ELECTRICITY THROUGH GARBAGE

By

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The whole world today faces the challenge of pollution in one form or the other, which if, ignored poses a giant threat to the beauty and safety of mother planet earth. The coming generations will find it difficult to forgive the mistakes of their fore fathers for utilizing the nature's blessings in a reckless manner and thereby leaving an agonizing environment which will not only be suffocating but also mutated for the worse.

All activities of human beings are adding a burden to the environment's various segments i.e., air, land, and water. A variety of waste is generated in million of tones every day through municipal, agriculture, industries, hospitals, mining, and forests. The least harmful is the putriscible waste that can be recycled most effectively. Garbage, rubbish, agriculture, and forest waste fall in this category.

Garbage is generated in form or the other in urban areas in residential localities, offices, recreation sites, schools and colleges. Ironically, garbage is a common addition on road sides in Pakistan where the food items are sold under unhygienic conditions and the resulting wastes is disposed off, on site, to nurture flies, creating a very uncomfortable situation for pedestrians. It is also in humanitarian to see children especially from the neighboring countries collecting items e.g., paper etc. from such dumps which smell and are a cause of pathological attacks.

Previously, the garbage of Lahore was dumped outside at Sughian bridge and Chungi Amer Sidhu without being properly covered with soil. Even river Ravi, once a pleasure to the eyes and soul could not escape this pathetic approach. Incineration was carried out to reduce the amount

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FIG. 1. Throbbing Childhood

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of garbage and the local inhabitants suffered from several diseases, mainly the respiratory. Poignantly not only the deprived locals encountered the consequences the privileged also paid a price as the incineration process pollutes air and the pollutants are carried and dispersed over the whole area.

Pakistan faces a dearth in energy by approximately 4000 MW (editorial, Dawn, May 13, 2009). The ill planned policies made the whole nation suffer. Several industrial units closed down and many had to operate under production. The energy crises has an immense impact on the economics and the common man is unable to make both ends meet. This increases the need for alternate energy sources manifold. Renewable fuels are most required that could play their important role in sustainable development. Biomass is an incredibly important field within the broader subject of renewable energy and electricity generation. Not only can the biomass be used as biofuel (such as the increasingly popular bio diesel) but it can also be used to create gases such as methane which can in turn be used for generating electricity. Whilst biomass based fuels are still part of the carbon cycle, meaning that they do produce carbon emissions, many of the techniques used to harness the energy of biomass reduces or eliminates harmful chemicals and gases which would otherwise have been released during their natural decomposition. An important example is the CH_4 gas that has much higher i.e., times 23 per molecule ratio of radiative forcing (absorption of radiation in the atmosphere) as compared to CO_2. It absorbs in the atmospheric window of IR between CO_2 and water vapors and is thus potentially a very strong green house gas.

Carbon fixation occurs while the plant is growing and this biological matter can be used effectively to make biomass a carbon neutral source of power. The biomass source can be replaced by growing more and more trees.

Refuse and waste i.e., garbage is another source of biogas. This effectively means that waste that might otherwise have been buried in landfill or left to decompose can instead be reused.

As biomass energy generation is still a predominately experimental field of science there are many different methods in use for harvesting and using biomass, and many different forms of biomass being relied upon as fuel. Because biomass includes any biological material that is living or recently dead the term encompasses garbage, sewage, wood, algae, plant oils and non-food residual parts of plants.

Because each of these types of biomass requires different ways of processing, a number of techniques have been developed. Aside from anaerobic digestion (the process for converting landfill and waste into biogas), biomass can also be fermented or distilled, composted, burned, or processed through pyrolysis, acid hydrolysis or hydrogenation. Biomass is also being used experimentally for creating plastics, some of which dissolve in seawater.

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WASTE TO ENERGY
THE PROCESS

The system involves sorted carbon waste, including plastics, paper, cardboard, food and other plant material, entering a plasma gasification chamber and being turned into syngas by the application of very high temperatures. Plasma gasification is different from incineration as dioxins become a nuisance. Besides, incineration processes have low efficiency and more waste. However, it is important that the garbage should be sorted out to avoid any hydrogen chloride, which can be done by adding calcium oxide.

Plasma gasification of garbage is done at very high temperatures (+6000°C). At this temperature almost all the garbage is burnt out .The syngas produced as a result of plasma gasification is a mixture of hydrogen and carbon monoxide. After scrubbing, syngas i.e., two thirds, can be used to generate electricity that can power the same plant and the remaining one third can be sold for other purposes. At such high production temperatures huge amount of heat is generated that can be used to power a steam turbine in the plant, generating more electricity.

The solid waste left after plasma gasification, i.e., the slag, after removal of heavy metals can be processed into bricks, synthetic gravel or asphalt. This will limit the mining of some of minerals used for the same purpose. Land filling will also reduce as no matter what the lining material is, they eventually leak and contaminate the ground water below.

Chemical catalysts can be used to convert the syngas into a mixture of alcohols that includes ethanol. Such a mixture is intrinsically inefficient i.e., the carbon, hydrogen, and oxygen that go into the other alcohols could, in principle, have gone into ethanol instead. Here microbes can be used to convert the syngas to ethanol more efficiently.

Plasma arc gasification is a new waste disposal technology that turns garbage into usable byproducts without burning it. Very high voltage electrical current is passed through two electrodes, creating an arc in the space between them. Inert gas under pressure is passed through the arc into a sealed container of garbage. Temperatures as high as 25000 ºF i.e., 13,871 °C are reached in the arc column, breaking and converting matter into gaseous atomic form. Very high voltage application is a limitation but benefits may become a priority in special circumstances.

The other advantage of plasma gasification will be the utilization of cleaned syngas in internal combustion engine (ICE) generator, with an average generation efficiency of about 30%. Yet another plausibility would be to process syngas into hydrogen and replace the ICEs by a new alkaline fuel cells, which holds promising for high conversion efficiency of hydrogen to electricity through any other process. It is assessed that the new new generation fuel cells will increase the net output of electricity by a minimum of 60% over an internal combustion engine generation system or by 130% over a steam turbine system. It is claimed that net output of electricity of Grid system can be increased by over 50% compared to existing technologies (Waste2Tricity, U.K) quite reducing the electricity prices (Fig. 2).

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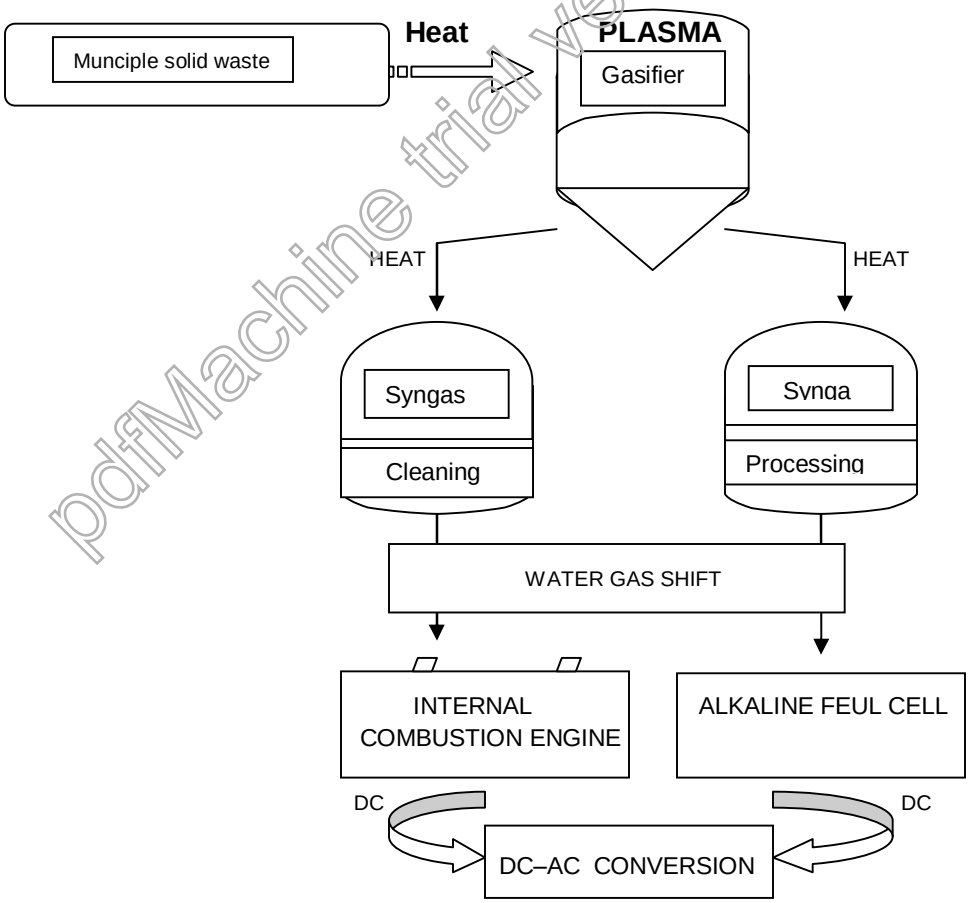


