is based on the geometrical fit between the rotating element (rotor), and the stationary element (stator). The rotor typically has a single helix shape and is normally made of a metallic material. The stator is formed as a double helix. The interference fit between the rotor and the stator creates a series of sealed chambers called cavities.

Pumping action is achieved by the rotor turning eccentrically within the stator. Fluid enters the cavity formed at the inlet and progresses within that cavity to the outlet. The result is a true positive displacement, non-pulsating flow that is directly proportional to the pump's speed. This allows the pump to deliver material at a wide range of flow rates from small shots to continuous flow. The motor usually operates at higher pressures, temperatures and high speeds. These motors are available in different configurations depending upon the type of well and the load required.

In the international arena, Pakistan stands among the under developed countries. Most of the drilling tools used in Pakistan are imported. Not only is this, about 90% exploration in Pakistan being done by foreign oil companies. There is not a single Pakistani company which could boast of exploring oil in Pakistan completely on its own resources. Keeping in view these circumstances following aims were kept in front for designing and fabrication of Mud Motor.

- To design a 1:2 Mud Motor power section based on engineering background.
- To fabricate the power section of Mud motor (Rotor and Stator) using indigenous resources of manufacturing.
- To study the effect of different parameters on performance
- To obtain performance curve and to estimate efficiency.
- To prove that Mud Motor can be designed and manufactured with the local resources and grey matter.
- To set a platform for design in Oil and Gas industry of Pakistan.
- To prove that Drilling industry in Pakistan has potential to develop any state of the art technology in the oil industry

***Keywords*—**Mud Motors, Moineau Principle, Power section, drilling, eccentricity, lobes, Nutation

[1] Computer Engineering Department, Centre for Advanced Studies in Engineering, Sir Syed Memorial Building, 19-Ataturk Avenue G-5/1, Islamabad, Pakistan.

I. INTRODUCTION

Crude oil is considered to be the black gold in the present era. Almost all the known equipment and technology is someway or other dependent upon the crude oil. Its importance can hardly be over emphasized in this age. Nations carved their economy according the amount of crude oil they produce or import. Therefore its exploration is considered a matter of great importance for any country.

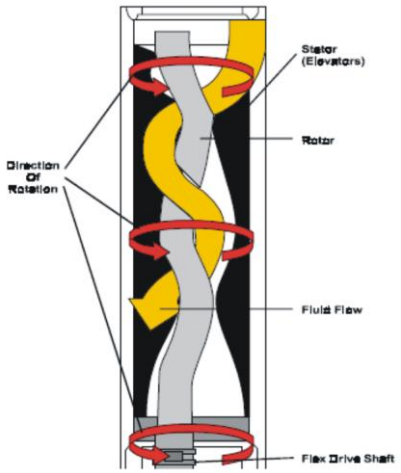
Mud Motor is considered to be a tool of great importance in the exploration of oil. Due to its complex design, maintenance requirements, early wear and tear and shorter life; it is an expensive tool. The technology of the tool is owned by three renowned oil companies of this field. Because of these reasons it is an expensive tool and is used for following purposes.

- Directional Drilling
- High torque

Such a tool is an engineering miracle to design and fabricate.. Mud Motor is available in a variety of configurations depending on their usage and design. Fabrication of the prototype is also a trouble as rotor and the stator has profiles which are to be manufactured on six axis machine.

Today's positive displacement motors are based on the work of Rene Moineau, a French inventor and engineer. Moineau's original concept, developed and refined in the 1930s and 40s, was envisioned as an agricultural pump that is tolerant of solids, but with precise volume control. The down hole drilling motor is a reverse application of this pumping principle, whereby pressurized fluid flow through the power section produces useable bit torque and speed. The first application of the Moineau principle in a commercially successful oilfield drilling motor in the Western Hemisphere was the Dyna-Drill motor in the mid-1950s. The early Dyna-Drill motors were single lobe configurations with high-speed, low-torque motor output. Multi-lobe designs, with rotors up to nine lobes with 10-lobed stators, were developed in the U.S.S.R. in the 1970s. These multi-lobed power sections provided improved low-speed, high-torque characteristics that are common to motors used today. Mud motor is a positive displacement motor. It is based on the geometrical fit between the rotating element (rotor), and the stationary element (stator). The rotor typically has a single helix shape and is normally made of a metallic material. The stator is formed as a double helix. The interference fit between the rotor and the stator creates a series of sealed chambers called cavities.

Pumping action is achieved by the rotor turning eccentrically within the stator. Fluid enters the cavity formed at the inlet and progresses within that cavity to the outlet. The result is a true positive displacement, non-pulsating flow that is directly proportional to the pump's speed. This allows the pump to deliver material at a wide range of flow rates from small shots to continuous flow.



Since the material is conveyed through sealed cavities, it is possible for solid objects with diameters less than that of the cavities to be conveyed intact, without damage to the pump allowing the pump to be used in highly abrasive applications which would otherwise destroy a gear or piston pump.

II. PARAMETRIC ANALYSIS

Rotor/Stator Working:

There are several equations on which lies the principle of mud motor. One of the basic principles is Bernoulli's equation:

$$P + \tfrac{1}{2}\rho V^2 + \rho g h = \text{Constant}$$

Where

P = Pressure (Pa)

ρ = density (kg/m3)

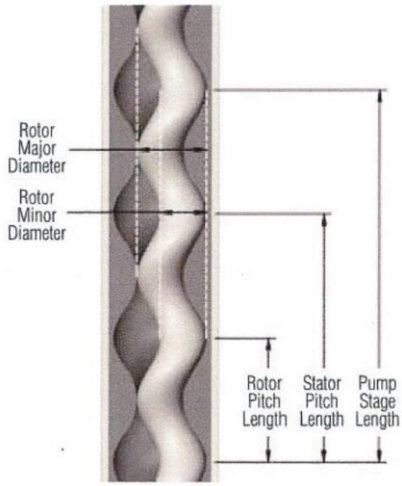
V = velocity (m/s)

H = Height (m)

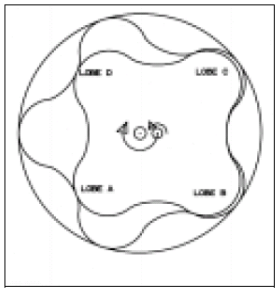
This equation clearly shows that pressure is inversely proportional to speed. Also the continuity equation is:

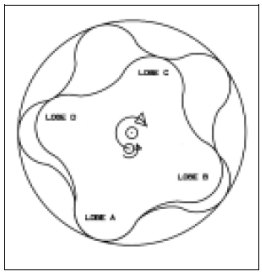
$$\rho A_1 V_1 = \rho A_2 V_2$$

The equation shows that diameter of a cavity has inverse relation with velocity of fluid. The smaller the cavity diameter, the higher the velocity of the fluid. Keeping in mind these two equations, we can logically describe the working of mud motor.



The helically machined rotor with N number of lobes turns within a helical stator, with (N+1) lobes. Having one less lobe creates sufficient clearance allowing the rotor to rotate within the stator. The rotor forms a continuous seal lengthwise with the stator at their contact points creating wedge-shaped cavities containing drilling fluid in it. During drilling operations, high pressure fluid is pumped into the top end of the Power section where it fills the first set of open cavities. Now the fluid passing through the large cavity has low velocity as compared to the fluid passing through small cavity, which has high velocity. When drilling fluid pressure is applied to these cavities, the rotor is forced to rotate within the stator in a motion known as nutation. Nutation is defined as the oscillatory movement of the rotor's axis. For each nutation cycle made by the rotor inside the stator, the rotor rotates the distance of one lobe width. As the rotor turns, adjacent cavities are opened allowing the fluid to flow progressively down the length of the power section. The centerline of the rotor is offset from the center of the stator by a fixed value known as the "eccentricity" of the power section. When the rotor turns inside the stator, its center moves in a 45rcircular motion about the center of the stator. Rotation of the rotor about its own axis occurs simultaneously but it is opposite to the rotation of the rotor center about the stator center. The cycle continues and as a result we get eccentric rotation of rotor inside stator.