FIG. 2. Plasma Gasifier with extensions into future awards

THE WASTE GASIFICATION PROJECTS

Several international firms are involved in such projects that declare garbage conversion to electricity as commercially viable and acceptable technologies. The Sun Energy Group, which has proposed building a massive plasma gasification facility in New Orleans, state that disposing of a ton's worth of trash will yield 55.2 kilowatts of power. Such plants are already operating. Canada's Plasco Energy Group, says that 46 percent of zapped waste now becomes energy, compared with 18 percent with earlier plant designs. The Swiss Company Pyromex has been developing waste management technologies for almost twenty years. In 1999 the first industrial plant was built in Germany. According to the company, the Pyromex gasification system can treat all types of waste, with the single exception of heavily contaminated nuclear residues. Japan is processing garbage on a smaller scale practicing strict air quality standards. A proposal is put forward by Montenay Inc. for Greater Vancouver, having 80 per cent larger capacity than the existing garbage burning facility in Burnaby. Chamco also provides the technology for turning raw garbage into refused derived feul (RDF).

SOURCES OF GARBAGE

The urban waste from thickly populated cities collects via following sources:

- Residential areas
- Commercial areas
- In-house small industry areas
- Trading areas
- Hotel and restaurants
- Markets especially open markets of fruits, vegetables and food
- Institutional areas i.e. School, Offices, Hospitals etc.
- Construction sites e.g., soil, un used hard gravel mix, old concrete etc.
- Streets
- Drain/nallah cleaning areas

COMPOSITION of MUNCIPAL WASTE

The general municipal solid waste containing both putrucible and non putrucible matter from the thickly populated cities constitutes the following:

- Paper and cardboard 15.00%
- Plastics 0.75%
- Metals 0.80%
- Glass 0.40%
- Sand & Fine Earth 35.00%
- Compost able matter 37.50%
- Others 10.55%

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WASTE O ENERGY NEED IN PAKISTAN

Pakistan is amongst the third world countries that is now struggling even more for its survival due to policy and strategy vacuum. It faces several problems that need to be addressed very seriously. Health is one of the major concerns that is directly linked with environmental issues and needs to be addressed very seriously. Lahore alone faces a huge challenge of environmental pollution on one hand and the energy deficiency on the other.

DATA REGARDING WASTE IN LAHORE

The statistical data of Lahore in the province of Punjab is given as under

Total area:		1,772 km² (684 sq mi)
No. of Towns:		9
Population		
2007	Total:	6,319,000
	Density:	3,566/km² (9,238.3/sq mi)
		Combined population of Lahore City and Lahore Cantonment
2009	Total	10,000,000

	Combined population of Lahore City and Lahore Cantonment
Waste and Garbage produced per month	180,000 tons
Waste and Garbage produced per day	6,000 tons solid waste
Solid waste lifted up	5,000 tons per day
Solid waste heaped up	1,000 tons per day

Lahore is a big city of Pakistan accommodating a huge population of 10,000,000. The city has a rich cultural heritage. It has beautiful buildings and gardens and appealing food items. Unfortunately, the beauty of almost all the places, especially, the prestigious heritage sites are masked by heaps of garbage that not only destroy the aesthetic appearance but are also a cause of disease. The city produces waste and garbage of 6,000 tons per day (The Nation daily, June 01, 2010). About 5000 tons of this garbage is lifted up for land filling and dumps and 1000 tons is left at different places. The solid waste management (SWM) of Lahore accuses non availability of land for the unpicked garbage. This garbage is a source of different diseases like as cholera and typhoid. It is also a breeding place of mice and insects. Heaps of this type produces 70,000 flies per week per mm^3.

It is encouraging to know that the Solid Waste Management (SWM) department plans to sell tones of municipal waste to foreign recycling factories of China and France and also one Lahore based firm. The factories are being set up in the area of Sundar Industrial Estate and Kahna Kachha (The Nation Published: November 19, 2009). The companies will recycle the waste to produce Refuse Dried Fuel (RDF), a combustible item used in factories like cement, compost fertilizer, articles of daily use and electricity from the waste.

If the plan matures the heaps of garbage will disappear from the roads, streets and residential areas of the metropolis. According to rough estimates shown by a recent study in Hamilton. Ont., land fills charge municipal authorities at an average of $ 35 per ton. Dropping off a ton of garbage at a plasma gasification would cost $ 172 per ton. Looking at the figures given in table, the Lahore population is increasing by approximately 4 million per year. This alarms that garbage production will also rise like wise. Therefore, it will further enhance the need of conversion technologies to be implemented for clean fresh healthy air.

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THE BONDING AREAS

1. Garbage sorting. it should be done at source i.e., paper and food should be disposed in bags different from that for glass, plastic and ceramic. Pathetically, it is done at the garbage heaps where dogs and children are equally seen, both in the struggle of survival.

2. The gasification chambers should be under vigilant monitoring and control and located away from the cities.

3. Syngas should be properly cleaned before being sold i.e., emissions must not contain toxic acids and other pollutants. It must be eco friendly.

4. Heavy metals must be removed before the residue is sold to the cement industry.

5. Research should be promoted in the Universities to extract electricity from pollution and organic waste product mainly through biotechnology.

6. The educational institutions must adopt the policy of training young women and men for sorting the waste at waste. Such a project is already close to finalization at Forman Christian College, Lahore.

7. Government incentives to industries and institutions adopting environmentally attitude i.e., less production of waste

8. Seminars and forums must be held

9. Competitions should be conducted at school level.

10. The media must play its role in motivating public

Conversion of waste to electricity must not become an excuse to produce more of garbage. The media and the educational institutions must play its important role to educate people. It should be a shared vision of the nation to see the country clean and healthy.

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EFFECT OF POST WELD HEAT TREATMENT ON THE MECHANICAL PROPERTIES AND MICROSTRUCTURE OF CARBON STEEL WELD USING ER309L FILLER METAL

By

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Abstract:
Welding is one of the important methods of fabrication where strength and pressure tightness are prime requirements. This research work involves welding of two dissimilar steels to overcome problems like HAZ embitterment, strain age embitterment and lots of residual stresses that can cause failure during subsequent use of components. Post weld heat treatment (PWHT) is one of important technique or step that can be used to overcome above mentioned problems. Keeping in view above mentioned situation this project consists of welding of two different kinds of steels by the same technique and then post heated at different temperature to study the effect of post heating temperature on mechanical properties of welds.

Medium carbon steel was welded with 20MnCr5 steel by using filler metal ER309 to produce dissimilar welds. To assure that these welds are sound they were tested by X-ray radiography. These welded specimens were post heated at different temperatures of 200C, 350C, 500C, 650C, and at 800C for one hour followed by furnace cooling. After heat treatment, each sample was tested mechanically and their microstructures were observed and compared with already published information. The results show that with increase in post heating temperature, ductility increases and a sudden increase in elongation was observed in the specimen which was post heated above transformation temperature i.e. 800C. Fracture surface of all samples were studied by using Scanning Electron Microscope (SEM) Strength also varies with temperature as initially it increases up to 500C and then it starts decreasing.

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INTRODUCTION

The development of residual stresses approaching or even exceeding the yield stress is possible when welding thick sections. For certain industry sectors, eg. Petrochemical, Chemical, Oil and Gas, etc. The existence of residual stress of this magnitude is completely unacceptable. With pressure equipment operating at 2000 C and below a variety of stress corrosion cracking mechanisms under the general term “environmental cracking” become prevalent. There is also the problem of fatigue to be considered and the effect that residual tensile stresses have in that regard.

Post weld heat treatment in the context described here refers to the process of reheating a weld to below the lower transformation temperature at a controlled rate, holding for a specific time and cooling at a controlled rate. No consideration has been given to normalizing of welds in carbon-manganese and low alloy steels, to solution annealing of stainless steels or to any precipitation hardening treatments to other alloy materials. Therefore, almost by exclusion, the materials involved will be Carbon Manganese steels, C-Mo, 1¼Cr½Mo, 2¼Cr1Mo, 5Cr1Mo, 9Cr1Mo and 12Cr1MoV steels.[1]

The increased cost of raw materials in recent years is prime reason that why metal selection for a particular product is becoming important. Although steels with excellent properties like strength, corrosion resistance, wear resistance and surface finish are available in the market but it can not be used for applications like windows, door hooks and bicycle handles etc why because expensive materials are only used for special applications.

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Heat Treatment is an important operation in the final fabrication process of many engineering components. Only by heat treatment it is possible to impart high mechanical properties to steel parts and tools for sophisticated applications. Heat treatment is considered to be very important tool of the metallurgist by which we can alter the properties of steel easily. The same steel can have a very wide range of mechanical properties if subjected to different heat treatments. Today when science and technology are advancing very rapidly in hunt of higher and higher properties in materials, heat treatment plays a very important role.[2]

Low carbon 12% Cr stainless steel T410S (UNS S 410008) is extensively used in the construction of equipment for the petrochemical industry. Although it is one of the “weld able” stainless steels, the welding of this type of material requires the knowledge of the metallurgical and thermo-mechanical mechanisms that generate Hydrogen Induced Cracking (HIC) in the heat affected zone (HAZ). For this reason, a preheating process and a post welding heat treatment are required. The development of this type of stainless steel and low carbon filler metals has minimized the risk of HIC. This type of material has excellent corrosion resistance in environments found in the oil and gas production and also suitable creep resistance. An example of its application in the petrochemical industry is the coke drums. The delayed coking drums are operated under severe conditions of warm-up and forced cooling off, inducing repetitive thermal stresses on the vessel walls. [3].The critical service of this equipment is during its operation, since by service, they develop corrugations or bulges in the vessel body. These defects are distortions of the diameter that generate stress concentrations, enlarging the possibility of vessel failure, specifically in the welded joints [4], [5], [6] and [7].

In theory, when the filler material is similar to that of the base metal, a preheating process should be applied to the welded parts before the welding process. However, it is possible to avoid the preheating process using an austenitic filler metal, like ER309L. The austenitic phase in the welded metal works like a hydrogen trap, avoiding hydrogen migration to the high risk zones. This capacity of austenite is due to its hydrogen solubility compared with that of ferrite or martensite [8]

Some inverstigators assumed that the crack growth pattern is due to the different phases in the microstructure in this small zone (HAZ), which is influenced by parameters such as the filler metal type, preheating temperature, heat input, cooling rate, etc., the fractures tend to turn aside from high strength coarse grains to regions with lower strength within the weld metal or the HAZ fine grain zone [9] and [10]

Rowe et al.[11], made welds with dissimilar filler metal and hydrogen in the shielding gas and found the cracks induced by hydrogen occurred in the martensitic zones of the weld metal and along the fusion line. In other experiments reported that the austenitic weld metal did not reveal martenstic structures nor transformations induced by deformation. [3]

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Experimental work

Materials

Carbon and alloy steels are more frequently welded than any other materials due to their widespread applications and good weld ability. Both base metals were of two different composition of steel. Filler metals used was ER309L, where E stands for Electric Arc Welding, R shows its coating composition that is Rutile based having Rutile Major component Specific compositions of both base metals and filler metal are shown in the table 1

Elements / Metals	C	Si	Mn	P	S	Cr	Mo	Ni
Base metal 1045	0.456	0.2327	0.68	0.0086	0.0057	0.0381	0.007	0.0255
Base metal 20MnCr5	0.19	0.388	1.288	0.0279	0.024	1.119	0.0243	0.0672
Filler Metal ER309	0.1432	0.541	2.059	0.0212	0.0062	21.30	0.1661	11.55

Table 1 Composition of base metals and filler metal (weight %)

3.2 - Edge preparation:
Twenty millimeter thick having length 200 millimeter, breadth 100 millimeter samples of both kinds of steels was taken. Then samples were first cleaned and their edges were prepared using Shaping machine to make a Double V joint having bevel angle of 60 degree and root face of 2 millimeter for proper penetration and fusion as shown in figure 1. Filing was also carried out to remove burrs and sharp edges of prepared specimens and to clean any dirt or any other foreign materials like oil, grease etc

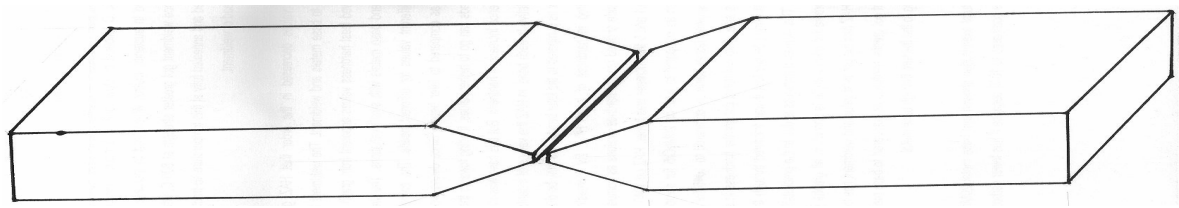


Figure 1 Specimens after Edge preparation.

Welding:
Samples were welded using Shielded Metal Arc Welding process (SMAW). A DC Generators was used as a source of power supply and with reverse polarity to ensure full penetration and fusion as pieces were too thick. 30 volts and 110 Amperes current was used in flat position to ensure maximum soundness.

Radiography:
The specimens were examined by X-ray radiography to observe internal defect. X-ray radiography was carried at Inspectest Private Limited Feroozpur road Lahore.

Preparation of Samples:
These perfectly sound welds were cut into small pieces to be suitable for tensile test, hardness test and for Metallographic. Tensile specimens were cut and prepared to fixed size having 50 millimeter gauge length and uniform cross section as shown in figure 2.Small tolerance (0.5mili meter) was added in dimension of prepared samples

Post Weld Heat Treatment:
Prepared specimens were then post heat treated for the same time interval at different temperatures. All specimens were heated to the temperature and cooled in furnace. Detail of post heating temperature, homogenization time and soaking time is shown in table 2

Table 2(Schedule of PWHT)

Sample #	Temperature (C)	Homogenization Time(min)	Soaking Time (min)	Total time (min)
1	As welded	-----	-----	-----
2	200	20	60	80
3	350	18	60	78
4	500	15	60	75
5	650	13	60	73
6	800	10	60	70

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Mechanical Testing:
Transverse Tensile Test:
Tensile test for each sample was performed using Universal Testing Machine. Length of tensile test specimen was 200mm and 50 mm gauge length and cross sectional area 130mm^2 as shown in figure 2

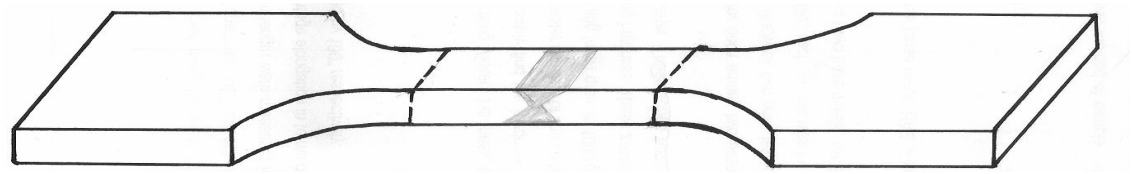


Figure 2 Tensile test specimen cut from welded sample.

Hardness Test

Samples were tested for hardness using Micro hardness tester and Rockwell hardness tester (C scale). Micro hardness tester use 1000gm load and square based diamond pyramid and Rockwell C scale uses 150 Kg load and diamond indenter. Hardness was measured from different zones of specimens in order to study relative behavior of specimens.

Results and Discussion:

Results:

Variation in Percentage Elongation:

Measured values of change in length of different samples during tensile test is tabulated in table 3 and graphically represented in figure 3.