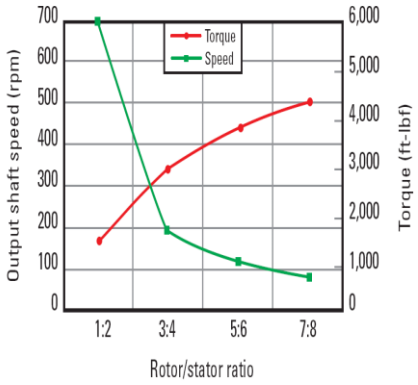


Rotor/stator ratios:

The lobes of a rotor/stator are analogous to the teeth on a gear in that as the number of lobes change so does the torque versus speed ratio. These rotor/stator configurations are designated by the ratio of their lobes. Generally as the number of lobes increases so does the torque (reducing the speed). Another factor affecting torque is the number of stages. Extended power sections offer increased torque without reducing speed by increasing the overall length of the power section

(increasing the number of stages). The 1 to 2 lobe configuration, used in high-speed motors, has a helical shaped rotor with a circular cross section (1 lobe). The elastomeric liner opening of the stator is oblong in cross section (2 lobes), and is moulded in a helical shape with a pitch length twice that of the rotor pitch length. The multi-lobe configuration, employed in low speed, high torque motors, uses a rotor with a multiple-lobed cross section that also forms a helix. Its pitch length is longer than the rotor's pitch length by the ratio of the number of stator lobes divided by the number of rotor lobes.

The lobes on a rotor and stator act like a gearbox. As their numbers increase for a given motor size, the motor's torque output generally increases and its output shaft speed generally decreases. Because power is defined as speed times torque, a greater number of lobes in a motor does not necessarily produce more horsepower. Motors with more lobes are actually less efficient because the seal area between the rotor and stator increases with the number of lobes



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Number of Stages:

Increasing the number of stages in a motor will increase the available torque output. The stator stage length is defined as the axial length required for one lobe in the stator to rotate 360° along its helical path around the body of the stator. The stage length of a rotor, however, is not equivalent to the stage length of its corresponding stator. A rotor has a shorter stage length than its corresponding stator. Stage length is dependent on the lobe pitch angle of the spiral. As the pitch angle increases, resulting in a tighter spiral and shorter stage length, the force vector perpendicular to the longitudinal axis of the rotor (torque) and the volume of the cavity within the stage decrease. This results in a reduction of torque output and an increase in the motor's speed. Conversely, a decrease in pitch angle produces a longer stage length, resulting in an increase in torque and a decrease in speed.

For a power section with a set lobe ratio, more stages increase the number of fluid cavities in the power section. Each cavity is capable of holding pressure, so as the number of cavities increases, the total pressure drop over the power section increases. Therefore, the total pressure drop and stall torque capability theoretically increases linearly with the number of stages. In the same differential pressure conditions, the power section with more stages will maintain speed better. Since there will be less pressure drop per stage, there will be less leakage. The equation that describes the general relation of the rotor stages to the stator stages is

Rotor stages = (n + 1/n) x stator stages

Where n = No of Rotor Lobes

Pressure drop per stage:

The maximum designed pressure drop per stage is a function of the lobe profile and the hardness of the elastomer lining. Changes in the hardness of the elastomer affect not only the pressure drop but also the resiliency and life of the elastomer.

Slip:

Slip is caused when high-pressure fluid blows through rotor and stator seal lines. Slip results in power section speed reduction and is defined as the percent reduction in rotor speed below maximum theoretical for a given flow rate. The following table summarizes the impact of different design and operating parameters on power section slip.

Penetration Rate:

It is typically assumed that there is a linear relationship between the rotating speed and the penetration rate of an impregnated bit (i.e., if bit speed is doubled then penetration rates also double). The same rule applies for weight on bit (WOB). Maximum penetration rates therefore require both high WOB and high bit RPM.

III. PARAMETERS OF THE PROTOTYPE

Before going into the design of project, available resources and constraints were fully considered. Initially a set of design parameters was selected and a design was made accordingly and analysis was carried out.

- Number of rotor lobes = 3
- Number of stator lobes = 4
- Length of Power Section = 36
- Stator pitch length = 12
- No of stator stages = 3
- No of rotor stages = 4
- Rotor Pitch length = 9
- Rotor mean diameter = 4.5
- Stator mean diameter = 9.5
- Eccentricity = 2.5
- Hp = Hydraulic horse power = 7.5
- Q = Rated Flow rate = 79.25gpm
- P = Rated Pressure = 45.52 Psi

(All Dimensions are in Inches)

The available resources specially machining constraint forced us to change the design and to scale down the model. New parameters were set and design was made and analysis was performed.

Change in Parametric values:

- Number of rotor lobes = 2
- Number of stator lobes = 1
- Length of Power Section = 24
- Stator pitch length = 12
- No of stator stages = 2
- No of rotor stages = 4
- Rotor Pitch length = 6
- Rotor mean diameter = 3
- Stator mean diameter = 5
- Eccentricity = 1
- Hp = Hydraulic horse power = 7.5
- Q = Rated Flow rate = 79.25gpm
- P = Rated Pressure = 45.52 Ps

Decisions regarding the design are availability dependent. Still the available machining resources didn't allow us to go with the above mentioned dimensions. Depending upon the availability of hydraulic pump, manufacturing facilities etc, following parameters were decided. The idea is to make the design as simple as possible and easily machine-able.

Final Parameters:

- Number of rotor lobes = 2
- Number of stator lobes = 1
- Length of Power Section = 14.4
- Stator pitch length = 7.2
- No of stator stages = 2
- No of rotor stages = 4
- Rotor Pitch length = 3.6
- Rotor mean diameter = 1.8
- Stator major diameter = 3.92
- Stator minor diameter = 2.18
- Eccentricity = 0.64
- Hp = Hydraulic horse power = 7.5
- Q = Rated Flow rate = 79.25gpm
- P = Rated Pressure = 45.52 Psi

IV. CALCULATIONS

Taking into account the design parameters and using the formulas, following values are calculated for the prototype.

$$P=162.208 \text{ Psi}$$

Pumping area = 2 x er x dr

$$A= 2.3 \text{ in}^2$$

Cavity Volume = Pumping area * Stator Pitch

$$V_c= 16.56 \text{ in}^3$$

Starting Moment is calculated to be

$$\Gamma = 112.2 \text{ ft-lbf}$$

This is the no load torque. It requires a differential Pressure of

$$\Delta P= 510.85 \text{ Psi}$$

For ideal conditions, when losses are not considered, rpm is

$$rpm = 351$$

Specific Displacement of the fluid per revolution of the rotor comes out to be

$$S=16.56 \text{ in}^3 / \text{rev}$$

Thrust on drive mechanism i-e rotor is calculated to be

$$F= 3306.148 \text{ ft-lbf}$$

$$F=16.93 \text{ KN}$$

Maximum velocity inside the motor section comes out to be

$$V_{max} = 14 \text{ m/sec}$$

These values are calculated theoretically using the mud motor and the fluid relations which does not include the slip, friction, incompressibility and other factors which do play a role in the values of these calculated parameters.

These factors are considered in the CFD analysis and the results, worked out, are compared with the theoretical one. From the software results, mechanical efficiency and power are calculated.