Table 3 (Percentage elongation)

PWHT Temperature C	Original gage length(mm)	Final gage length(mm)	Change in length(mm)	%age Elongation
As welded	50	53.24	3.24	6.48
200	50	55.04	5.04	10.08
350	50	55.16	5.16	10.32
500	50	55.42	5.42	10.84
650	50	56.00	6.00	12.00
800	50	61.46	11.46	22.92

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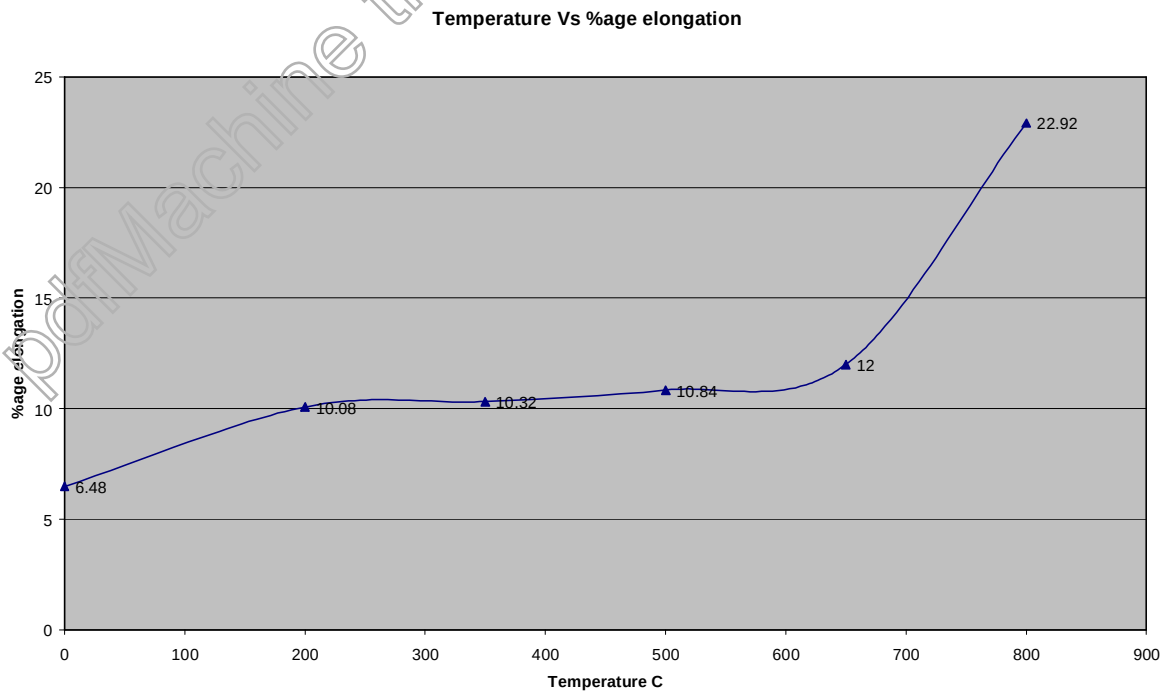


Figure 3

Variation in Strength:
Changes in tensile strength produced during PWHT are tabulated in table 4 and graphically represented in figure 4

Table 4 Variation in tensile strength

PWHT Temperature ^{0}C	X-Sectional Area (mm^2)	Ultimate load (kg)	UTS (kg/mm^2)
As welded	105.36	6920	65.68
200	118.06	8140	68.94
350	104.81	7260	69.26
500	117.85	8100	68.73
650	130.95	7740	59.11
800	106.21	6300	59.37

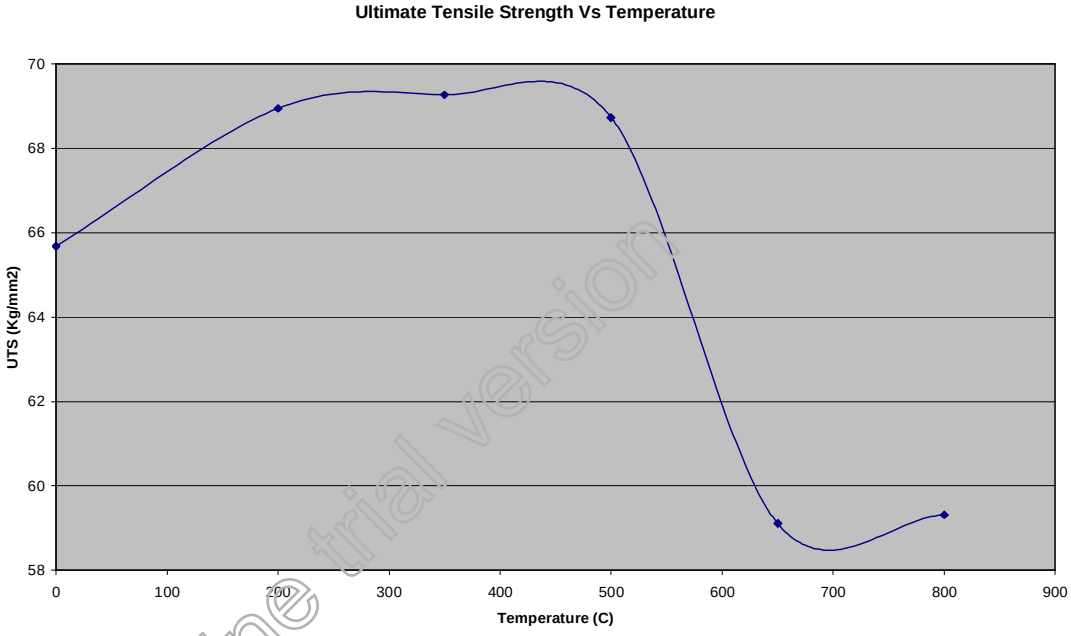


Figure 4

Variation in Hardness:
Variation of hardness in different zones at different temperatures is tabulated in Table 5 and graphically represented in Figure 5. Variation in hardness over the cross section of specimen in the zones of heat affected zone (HAZ), weld metal (WM) and base metal(BM) is illustrated in tables 6, 7 and in figures 6 and 7 respectively.

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Table 5 Hardness (HRc) at different zones of each specimen

Temperature (C)	BM 1045	HAZ 1045	WM	HAZ 20MnCr5	BM 20MnCr5
As welded	20.5	23.0	8.5	25.1	7.5
200	22.5	23.7	10.6	23.5	11.5
350	22.5	22.8	9.1	24.7	10
500	17	21.3	10.3	23.6	10.5
650	7	12.4	8.8	10.3	0.5
800	1.5	3.2	4	0.5	1.5

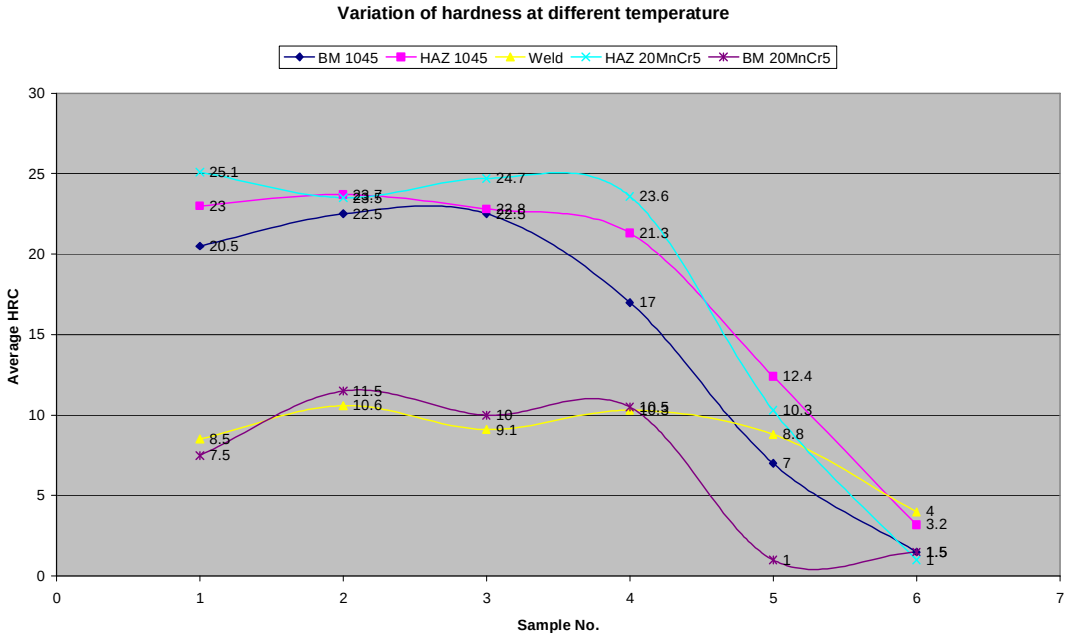


Figure: 5

Table: 6 Variation of hardness in HAZ 1045 over cross section

PWHT Temperature (^{0}C) / Distance (mm)	As welded	200	350	500	650	800
2	31	30	30.5	27.5	17.5	1
4	27	29	19.5	25	16	2
6	18	23	19.5	20	15.5	1
8	19.5	19	23	19.5	13	5
10	19.5	20	22	16.5	12	4.5
12	18.5	21.5	20	17	11.5	4.5
14	20	21	27	18.5	10.5	4
16	28.5	29.5	30.5	23.5	12.5	4

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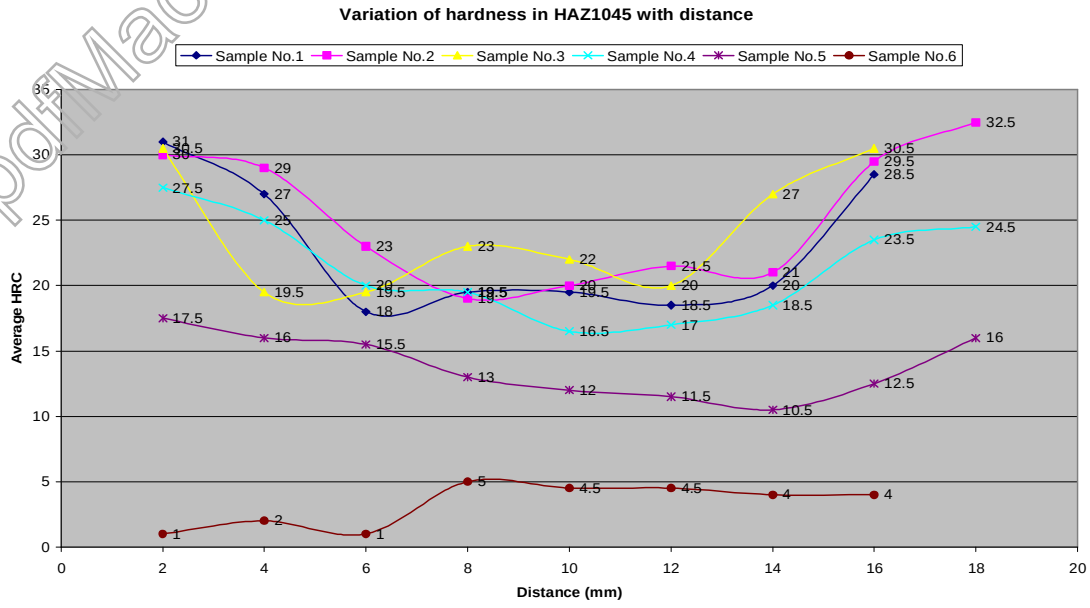


Figure 6 (Distance 10 mm is center of specimen)

Table: 7 Variation of hardness in weld metal over cross section

PWHT Temperature (^{0}C) / Distance (mm)	As welded	200	350	500	650	800
2	4	3.5	3	6	3	2
4	6.5	9.5	9	8.5	9	2.5
6	12	12.5	12.5	13.5	10	7
8	11	14.5	15.5	14.5	13.5	7.5
10	15.5	17.5	15.5	16.5	13.5	6
12	10	12.5	9	9.5	8.5	6
14	7.5	9.5	7	8	8.5	4
16	1	9	5.5	6		

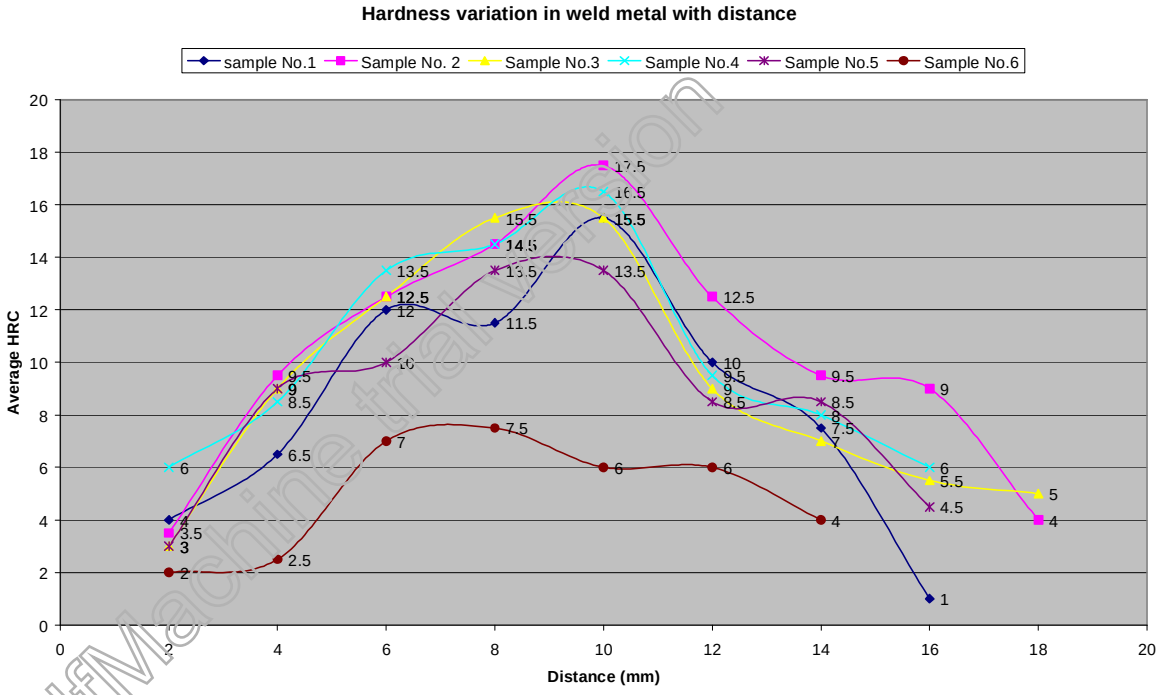


Figure 7 (At 10 mm is center of specimen)

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Discussion

The results show that as the temperature of PWHT increases, there is a notable variation in mechanical properties of all zones (i.e. weld, HAZ and base metal). Strength and hardness decreases slightly up to a certain temperature and then drop suddenly. While ductility increases slightly up to 500C and then it increases sharply.

Strength Behavior:

Tensile strength decreases gradually from sample #1 (as welded) to sample #5 (post heated at 650C). This is probably due to the removal of residual stresses by thermal energy received. First five samples were fractured from weld metal (fusion zone). While sixth sample (post heated at 800C) shows a sudden drop in tensile strength but it didn't fracture from fusion zone The reason for sudden drop in tensile strength is quite understandable. As the sixth sample was

post heated above transformation range and it was cooled in furnace, it got full annealing giving coarse and soft structures (pearlite plus ferrite) in base metals while austenitic stainless steels also shows decreased hardness but slope of curve was smaller as compared to the base metals this whole behavior is indicated in figure 4

Ductility Behavior:
Ductility measured in term of percentage elongation and a graph constructed between percentage elongation and temperature of PWHT shows that with increase in PWHT ductility increases slightly from 6.48% to 12% but in case of sixth sample it increases abruptly to 22.92%,also indicated in figure 3. Increase in ductility below transformation range was due to removal of residual stresses while abrupt increases is due to full annealing of sample giving softest structure.

Hardness Behavior:
Different hardness graphs are constructed to relate hardness variations in different zones with temperature of PWHT. Figure 5. shows relationship between Rockwell hardness of all zones that are base metals, heat affected zones(one on 1045 base metal side other on 20MnCr5 side), weld metal and PWHT temperatures, which illustrate that with increases in PWHT temperature hardness of base metals decreases but base metal 20MnCr5 has comparatively lower hardness values than base metal 1045 which is due to less amount of carbon contents in 20MnCr5 (that is 0.20% as compared with 0.46% of 1045) but decrease in hardness is due to softness created by tempering effects and annealing. Behavior of hardness of HAZ is some what similar to strength variations; it does not show considerable decrease until sample #5 and #6. Here is an interesting point to note that HAZ hardness of 20MnCr5 is greater than HAZ of 1045 opposite to Base metals but after PWHT temperature of 600C it decreases more steeply as compared with 1045 treated at and above 600C. A possible reason for such an interesting behavior is that 20MnCr5 steel contains 1.15% Chromium that may have played its role to form Chromium carbide which makes HAZ harder but after temperatures of 650C it dissolved (as it was furnace cooled) and induces softness as compared with 1045 HAZ. Hardness of weld metal changes very little with PWHT which indicates ER309 stainless steel is less hard materials with good ductility and it is much less sensitive to PWHT temperatures than carbons steel base metals and their HAZs. Because it is austenitic grade which does not changes in its structure with temperature. It shows very little variation in hardness but heating above transformation range its hardness decreases to 3.2HRC from average 9.5HRC. Ratio of variation in the hardness is much less as compared with HAZ and base metals. It is due to the fact that austenitic stainless steels are not affected to larger extent by heating below transformation temperature. But heating in transformation range coarsens its grain size which tends to make it softer comparatively.