Based on the parametric analyses, power section of the motor and the rest of the assembly of the mud motor for straight drilling were modelled in Pro engineer.

Calculations using CFD results

By applying the torque and the rpm values with the required material and interference properties and compressibility effects, flow rate and differential pressure values come out to be:

$$Q= 56 \text{ g/min}$$

$$\Delta p= 425 \text{ Psi}$$

From these values, we calculated the torque and rpm values which comes out to be

Torque = 93.34 ft-lbf

Rpm = 156.23

Slip factor from the material properties of the mild steel is taken to be as .2.

Mechanical efficiency:

Plugging in the values for Mechanical efficiency, we have

ήm = (62.8 * Torque * rpm) / (P * Q)

= 71.24 %

Mechanical horse power:

Also, mechanical horse power comes out to be:

$Hp_{mechnical}$ = T x Sr / 5252

= 2.8 hp

V. PRO ENGINEER DESIGN AND SIMULATION

Pro Engineer wild fire 3 (M001) has been used as a major tool in the design of power section of Mud motor prototype. Five different modes of Pro engineer have been used in designing and simulation. These are as follows.

1. Part modeling
2. Assembly
3. Drawing
4. Mechanism
5. Manufacturing

After doing theoretical analysis of power section, stator and rotor dimensions were set, based on different parameters. Parts were modelled in Pro engineer and drawings were generated. However due to inadequate manufacturing resources model was scaled down and dimensions were changed to meet the requirements. Final dimensions of power section based on theoretical calculations are as follows.

Stator

Outer diameter d0 = 4.33071 inches

- Major diameter d1 = 3.9400 inches
- Minor diameter d2 =2.1700 inches
- Eccentricity ec = 0.8566 inches
- No of stages n =2
- Length of stator Ls = 14.7400 inches
- Stator pitch Ps = 7.3700 inches
- Helix angle α = 4.73 degrees

Rotor

- Major diameter d1 = 2.400 inches
- Minor diameter d2 = 1.800 inches
- No of stages n = 4
- Length of rotor Lr = 14.7400 inches
- Rotor pitch Pr = 3.6850 inches
- Helix angle α = 4.73 degrees
- Length of rotor 1 = 5 inches
- Catch

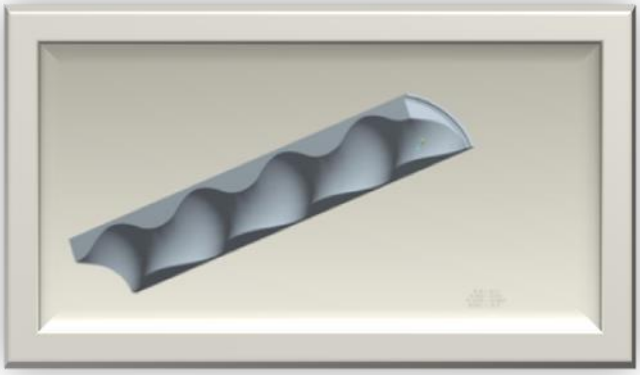
Elastomer

Thickness of Elastomer t = 0.21 inches

STATOR

Local machining facility allows stator to be made in four parts. The reason is stator is a part which is to be machined on 5 axis CNC machine. However local machines available are 3 axes. Different views of quarter part and complete assembly of stator is as follows.





ROTOR

Rotor is of single helix shape made by using variable section sweep. Rotor profile is hypotrochoid in nature. Different views of Rotor are as follows.





UNIVERSAL JOINT

This is a special universal joint assembly which is designed to give concentric output at the bit. It simultaneously covers the rotation and the nutation motion of the rotor. It is an assembly of two universal joints which are in phase at the two ends. Model of Cardon universal joint is as follows:



BEARING

A simple ball bearing is used at the bottom for making the output concentric and to hold the rotor. The numbers of balls used are eighteen.



ROTOR CATCH DEVICE

Rotor catch device is a simple extrusion which is used to hold the rotor. It has an inner cross section having dimensions smaller than the profile so that rotor catch can sit on it. A brass bush is used to avoid wearing of the material. It prevents the rotor from sliding down.



PRO ENGINEER ASSEMBLY

The assembly mode of Pro Engineer is used to make the complete assembly of the prototype. Parts are assembled using different constrains as per requirement. Two different types of constrains used for making the assembly.

1. User defined constrains
2. Assembly constrains

Constrains applied on the parts are as follows.

PART	ASSEMBLED TO	CONSTRAIN
STATOR	PRO E COORDINATE SYSTEM	FIXED
ROTOR	SLIDER EDGE	PIN,SLIDER
CARDON UNIVERSAL JOINT	ROTOR	MATE,ALIGN
BEARING	STATOR	INSERT, ALIGN
ROTOR CATCH DEVICE	STATOR	MATE,ALIGN
DRILL BIT	CARDON UNIVERSAL JOINT	MATE,ALIGN

In order to make the rotor simultaneously rotate and nutate, two more parts are used. One is a surface whose length is twice than that of eccentricity and the other is a slider which slides on that surface. Rotor is given the pin joint constrained with the slider.

MUD MOTOR COMPLETE ASSEMBLY



MECHANISM

Pro engineer mechanism mode is used to generate the required motion using different set of motors. It also helps in motion analysis of the assembly. Motor assembly is opened in mechanism mode and two motors were attached to the rotor. These are:

1. Servo motor on the pin joint to generate rotation.
2. Servo motor on the slider joint to generate nutation.

A ratio is maintained between the speeds of the motors so that rotor simultaneously nutate and rotate within the stator. Once the motion is generated interference fit is checked between different parts. Mechanism mode helps to measure different values while the motion is being generated. Two types of analyses were made on mechanism mode.

1. Interference fit analysis: It gives the interferences between different moving components.
2. Collision detection analysis: It detects different colliding parts while moving.

VI. STRESS ANALYSIS OF MOTOR

Non-linear finite element analysis is used to perform the structural analysis on the motor. A 2-D model of motor was modelled in pro-e and imported to Ansys in parasolid format. A complete structural analysis is done in ansys to find out the level of stress and strain in the elastomer.

MATERIAL:

Rotor:

The rotor is made up of mild steel, while in actual practice; stainless steel is used with chrome plating. Mild steel instead of stainless steel because of the two reasons:

1. Shafts of stainless steel with diameter greater than 4 inches are not indigenously available.

2. Mild steel is economical and easy to machine as compared to stainless steel.

Stator:

Stator is also made of mild steel, while in actual practice; it is made up of heat treated steel. We have used mild steel instead of carbon steel because of machining issues.

Stator Elastomer:

An elastomer lining of NBR (Nitrile Butadiene Rubber) is performed ion the stator because of its excellent physical properties and oil resistance. RM103 can also be used which attempts to maximize the physical properties as well as wear resistance for abrasive applications, but it is not available locally. The lining of elastomer is done through dipping process.

Properties of Material Used:

Material	Type	Density Kg/m3	Young Modulus MPa	Shear Modulus MPa
Nitrile Butadiene Rubber	Polymer	910	1.6	0.5
Mild Steel 1020	Metal	7780	210000	76000

Material	Yield Stress MPa	UTS MPa	Breaking Strain	Thermal Expansion (10-6/ C)
Nitrile Butadiene Rubber	2.1	2.1	500	140
Mild Steel 1020	200	380	25	14

Loads:

Loads are defined in terms of pressure. During the operation of mud motor, fluid strikes the lobes of rotor, as a result rotor rotates in the stator. Pressure of fluid will act on the rotor and the stator elastomer.

Pressure Variation:

Pressure variation across the motor is assumed to be linear. In ideal case pressure variation is equally divided for each stage. In motor prototype number of cavities formed would be 4, so the total pressure on each cavity would be one-fourth of pressure drop across motor.

Minimum pressure at no load = 425 psi

Pressure distribution in per cavity = 106.25 psi

Stresses due to pressure = 732.6 KPa

Three types of stresses will act on elastomer.

- Axial stress σa

- Tangential stress σt
- Radial stress σr

Axial or Longitudinal stresses will act in the direction of force. Axial forces act in closed volumes. Tangential forces will act tangent to the direction of force. Radial forces will act in the radial direction. If thickness of wall is about one-twentieth, or less, of its radius then the radial stresses are negligible, so the radial forces are neglected.

Calculations and results

$$\sigma_a = p \times (d \times t) / 2 \times t$$

$$\sigma_t = p \times d / 4x\ t$$

Pressure at each cavity on no load = 732.6 KPa

Thickness of Elastomer = t = 5 mm

Diameter = 44 mm

The formulas given above are used to find out the tangential and axial stresses in motor.

Tangential stress = 3.58 MPa

Axial stress = 1.611 KPa

The yield or ultimate tensile strength of Nitrile butadiene rubber is:

Yield strength / UTS of NBR = 36 MPa

Using yield strength max pressure prior to failure can found by plugging the values of yield strength in above formula. The maximum pressure prior to failure comes out to be:

P_{max} = 10,000 psi (73.4 MPa)

This is the maximum pressure which an elastomer can bear. Using this pressure maximum torque can also be found.

Maximum torque = 2000 ft- lbf

Maximum torque is limited by the mechanical strength of the stator elastomer. Elastomer failure will occur at torque greater than 2000 ft-lbf.

VII. MANUFACTURING OF THE PROTOTYPE

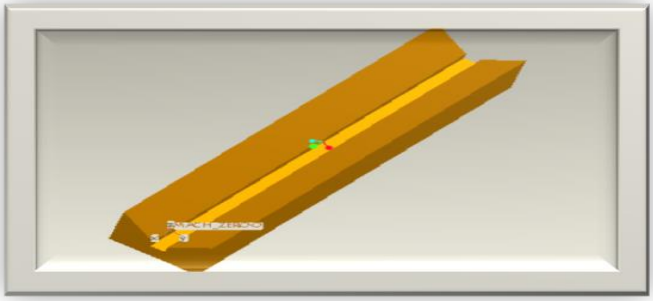
Manufacturing of prototype of mud motor was the most difficult task. In actual practice, mud motors are manufactured using casting. Casting requires large molds and dies, which itself is a big project. So we had left with the only option of machining using CNC Milling. The profile of stator was quite difficult to manufacture because of its complex machining. It requires 7-Axes milling machine to cut the inner profile of stator. Unfortunately 7-axes milling machine is not available in Pakistan. Only 3 axes CNC Milling machines are available locally, so we have divided stator in to four parts to reduce the complexity in machining.

Stator Machining:

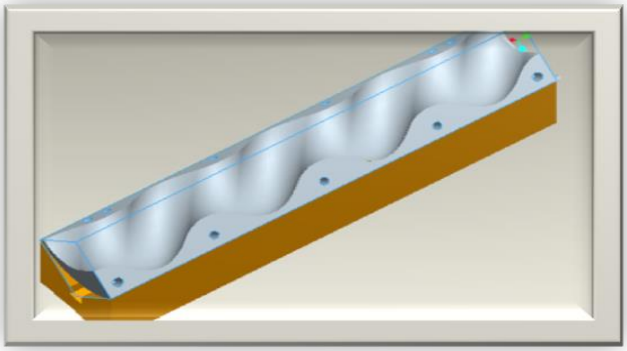
Machining of stator is done in pro-e manufacturing mode. A complete program was developed and NC was checked. The program file was given to the CNC Machine as a result machining was performed

Fixture:

A fixture was manufactured for the fixing and clamping of stator in CNC Milling.

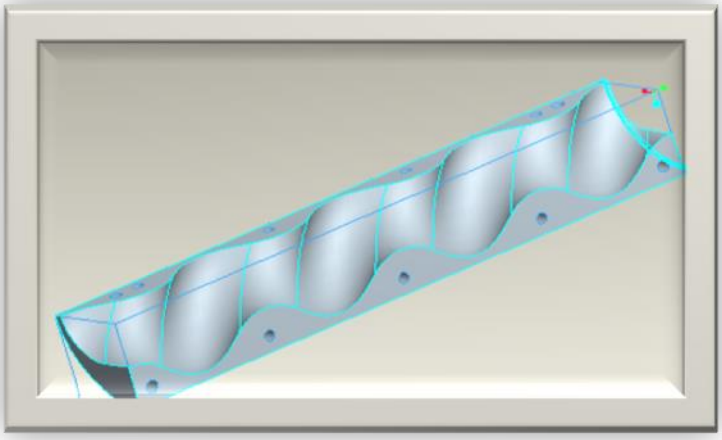


Stator mounted on fixture:

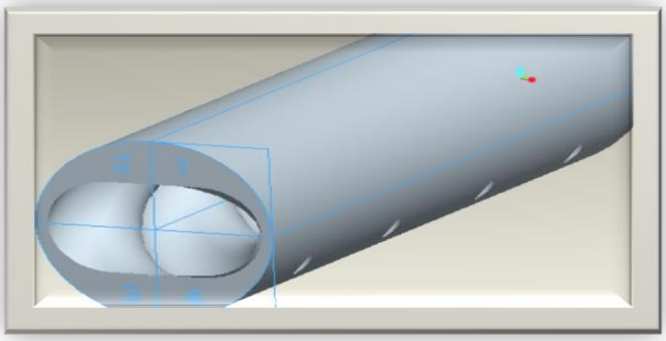


Finished stator:

This is finished part of stator, four such parts were manufactured and assembled to form a complete stator assembly.



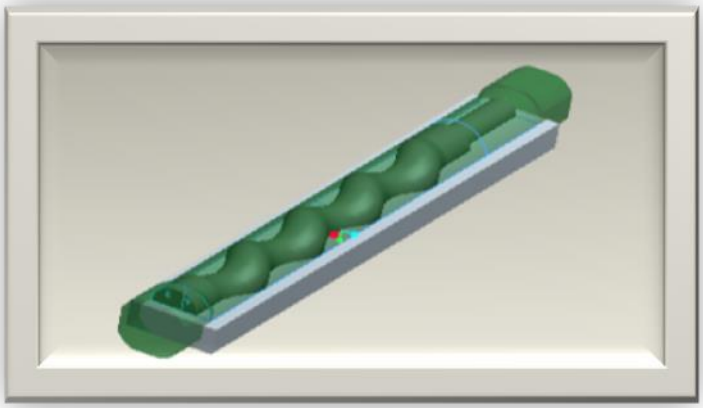
Stator assembly:



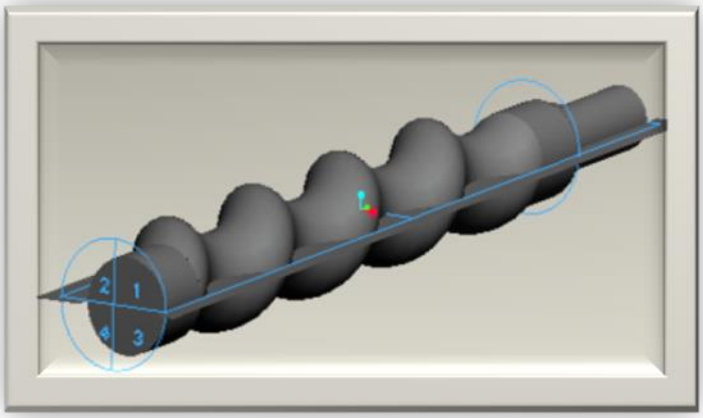
Rotor Machining:

The machining of rotor is not as complex as the machining of stator. The machining of rotor is done in two phases. A plane is defined which cuts the rotor in to two equal parts for simplicity in machining.