Another very interesting relation observed in case of hardness of each sample from one surface to other side both in case of HAZ and weld metal over the cross section of welds and HAZ. It shows that hardness of HAZ of each sample is maximum near surface and it decreases towards its core having minimum at center and again it increases to maximum towards other surface. This interesting behavior is probably due to the fact that in case of multipass welds this variation is supposed to be due to the tempering effects produced by welding heat on HAZ previously produced. As base metals are carbon steels this tempering affect helps to soften the HAZ producing such a hardness profile. But in case of weld metal this effect is exactly reverse of HAZ, hardness is maximum at core of weld and it decreases towards surfaces. This is due to the fact that when previously deposited beads of 309 stainless steel were heated by heat generated by subsequent welding passes it is quite possible that dissolution of delta **(□)** ferrite occurs because this region is reheated below the gamma **(□)** solvus temperature, This makes it susceptible to fissuring under strain, due to lower ferrite and reduced ductility which is possible reason for more hardness observed in the internal beads. This is shown in figure 6 and 7

Conclusion:

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This paper investigates the possibilities of using post weld heat treatment ("PWHT") for reducing residual stress and hardness and thus improving ductility of weld produced by using two different compositions of carbon steels(having same P number) welded by ER309 electrodes.

Key findings are that,

a) Tensile strength losses during PWHT cycle and that loss depend upon PWHT temperature. Tensile strength decreases drastically above 600C so if some manufacturer needs to obtain good tensile strength in welded component, it is not recommended to PWH treat above 500C.

b) Ductility increases with increase in PWHT temperature but heating above transformation range is not suitable as it gives extra softness but at the same time it is not economical to heat components in the transformation range.

c) Hardness has some what strength like behavior for HAZ and base metals but optimum condition seems in range of 350C to 500C with acceptable combinations of mechanical properties for most of applications.

d) It is observed that Austenitic stainless steels are much less affected by PWHT as compared with carbon steels as they have very good weld ability, so if austenitic are to welded or some where used as filler metal it do not need to be Post heated

e) It is also evident from experiment that in case of multipass welds across the cross section of welded component mechanical properties vary (specially in zones of HAZ and Fusion Zone) giving non uniformity to mechanical properties. So single pass welds will have to be preferred on multipass welds. In case thick pieces to weld use Submerged Arc Welding Process (SAW) where we need homogeneous properties across the cross section of weld (as with the help of SAW it is possible to weld even thick pieces in single pass without any difficulty)

f) With increase in temperature of PWHT chances of brittle fracture decreases.

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PROSPECTS OF RAIN WATER HARVESTING FOR PROMOTING AGRICULTURE AND LIVESTOCK RAISING

By

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ABSTRACT

Almost 25-35% of total rain water is lost in the form of surface run off causing flooding & soil erosion in the down stream areas. Conserving this water cannot only solve the problem of water shortage for crop & livestock raising and other household needs but also can reduce soil erosion & protect the environment. Investment in this indigenous system can give best results in the areas with brackish underground water. Out of the total arid land of 70million hectares outside Indus Basin, only 18 million hectares need special attention to alleviate poverty in the area. Rain water harvesting for irrigation and drinking water has a vast potential for the area.

1. INTRODUCTION

Rain harvesting system is in fact, an ancient form of water management that is unique to semi-arid environments. In this system rain/flood water is diverted from the streams with the use of dams, embankments, small channels and used for irrigating fields and livestock raising. It serves local farming systems, range lands as well as drinking water supply – either directly or through the recharge of shallow aquifers. Few people in the country are aware that the rain water harvesting in Pakistan is the second largest system after the Indus Basin Irrigated Agricultural System, providing food and livelihood to million of people – often the poorest of the poor. This system is completely dependent on water that comes from seasonal rains.

Pakistan falls in the arid & semi-arid climatic region and about 11 million hectares of Pakistan are under main deserts namely Thar, Cholistan, Thal, Chaugi and Kharan making 14% of the whole country. These deserts have acute shortage of water supplies and often result in mass migration of inhabitants for search of food and fodder. In deserts, primary source of water is rainfall and underground water are mostly saline. These areas have acute shortage of water supplies and when there is no rainfall in deserts, it causes drought and famine. The years without rain reduce grazing lands, increase livestock mortality and add untold miseries to human beings.

In these areas, the millions of people depend on rain water for their domestic water needs and rain is not a regular phenomenon throughout the year. Rain water harvesting is the only possible choice, which can solve their problem of water scarcity but unfortunately it is often overlooked by planners, engineers and builders due to lack of information. It has been estimated that almost 25-35% of total rain water is lost in the form of surface run-off and causes flooding and soil erosion in the down stream areas. Conserving this water can not only solve the problem of water shortage for crop & livestock raising and other household needs but it will also reduce soil erosion and protect the environment.

As population of the country continues to increase, the necessity for an increased food supply will require the use of marginal and desert lands for livestock & farm production. The saline groundwater cannot be used for human & animal consumption & for growing crops & trees. To combat this problem water harvesting techniques have generally been used to get water for sustenance of life.

Pakistan is facing a potential environmental catastrophe as a result of climatic change affecting water supply in many parts of the country. Rainfall is becoming more erratic with less water supply in the rivers. We clearly need to invest in this indigenous method of irrigation which is

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sustainable in the long run and can be adopted with better technology in a country that is largely dependent on agriculture for its well being.

2. RAINFALL IN PAKISTAN

Rainfall in Pakistan is low and irregular. Most of the rainfall occurs in monsoon season of July to September. Both the intensity and volume in the monsoon season are high and could be utilized by crops. The contribution of rain to crops in the irrigated areas of Indus Basin has been estimated at about 7.55 MAF. The contribution of rains to crops in barani areas has been estimated at about 6 MAF. On the whole more than half the country receives less than 205 mm(8 inches) of annual rainfall. In non-irrigated areas (Barani areas) rainfall is utilized for rain fed agriculture and for meeting the drinking water needs of people and livestock. The historic rainfall for 18 year (1991 to 2008) is summarized on annual basis in Table-1. The spacial rainfall varies widely in the country as depicted in Figure-1. The results show average annual rainfall of 893 mm with the minimum 448 mm in the year 2000 and maximum 1140 mm in the year 2003.