Rotor before machining:



Final rotor:



VIII. ALLOWANCES AND TOLERANCES

Tolerances for Rotor:

According to ANSI Standard Tolerances, if Nominal Size, in Inches, lies between 1.19 and 1.97 then the tolerance would be 4.0×10^{-3} inch for milling operation.

Since the diameter of rotor is 1.8 inches and machining is milling so the tolerances added is 4×10^{3} inches.

Tolerances for Stator:

According to ANSI Standard Tolerances, if Nominal Size in Inches lies between 1.97 and 3.15.

Then the tolerance would be 4.5×10^{-3} inch for milling operation. Since the diameter of stator is 2.44 inches and machining is milling so the tolerances added is 4.5×10^{3} inches.

Interference fit:

According to ANSI Standard interference fit, if Nominal Size in Inches lies between 1.97 and 3.15.

Then the tolerance would be $(2.3+0.4) \times 10^{-3}$. Since the diameter of stator is 2.44 inches so the interference fit added is $(2.3+0.4) \times 10^{-3}$ inches.

IX. CONCLUSION

The research methodology ended in a successful designing and manufacturing of the prototype of the power section of the Mud Motor. Although there are still complications available in the final model, however a platform is set up for engineers to go for the working design of the motor at commercial level. The design methodology has been setup and further research will result in better design and manufacturing of the prototype of higher lobes.

The power section of the motor (Rotor and Stator) are high precision parts which require complicated machining on 5 or 7 axis CNC Machine. However the prototype has been made using Local three axis CNC machine by machining in four parts. The challenge is to assemble the parts so that the parts meet the required Hypotrochoid and tropochoidal curve profile. However the parts were successfully assembled and prototype of the power section was manufactured. All this proves that Hi-tech expensive tools can be designed and fabricated indigenously by making a little effort for the availability of machining and related technologies.

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PLASTIC POLLUTION: IMPACTS ON BIODIVERSITY

The Theme of "World Environment Day, June 5, 2018"

BEAT PLASTIC POLLUTION: and *If you cannot reuse it, refuse it.*

By:

Dr. Abdul Aleem Chaudhry

The Day is celebrated to raise awareness and urge governments, industry, communities, and individuals to come together and explore sustainable alternatives and urgently reduce the production and use of single-use plastic that pollutes oceans, damages marine life and threatens human health.

Plastic has become the most common material since the beginning of the 20th century and modern life is unthinkable without it. Unfortunately, what makes it so useful, such as its durability, light weight and low cost, also makes it problematic when it comes to its end of life phase due to its non-biodegradable nature.

Plastic bags and climate change are linked in a variety of ways. From air quality to ocean toxicity, plastic bags contribute to eco-system disruption. Even worse, plastic is poisonous. Some of its ingredients such as biosphenol-A and Phthalates have been proved to cause cancer, birth defects, impaired immunity, endocrine disruption and other ailments. Additionally, plastic threatens wildlife and is a pollutant of groundwater. Cases of groundwater pollution due to landfills have been reported worldwide, and toxic leachates from landfills are among the major groundwater quality risks, according to the International Association of Hydrological Sciences.

"The plastic bags are so flimsy that millions of them only get used once before being thrown away, you see them in the trees, in the hedges and on the ground. And when they settle on the ground, they collect small pools of stagnant water, in which mosquitos breed."

Plastic pollution is the accumulation of plastic products in the environment that adversely affects wildlife, wildlife habitat, or humans. Plastics that act as pollutants are categorized into micro-, meso, or macro debris, based on size. Plastics are inexpensive and durable, and as a result levels of plastic production by humans are high. However, the chemical structure of most plastics renders them resistant to many natural processes of degradation and as a result they are slow to degrade. Together, these two factors have led to a high prominence of plastic pollution in the environment.

Plastic pollution can afflict land, waterways and oceans. Living organisms, particularly marine animals, can be harmed either by mechanical effects, such as entanglement in plastic objects or problems related to ingestion of plastic waste, or through exposure to chemicals within plastics that interfere with their physiology. Humans are also affected by plastic pollution, such as through disruption of various hormonal mechanisms.

Plastics themselves contribute to approximately 10% of discarded waste. Many kinds of plastics exist depending on their precursors and the method for their polymerization. Depending on their chemical composition, plastics and resins have varying properties related to contaminant absorption and adsorption. Polymer degradation takes much longer as a result of haline environments and the cooling

effect of the sea. These factors contribute to the persistence of plastic debris in certain environments. Recent studies have shown that plastics in the ocean decompose faster than was once thought, due to exposure to sun, rain, and other environmental conditions, resulting in the release of toxic chemicals such as bisphenol A (BPA). However, due to the increased volume of plastics in the ocean, decomposition has slowed down. The Marine Conservancy has predicted the decomposition rates of several plastic products. It is estimated that a foam plastic cup will take 50 years, a plastic beverage holder will take 400 years, a disposable nappy will take 450 years, and fishing line will take 600 years to degrade.

It has been estimated that global production of plastics is approximately 250 m tons/yr. Their abundance has been found to transport persistent organic pollutants, also known as POPs. These pollutants have been linked to an increased distribution of algae associated with red tides.

China is the biggest offender, discarding nearly 30 percent of the world's ocean-bound plastic. According to an analysis of plastic trash in the sea, 8 billions of trash or grocery bags, filled with plastic trash, are dumped into the world's water. Plastic waste is generated by people from 192 countries, living within 30 miles of the coast. The researchers have found that if nothing changes, as many as 155 million tonnes (10 bags) of trash for every mile on a coastline would be tossed out and find its way into the oceans in 2025. According to the report most polluting countries are Indonesia, Philippines, Vietnam, Sri Lanka, Thailand, China and USA.

Some researchers suggest that by 2050 there could be more plastic than fish in the oceans by weight.



Effects on Environment

The distribution of plastic debris is highly variable as a result of certain factors such as wind and ocean currents, coastline geography, urban areas, and trade routes. Human population in certain areas also plays a large role in this. Plastics are more likely to be found in enclosed regions. It serves as a means of distribution of organisms to remote coasts that are not their native environments. This could potentially increase the variability and dispersal of organisms in specific areas that are less biologically diverse. Plastics can also be used as vectors for chemical contaminants such as persistent organic pollutants and heavy metals.

On Land

Chlorinated plastic can release harmful chemicals into the surrounding soil, which can then seep into groundwater or other surrounding water sources and also the ecosystem. This can cause serious harm to the species that drink the water.

Landfill areas contain many different types of plastics. In these landfills, there are many microorganisms which speed up the biodegradation of plastics. The microorganisms include bacteria such as *Pseudomonas*, nylon-eating bacteria, and Flavobacteria. These bacteria break down nylon through the activity of the nylonase enzyme. Breakdown of biodegradable plastics releases methane, a very powerful greenhouse gas that contributes significantly to global warming.

In Oceans

In 2012, it was estimated that there was approximately 165 million tons of plastic pollution in the world's oceans. One type of plastic that is of concern in terms of ocean plastic pollution is nurdles. Nurdles are manufactured plastic pellets (a type of microplastic) used in the creation of plastic products and are often shipped via cargo ship. Many billions of nurdles are spilled into oceans each year, and it has been estimated that globally, around 10% of beach litter consists of nurdles. Plastics in oceans typically degrade within a year, but not entirely. In the process, toxic chemicals such as bisphenol A and polystyrene can leach into waters from some plastics. Polystyrene pieces and nurdles are the most common types of plastic pollution in oceans, and combined with plastic bags and food containers make up the majority of oceanic debris.