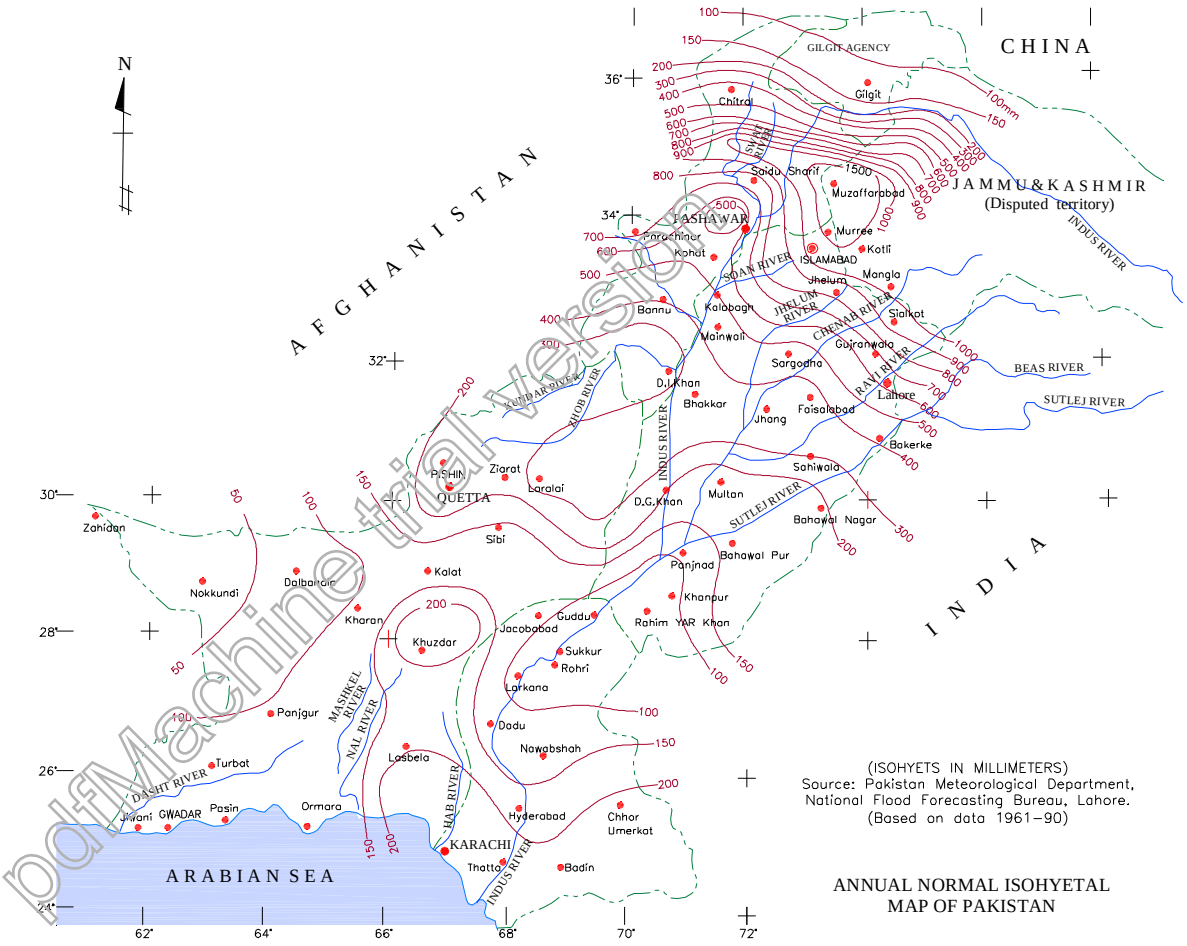


Figure I

Normal Annual Rainfall and Index of Wetness

Average or normal annual rainfall is the average of annual rainfall totals over a considerable period of years. The index of wetness (I_w) is the ratio of actual rainfall in a given year at a place to the normal annual rainfall of that place. Index of wetness, thus, gives an idea of the deficiency of rainfall and wetness of the years; a 60% index of wetness indicates 40% deficiency of rainfall. According to Garg (1987), a deficiency of about 30-45% is a large deficiency and more than 60%, a disastrous deficiency. Year with the index of wetness equal to '1', is called normal or average year.

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Table-1 Annual Rainfall and Index of Wetness

Year	Annual Rainfall (mm)	Index of Wetness	Remarks
1991	1134	1.27	Wet Year
1992	915	1.02	Wet Year
1993	886	0.99	Dry Year
1994	950	1.06	Wet Year
1995	1103	1.24	Wet Year
1996	864	0.97	Dry Year
1997	1110	1.24	Wet Year
1998	913	1.02	Wet Year
1999	907	1.02	Wet Year
2000	448	0.50	Driest Year
2001	543	0.61	Dry Year
2002	674	0.75	Dry Year
2003	1140	1.28	Wettest Year
2004	651	0.73	Dry Year
2005	895	1.00	Normal Year
2006	859	0.96	Dry Year
2007	1098	1.23	Wet Year
2008	981	1.10	Wet Year
Average	893	-	-

3. RAIN HARVESTING POTENTIAL AREAS

Cholistan Desert

Water from rainfall run off available from 441900 hectares in Cholistan desert varied from 166 m^3 in 1989 to 663 m^3. This water could not be harvested and stored properly for beneficial uses like agricultural production which could result in improvement in the socio-economic conditions of the people and environment.

Pothohar Area

The pothohar area lies between Jhelum and Indus rivers in the Rawalpindi Division. The topography of the area is undulating and gradually sloping from north-east to south-east with deep incised river valleys. The rainfall ranges from 1000 mm in the north-east to 350 mm in the south-east Agriculture is mainly rainfed and crop yields are very low due to shortage of water. The rainfall received during monsoon season (July – September) is 75% of the annual rainfall. Run off available in Pothohar Plateau is about 3.50 MAF (4.31 BCM) out of which 0.10 MAF (0.123 BCM) is being utilized by means of mini dams and small dams and balance 3.40 MAF (4.18 BCM) is going to river Indus and Jhelum. The proper harvesting of this available run-off could bring about a green revolution the area.

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Kharan Closed Desert Basin

Kharan Closed Desert Basin constitute vast tract of barren lands comprising the north western part of Balochistan. The area is surrounded almost on all sides by overlapping ranges of dry mountains, out of influence of monsoon and westerly disturbances. It is an area of closed drainage whereby streams drain into swamps of Murgha and Mashkhel that often dry after low precipitation spells. Nevertheless heavy rainfalls occasionally produce heavy floods which go waste because of lack of conservation structures constructed in the area to conserve flood flows.

Makran Coastal Basin

Makran Coastal Basin encompasses an area of about 123050 Sq. Km (47500 Sq.miles). Physiographically, the area possesses a series of mountain ranges, vast alluvial plains and plateaus. The ranges give rise to a number of rivers and hill torrents of various sizes which do

not have a common drainage and individually outfall into the Arabian Sea. Mean annual precipitation in the area varies from 125 mm to 200 mm with an average of about 150 mm. The area is predominantly under the influence of monsoon which occasionally generates flash floods causing inundation of large areas and damage to village abadies, agricultural areas and infrastructure. Major part of runoff from the precipitation is wasted into Arabian Sea unused. The flood flows can be managed by constructing diversion weirs and delay action dams.

Water Potential of Hill Torrents

Hill torrent of Pakistan compasses over 65% area of Pakistan. Hill torrents generate run off of which about 18 MAF can be conserved for development of sustained irrigation system and for embarking upon other socio-economic activities for the uplift of the areas. This consists about 16% of the total canal diversions and 22% of actual diverted water available at the farm gate. Thus flood flows of hill torrents offer great perspective for development to meet growing demand of water for agriculture. Harnessing of flood flows of hill torrents is, however, a complex undertaking due to large variation in peak to normal flows, high sediment load and spacial and temporal mismatch with crop water requirements. Hill torrents are innumerable throughout the country and can be grouped in different zones as detailed in Table-II and depicted in Figure-II.

Table-II Hill Torrents Areas of Pakistan

Sr.No.	NWFP	Punjab	Sindh	Balochistan
1.	D.I. Khan	D.G. Khan	Kirthar range	Indus Basin Components(IBC) INCLUDING Quetta region
2	Hazara-Kabul-Bannu Basin(HKB)	Pothowar Doab	Karachi area	Kharan closed desert Basin (KSD Basin)
3	FATA	Rechna and Chaj Doabs	Sehwan and Pataro area	Makran Coastal Basin
	Annual Run Off (MAF)			
	13.71	3.81	7.86	0.728

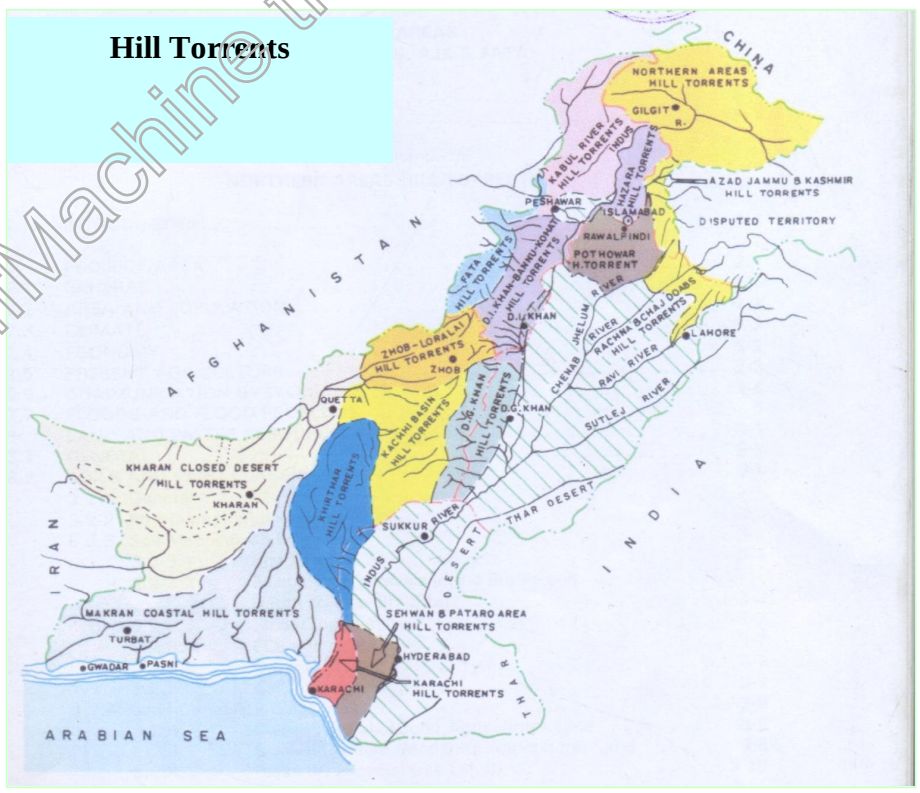


Figure II

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Opportunities

In view of recurring shortage of food grain in the country, there is growing pressure to use all resources of water. Flood flows of hill torrents offer considerable prospects for development to meet growing demand of water for agriculture. Large amounts of floods flows are annually lost un-conserved resulting in serious damage to the areas. This water if properly harvested offers good opportunities to involve village communities in low cost self help schemes for drinking water, cattle water or agriculture. The technology originates from the arid zones and is strait-forward, cost-effective, small-scale, environmental friendly and attractive for rural populations. Erratic low rainfall and water harvesting should be used in wet years to build up storage for dry years. An alternative source of water such as a tubewell is important.