One study estimated that there are more than 5 trillion plastic pieces (defined into the four classes of small microplastics, large microplastics, meso and macroplastics) afloat at sea.

The litter that is being delivered into the oceans is toxic to marine life, and humans. The toxins that are components of plastic include diethylhexyl phthalate, which is a toxic *carcinogen*, as well as lead, cadmium, and mercury.

Plankton, fish, and ultimately the human race, through the food chain, ingest these highly toxic carcinogens and chemicals. Consuming the fish that contain these toxins can cause an increase in cancer, immune disorders, and birth defects.

The majority of the litter near and in the ocean is made up of plastics and is a persistent pervasive source of marine pollution. There are 5.25 trillion particles of plastic pollution that weigh as much as 270,000 tons (2016). This plastic is taken by the ocean currents and accumulates in large vortexes known as ocean gyres. The majority of the gyres become pollution dumps filled with plastic.

Almost 90% of plastic debris that pollutes ocean water, which translates to 5.6 million tons, comes from ocean-based sources. Merchant ships expel cargo, sewage, used medical equipment, and other types of waste that contain plastic into the ocean. Naval and research vessels eject waste and military equipment that are deemed unnecessary. Pleasure crafts release fishing gear and other types of waste, either accidentally or through negligent handling. The largest ocean-based source of plastic pollution is discarded fishing gear (including traps and nets), estimated to be up to 90% of plastic debris in some areas.

Continental plastic litter enters the ocean largely through storm-water runoff, flowing into watercourses or directly discharged into coastal waters. Plastic in the ocean has been shown to follow ocean currents which eventually form into what is known as Great Garbage Patches. Knowledge of the routes that plastic follows in ocean currents comes from accidental container drops from ship carriers. For example, in May 1990 The Hansa Carrier, sailing from Korea to USA, broke apart due to a storm, ultimately resulting in thousands of dumped shoes; these eventually started showing up on the U.S western coast, and Hawaii.









Land-based sources of ocean plastic pollution

Estimates for the contribution of land-based plastic vary widely. One study estimated that, in 2015, Jambeck *et al*. (2015) calculated that 275 million tonnes of plastic waste was generated in 192 coastal countries in 2010, with 4.8 to 12.7 million tonnes entering the ocean - a percentage of only up to 5%.

A source that has caused concern is landfills. Most waste in the form of plastic in landfills is single-use items such as packaging. Discarding plastics this way leads to accumulation. Although disposing of plastic waste in landfills has less of a gas

emission risk than disposal through incineration, the former has space limitations. Another concern is that the liners acting as protective layers between the landfill and environment can break, thus leaking toxins and contaminating the nearby soil and water. Landfills located near oceans often contribute to ocean debris because content is easily swept up and transported to the sea by wind or small waterways like rivers and streams. Marine debris can also result from sewage water that has not been efficiently treated, which is eventually transported to the ocean through rivers. Plastic items that have been improperly discarded can also be carried to oceans through storm waters.







Effects on Animals

Plastic pollution has the potential to poison animals, which can then adversely affect human food supplies. Plastic pollution has been described as being highly detrimental to large marine mammals, described in the book Introduction to Marine Biology as posing the "single greatest threat" to them. Some marine species, such as sea turtles, have been found to contain large proportions of plastics in their stomach. When this occurs, the animal typically starves, because the plastic blocks the animal's digestive tract.

Marine mammals sometimes become entangled in plastic products such as nets, which can harm or kill them.

Entanglement

Entanglement in plastic debris has been responsible for the deaths of many marine organisms, such as fish, seals, turtles, and birds. These animals get caught in the debris and end up suffocating or drowning. Because they are unable to untangle themselves, they also die from starvation or from their inability to escape predators. Being entangled also often results in severe lacerations and ulcers. In a 2006 report known as Plastic Debris in the World's Oceans, it was estimated that at least 267 different animal species have suffered from entanglement and ingestion of plastic debris. It has been estimated that over 400,000 marine mammals perish annually due to plastic pollution in oceans. Marine organisms get caught in discarded fishing equipment, such as ghost nets. Ropes and nets used to fish are often made of synthetic materials such as nylon, making fishing equipment more durable and buoyant. These organisms can also get caught in circular plastic packaging materials, and if the animal continues to grow in size, the plastic can cut into their flesh. Equipment such as nets can also drag along the seabed, causing damage to coral reefs.





Ingestion

Marine animals

Sea turtles are affected by plastic pollution. Some species are consumers of jelly fish, but often mistake plastic bags for their natural prey. This plastic debris can kill the sea turtle by obstructing the oesophagus. So too are whales; large amounts of plastics have been found in the stomachs of beached whales.

Some of the tiniest bits of plastic are being consumed by small fish, in a part of the pelagic zone in the ocean called the Mesopelagic zone, which is 200 to 1000 meters

below the ocean surface, and completely dark. Not much is known about these fish, other than that there are many of them. They hide in the darkness of the ocean, avoiding predators and then swimming to the ocean's surface at night to feed. Plastics found in the stomachs of these fish were collected during Malaspina's circumnavigation, a research project that studies the impact of global change on the oceans. A study conducted by Scripps Institution of Oceanography showed that the average plastic content in the stomachs of 141 mesopelagic fish over 27 different species was 9.2%. Their estimate for the ingestion rate of plastic debris by these fish in the North Pacific was between 12,000 and 24,000 tons per year. The most popular mesopelagic fish is the lantern fish. It resides in the central ocean gyres, a large system of rotating ocean currents. Since lantern fish serve as a primary food source for the fish that consumers purchase, including tuna and swordfish, the plastics they ingest become part of the food chain. The lantern fish is one of the main bait fish in the ocean, and it eats large amounts of plastic fragments, which in turn will not make them nutritious enough for other fish to consume.

Deep sea animals as well have been found with plastics in their stomachs.















Birds

The amount of plastic in the seas has increased dramatically since the first record in the 1960s, coming from waste discarded by ships, offshore dumping, litter on beaches and waste washed to sea by rivers. It is impossible to digest and takes up space in the stomach or gizzard that should be used for food, or can cause an obstruction that starves the bird directly. Studies of birds in the North Pacific have shown that ingestion of plastics results in declining body weight and body condition. This plastic is sometimes regurgitated and fed to chicks; a study of Laysan albatross chicks on Midway Atoll showed large amounts of ingested plastic in naturally dead

chicks compared to healthy chicks killed in accidents. While not the direct cause of death, this plastic causes physiological stress and causes the chick to feel full during feedings, reducing its food intake and the chances of survival.

Plastic pollution does not only affect animals that live solely in oceans. Seabirds are also greatly affected. In 2004, it was estimated that gulls in the North Sea had an average of thirty pieces of plastic in their stomachs. Seabirds often mistake trash floating on the ocean's surface as prey. Their food sources often have already ingested plastic debris, thus transferring the plastic from prey to predator. Ingested trash can obstruct and physically damage a bird's digestive system, reducing its digestive ability and can lead to malnutrition, starvation, and death. Toxic chemicals called polychlorinated biphenyls (PCBs) also become concentrated on the surface of plastics at sea and are released after seabirds eat them. These chemicals can accumulate in body tissues and have serious lethal effects on a bird's reproductive ability, immune system, and hormone balance. Floating plastic debris can produce ulcers, infections and lead to death. Marine plastic pollution can even reach birds that have never been at the sea. Parents may accidentally feed their nestlings plastic, mistaking it for food. Seabird chicks are the most vulnerable to plastic ingestion since they can't regurgitate like the adult seabirds.





Short-tailed albatross (*Phoebastria albatrus*)



The remains of this Laysan albatross chick show the plastic ingested before death, including a bottle cap and lighter.



This black-browed albatross has been hooked on a longline.

After the initial observation that many of the beaches in New Zealand had high concentrations of plastic pellets, further studies found that different species of prion ingest the plastic debris. Hungry prions mistook these pellets for food, and these particles were found intact within the birds' gizzards and proventriculi. Pecking marks similar to those made by northern fulmars in cuttlebones have been found in plastic debris, such as styrofoam, on the beaches on the Dutch coast, showing that this species of bird also mistakes plastic debris for food.



An estimate of 1.5 million Laysan albatrosses, which inhabit Midway Atoll, all have plastics in their digestive system. Midway Atoll is halfway between Asia and North America, and north of the Hawaiian archipelago. In this remote location, the plastic blockage has proven deadly to these birds. These seabirds choose red, pink, brown, and blue plastic pieces because of similarities to their natural food sources. As a result of plastic ingestion, the digestive tract can be blocked resulting in starvation. The windpipe can also be blocked, which results in suffocation. The debris can also accumulate in the animal's gut, and give them a false sense of fullness which would also result in starvation. On the shore, thousands of bird corpses can be seen with plastic remaining where the stomach once was. The durability of the plastics is visible among the remains. In some instances, the plastic piles are still present while the bird's corpse has decayed.

Similar to humans, animals exposed to plasticizers can experience developmental defects. Specifically, sheep have been found to have lower birth weights when prenatally exposed to bisphenol A (BPA). Exposure to BPA can shorten the distance between the eyes of a tadpole. It can also stall development in frogs and can result in a decrease in body length. In different species of fish, exposure can stall egg hatching and result in a decrease in body weight, tail length, and body length.

Effects on Humans

Due to the use of chemical additives during plastic production, plastics have potentially harmful effects that could prove to be carcinogenic or promote endocrine disruption. Some of the additives are used as phthalate plasticizers and brominated flame retardants. Through bio-monitoring, chemicals in plastics, such as BPA and phthalates, have been identified in the human population. Humans can be exposed to these chemicals through the nose, mouth, or skin. Although the level of exposure varies depending on age and geography, most humans experience simultaneous exposure to many of these chemicals. Average levels of daily exposure are below the levels deemed to be unsafe, but more research needs to be done on the effects

of low dose exposure on humans. A lot is unknown on how severely humans are physically affected by these chemicals. Some of the chemicals used in plastic production can cause dermatitis upon contact with human skin. In many plastics, these toxic chemicals are only used in trace amounts, but significant testing is often required to ensure that the toxic elements are contained within the plastic by inert material or polymer.



It can also affect humans in which it may create an eyesore that interferes with enjoyment of the natural environment.



















Clinical significance

Due to the pervasiveness of plastic products, most of the human population is constantly exposed to the chemical components of plastics. 95% of adults in the United States have had detectable levels of BPA in their urine. Exposure to chemicals such as BPA has been correlated with disruptions in fertility, reproduction, sexual maturation, and other health effects. Specific phthalates have also resulted in similar biological effects.



Thyroid hormone axis

Bisphenol A affects gene expression related to the thyroid hormone axis, which affects biological functions such as metabolism and development. BPA can decrease thyroid hormone receptor (TR) activity by increasing TR transcriptional corepressor activity. This then decreases the level of thyroid hormone binding proteins that bind to triiodothyronine. By affecting the thyroid hormone axis, BPA exposure can lead to hypothyroidism.

Biodegradable and degradable plastics

The use of biodegradable plastics has many advantages and disadvantages. Biodegradables are biopolymers that degrade in industrial composters. Biodegradables do not degrade as efficiently in domestic composters, and during this slower process, methane gas may be emitted.

There are also other types of degradable materials that are not considered to be biopolymers, because they are oil-based, similar to other conventional plastics. These plastics are made to be more degradable through the use of different additives, which help them degrade when exposed to UV rays or other physical stressors. However biodegradation-promoting additives for polymers have been shown not to significantly increase biodegradation.

Although biodegradable and degradable plastics have helped reduce plastic pollution, there are some drawbacks. One issue concerning both types of plastics is that they do not break down very efficiently in natural environments. There, degradable plastics that are oil-based may break down into smaller fractions, at which point they do not degrade further.

Incineration

Up to 60% of used plastic medical equipment is incinerated rather than deposited in a landfill as a precautionary measure to lessen the transmission of disease. This has

allowed for a large decrease in the amount of plastic waste that stems from medical equipment. If plastic waste is not incinerated and disposed of properly, a harmful amount of toxins can be released and dispersed as a gas through air or as ash through air and waterways. Many studies have been done concerning the gaseous emissions that result from the incineration process.

Policy

Agencies such as the Environmental Protection Agency and the Food and Drug Administration often do not assess the safety of new chemicals until after a negative side effect is shown. Once they suspect a chemical may be toxic, it is studied to determine the human reference dose, which is determined to be the lowest observable adverse effect level. During these studies, a high dose is tested to see if it causes any adverse health effects, and if it does not, lower doses are considered to be safe as well. This does not take into account the fact that with some chemicals found in plastics, such as BPA; lower doses can have a discernible effect. Even with this often complex evaluation process, policies have been put into place in order to help alleviate plastic pollution and its effects. Government regulations have been implemented that ban some chemicals from being used in specific plastic products.

In Canada, the United States, and the European Union, BPA has been banned from being incorporated in the production of baby bottles and children's cups, due to health concerns and the higher vulnerability of younger children to the effects of BPA. Taxes have been established in order to discourage specific ways of managing plastic waste. The landfill tax, for example, creates an incentive to choose to recycle plastics rather than contain them in landfills, by making the latter more expensive. There has also been a standardization of the types of plastics that can be considered compostable. The European Norm EN 13432, which was set by the European Committee for Standardization (CEN), lists the standards that plastics must meet, in terms of compostability and biodegradability, in order to officially be labeled as compostable.

Non-usage and reduction in usage

The Ministry of Drinking Water and Sanitation, Government of India, has requested various governmental departments to avoid the use of plastic bottles to provide drinking water during governmental meetings etc. and instead make arrangements for providing drinking water that do not generate plastic waste. The state of Sikkim has restricted the usage of plastic water bottles (in government functions and meetings) and styrofoam products.[1] The state of Bihar has banned the usage of plastic water bottles in governmental meetings.

The 2015 National Games of India, organized in Thiruvananthapuram, was associated with green protocols. This was initiated by Suchitwa Mission that aimed for "zero-waste" venues. To make the event "disposable-free", there was ban on the usage of disposable water bottles. The event witnessed the usage of reusable tableware and stainless steel tumblers. Athletes were provided with refillable steel flasks. It is estimated that these green practices stopped the generation of 120 metric tonnes of disposable waste.

Creating Awareness

On 11 April 2013 in order to create awareness, artist Maria Cristina Finucci founded The Garbage Patch State at UNESCO–Paris in front of Director General Irina

Bokova. First of a series of events under the patronage of UNESCO and of Italian Ministry of the Environment. International organisations have also been raising awareness of plastic pollution.

Pollution in Pakistan has become a major environmental and economic concern, mainly due to poor pollution management, lack of awareness among public and week enforcement of environmental policies.

In Pakistan pollution is also spreading due to rapid industrial growth. The burning of materials made of plastic cause pollution. Pollution can build up in water sources and make it difficult for marine life. This was revealed in a research report conducted on Plastic Pollution, and presented by the students of Mohammad Ali Jinnah University Karachi at an Economic Festival held at university's campus.

Every year 5 to 13 million more tonnes of plastic end up in the oceans and a whopping 80 percent of that waste pour in from 20 countries.

The plastic pollution spreads environmental degradation and upsets the existing ecosystem; in Pakistan causes an estimated damage of 13 billion dollars to marine ecosystem annually, and damage to tourism, fishing and shipping industries of around $1.3 billion.

Urbanization and population growth has resulted in increased demand of plastic products and since these products were much cheaper and affordable as compared to metal, wood and ceramics, their use was increasing day by day. He warned that the reckless disposal of plastic products posed a serious threat to the environment, particularly the wildlife. The use of plastic products should be discouraged and inappropriate dumping of plastic waste on beaches or in public places should be stopped.

For controlling plastic pollution in the country, it was recommended to establish a hydro cracking plank; to make strict laws for controlling pollution, to ban plastic bags in the country and to promote use of paper bags.

Steps against plastic pollution

ABOUT two years ago, a groundbreaking initiative was launched in Morocco. Called Zero Mika, the initiative announced a ban on plastic bags. The ban did not apply to all plastic bags. Those used to gather household trash and agricultural and industrial products, as well as isothermal bags for maintaining medicine and other medical supplies at certain temperatures, were exempted from the ban.

The ban did, however, apply to the largest contributor of plastic bag pollution — bags used for carrying groceries and other purchased items. In short, bags that are easily and unthinkingly discarded on the streets.

The Zero Mika (zero plastic) law implemented by Morocco aims to reduce the polluting effects of the many tonnes of plastic bags that are produced every year. According to reports, Morocco has seized 420 tonnes of plastic bags since the implementation of the ban.

In choosing to take active steps against plastic pollution, Morocco and other countries that have implemented plastic bag bans have chosen to be part of the solution rather than the problem. Few people, including many reading this article

today, realize that an average single-use plastic bag takes 1,000 years to decompose.

Pakistanis, most of whom do not live by the sea, find it hard to care for the health of the oceans that they may never have seen, let alone the fate of generations to come.

At the same time, one can only hope that they may be convinced to care for what they see. A cursory glance at any part of Pakistan is guaranteed to reveal the ugly spectre of a plastic bag or several plastic bags either hanging from phone and electric wires, waving merrily from rubbish heaps and clogging gutters, or simply blowing around in the wind in a street or alley.

The bags are everywhere, and the rich and poor and concerned and completely thoughtless can all see for themselves just how horribly they transform the environment. If civic concern cannot galvanise them into action, perhaps a concern for the fact that nearly every view in every part of the country has been tainted by the plastic bag can bring about some action.

This is the reason why the example of Morocco is particularly pertinent. Unlike in Balochistan, which supposedly already announced such a ban, but whose enforcement seems lax if not non-existent, and the Sindh government, which had also announced such a ban but has since forgotten about it, Morocco has actually devoted resources to ensuring that it remains one.

It is not that the country has not faced a struggle in the form of a black market in which plastic bags are sold illegally, following the legislation that was passed with fines imposed on violators. The main point is that the bags are banned and their numbers are being drastically reduced since the time before the ban. That in itself is a victory.

Others are following suit. The Indian state of Maharashtra, whose coastline also borders the Arabian Sea, fed up with watching debris pile up on the beaches and in drains and city streets, has imposed a ban on all plastic goods. The ban imposed by the state government lays out exemptions for items such as garbage bags, packing for processed goods, milk pouches, medical supplies and other essential items. The use of plastic for any other purpose, given the thoughtless convenience of not having to use an alternative, will not be allowed.

Early reports showed an eagerness to comply; vegetable and fruit sellers on the streets of Mumbai had put up small handmade signs asking people to please bring bags from home, as they were no longer permitted to provide them.

There was, of course, a time in South Asia before the plastic bag became ubiquitous, a time when jute and cane baskets and rope bags or reusable plastic baskets were used to transport things. Unlike the Western world, admittedly the largest producer of plastic waste, Pakistanis only have to remember old habits, not necessarily learn new skills.

If the plight of the seagulls and the fish and the birds doesn’t move you, then just look outside, up and down and around. Wouldn’t it be simply wonderful, completely amazing, to never ever have to see the black and blue and striped shreds of plastic as the backdrop to every moment, every scene and every site?

Efforts to reduce the use of plastics

Efforts to reduce the use of plastics and to promote plastic recycling have occurred. Some supermarkets charge their customers for plastic bags, and in some places more efficient reusable or biodegradable materials are being used in place of plastics. Some communities and businesses have put a ban on some commonly used plastic items, such as bottled water and plastic bags.

- Many of the plastic products used only once and thrown away;
- No Planned Plastic Collection System by Municipal authorities;
- Recycle Management poor in urban and rural areas;
- Urbanization, usage and increase in plastic waste;
- Plastics do have a stronger management and policy rules;
- Lack of interest in maintaining clean environment;
- What to do with this waste? in Many of the peoples' mind;
- Plastic gets accumulated in water and land, it takes 500 years for it to decay;
- ***Plastic pollution kills sea species, birds, animals and harmful to human beings with health related risks***;
- The clogging of drains (sewage and storm) in urban areas are higher percentage ratio due to higher plastic wastage is found;
- Irrigation Canals and agricultural lands are more vulnerable in rural areas.

Effects

- The rural areas are more prone to this type of pollution and the related effects, as a majority of the people from these areas use plastic on a large scale;
- Many stray animals end up eating plastic bags and bottles due to improper disposal systems, and this can cause their death;
- During the rainy season, the plastic rubbish that has fallen on the road gets washed away into the nearby water reservoirs, canals, and drains, leading to their choking up and overflowing. Also, the water quality gets spoiled due to the addition of these synthetic materials;
- When dumped in landfills, plastic materials interact with water and form hazardous chemicals. If these compounds seep down towards groundwater aquifers, they degrade the water quality, leading to groundwater pollution;

Solutions and Preventive Measures

- Though commodities made of plastic are handy, it is time to become aware of the harm that plastic causes to life on Earth. Before the picture turns even uglier; it is better to take some effective preventive measures to reduce this type of pollution;
- To bring a decline in its usage, start using paper or cloth bags for shopping and other purposes as much as possible, and avoid bringing plastic bags at home;
- Understand the severity of the problem of plastic pollution, and know the consequences of dumping plastic in water and on land;

- Ensure proper disposal of plastic;
- Plastic which is disposed of can be recycled and used in many different ways such as for tote bags, wallets, or pouches. There are biodegradable plastic bags available, which can help to a considerable extent;
- These changes might be gradual and even less appealing against the problem; but taking small steps can greatly contribute to the reduction of plastic pollution. It is the time for us to take some preventive steps, and ensure a better life for the future generations.

REMEDY

- Reduce the amount of plastics you use**:**
- at the grocery store;
- aim for foods that come in larger single packages rather than individual ones;
- try to avoid produce wrapped in plastic bags or packaged in plastic trays;
- eliminate your single-use plastics and opt for reusable products;
- cut plastic beverage containers from your life;
- use cups, mugs, reusable water bottles;
- don’t forget your stylish reusable bags when you go for grocery;
- replace any plastic eating utensils, plates and cups with reusable ones –
- **Your monthly grocery bill will benefit too!**
- These changes might be gradual, and even less appealing against the problem; but taking small steps can greatly contribute to the reduction of plastic pollution. It is the time for us to take some preventive steps, and ensure a better life for the future generations.




PLEDGE
We realize that out environment is degrading day by day due to plastic pollution because it does not destroy easily and take a long time to destroy. Now lets take a pledge together.
We will stop the use of plastic bags and will use reusable cloth bags only.
We pledge that we will educate our community people to save our environment.
We will share the possible solution of Plastic Pollution with community people.

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