Practices & Techniques

Rainwater harvesting is a challenging task. Uncertainty of incoming discharges, high sediment / transport and excessive velocities are among the factors contributing to the complexity of this problem. Food management of hill torrents can be achieved through structural measures but most commonly used technology is through structural means involving engineering solutions to the problem which comprise the use of any one or combination of the following techniques:

- Storage/recharge dams
- Diversion weirs
- Flood walls
- Channelization
- In situ water harvesting(Contour furrowing, contour benching & bed furrow)
- Village ponds for rain water storage
- Roof rainwater harvesting (domestic purposes)
- Injection well for groundwater recharge in mega cities.

These measures not only furnish rain water for irrigation and / or groundwater recharge but at the same time provide safety from the damaging effect of flows. Such a solution for post areas, has to be combination of more than one of the above techniques.

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4. LIVESTOCK AND CROPS SCENAIRIO – CONSTRAINTS & PROSPECTS FOR ARID & SEMI ARID AREAS OUTSIDE THE INDUS BASIN

Pakistan has been hit hard due to continuous droughts and has been in the grip of dry spell during the previous years. Reservoirs, dams and rivers have been dried up. Extensive pumping and exploration has pushed the groundwater table deep down. Summer span has become long and monsoon rains come at a small scale and after long intervals. Winter rains have become the story of the past. We are not keeping pace with the recent ecological and climatic changes. Resultantly, in some parts of the country like Cholistan, Balochistan and Thar, hundreds of people have lost their lives and millions of animals have died. The death toll may rise due to sever shortages of water and non availability of fodder & pastures.

Arid and semi arid areas (rainfall from less than 100 mm 500 mm) constitute about 70 million hectares of the country's total geographical areas 79.6 million hectares. Out of these 40.9 million hectares (51.5%) are arid lands including 10.6 million hectares of hyper arid sandy deserts and 29.3 million hectares (36.8%) are semi arid. Viurtually the entire Northern areas, Balochistan, southern part of NWFP, central and southern parts of Punjab and a major area of Sindh are arid or semi arid. Of the arid land of the country 18 million hectares presently irrigated in the Indus Basin and 52 million hectares still arid or semi arid is mostly outside the Indus Basin.

It is the 52 million hectares, which needs very special attention because of extreme poverty and lack of livelihood opportunities where local scarce water resources need to be harnessed because major economic activity in these area is crop and livestock production and over grazing of depleted rangelands. These dry-lands produce over 10% of the total national wheat production, 27% of maize, 56% of sorghum and millets., 52% barely, 90% of guar-seed, 77% of

gram, 89% of pulses, 24% rape and muster seeds, 89% of ground nuts and 100% of caster beans. Similarly, out of a total population of 143 million heads of livestock in the country, 94 million are fed by arid or semi arid ranges, that provides 60% to 90% of their feed.

Their main water source is rainwater and groundwater. To give an idea, 10 mm of rain is equal to 100,000 liters of water per hectare. Harvesting of this water is key to the development of the areas. Rainwater can be harvested in areas receiving as little as 50-80 mm of average rainfall. Presently it is estimated that not more that 20% - 25% of rain water is harvested with current practices, while modern harvesting techniques in many parts of the world enable to capture almost up to total rainfall. With such additional water we can considerably increase crop production and reduce poverty in these economically depressed areas.

Considering that the Indus Basin's water resources are already over committed, and in the absence of new reservoirs, improved practices and water savings, the system's capacity to meet future demands remains limited. In the case of rural areas, pockets of extreme poverty are still found in the arid and semi regions outside the Basin where natural land and water resources are fragile, seasonal and inadequate. This leads to movement of populations to rural and urban areas within the Basin. With limited water prospects in the Basin this additional burden is increasingly becoming difficult to absorb. Therefore, local development of water resources outside the Basin in these catchments is imperative. Recent experiences involving communities in the development and management of water offer promising hopes whereby much can be achieved if communities are organized, trained, their capacity enhanced and supported with appropriate technological packages and access to resources. It is also seen that they are willing to use substantial resources of their own in developing water resources.

The Way Forward

Water is undoubtedly emerging as a very critical and misused natural resource. Wastage, over exploitation, pollution and depletion of available fresh water poses serious threats to mankind. According to the UN, there are about 1 billion people today who live in chronic water stressed regions, and it is estimated that this will go upto 3.5 billion by the year 2025. The situation in Pakistan is not much different. The limited extent of our resource and the complex nature of its occurrence make a simple solution impossible. We have to address issues of the water sector on several fronts. These are briefly described as follows:

- Improve water use and system efficiency
- Move towards sustainable groundwater management
- Make adjustment to land use patterns
- Improve irrigation and cultural practices
- Improve drought forecasting and management
- Promote rainwater-harvesting technologies
- Promote use of waste water for agriculture
- Promote biological approaches for rehabilitation of saline lands
- Harness the full potential of small basins outside of the Indus Basin

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DESIGN AND FABRICATION OF SILT DENSITY INDEX METER

By

A. Mashiatullah, R. M. Qureshi and Maaz Khan[1]

Abstract

Suspended solids and colloidal materials in feed water are one of the biggest problems in reverse osmosis systems. Even though most systems have some pre-treatment including 5 micron pre-filters, these fine particles are responsible for fouling of reverse osmosis membranes. In order to have some measure of the degree of this fouling problem, a concept called Silt Density Index (SDI) is used. Here a 0.45 micron filter is exposed to the feed water under constant feedback pressure and filtration rates are calculated. An apparatus was designed and fabricated for determination of silt density index of low turbidity water samples used in industrial processes such as thermal power plants etc. on commercial basis. The apparatus was mainly fabricated by machining carbon free stainless steel. Some attachments like pressure gauge (dial gauge), the pressure regulating valve and water flow control ball valve were also made of high quality stainless steel and procured from local market. The bottom filter was made of Nalgene (high quality PVC material) material. All joints were sealed with Teflon™ tape. Pressure was applied through a noiseless mini air compressor. The entire assembly was held onto a mobile stand. Sample water was allowed to flow through the system at constant feedback pressure of 30 psi. The feedback pressure was regulated manually using the pressure regulating needle valve. The bottom filter of the flow-through column employed a 47 mm nitrocellulose membrane. High purity standard stock water was prepared by filtration of de-ionized distilled water through 0.2 micron (Sartorius) nitrocellulose filter paper. Laboratory tap water was used as test sample. The instrument was partly tested for routine use. The SDI meter is being used for routine measurement of *silt density index* in domestic and industrial process water samples.

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Introduction

Reverse osmosis (RO) is the first major step for a water purification system that is to produce high purity water. However, the quality of the water being fed into the RO membrane is critical to the RO membrane's performance and lifetime. Silt density index (SDI) is used to evaluate the suitability of water for RO. Most RO membrane manufacturers state a maximum value for SDI, usually 5, for the influent water. Water that exceeds this SDI value is considered unfit for RO, and using high SDI water will usually void the RO membrane warranty. On the other hand, using low SDI water is observed to extend, sometimes double the lifetime of the RO membrane[(2)].

The quality of the source (usually city) water can be quite variable. If the water is obtained from a well tapping aquifer, the source water can have a low SDI, from 3 to 5. When the source water is obtained from a lake, river, or reservoir, the SDI is quite high.

Table-1 gives the source and SDI values of city water from four cities. The pressure regulator should be adjusted to yield a constant 30 psi feedback pressure. A 0.45 um cellulose acetate analysis membrane is used. It is installed in the holder with the shiny side facing upward. The schematic diagram of the SDI meter is shown in Fig. 1. The SDI is measured from the decay in the time required to fill a 500 mL container, according to ASTM D4189-82 (1) as follows:

$$SDI = \%P_{30}/T = 100(1- t_i/t_f)/ T$$

where:

$\%P_{30}$ is the plugging rate at 30 psig feed pressure, T is the total elapsed flow time (usually 15 min), t_i is the initial time required to collect 500 mL of sample, and t_f is the time required to collect 500mL of sample after test time T.

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Frequently the SDI test membrane is observed to plug (where pluggage is defined as 20 seconds between drips) before 15 minutes has elapsed. Then the Modified SDI is calculated as follows:

Modified SDI = 100/Time to pluggage (minutes)

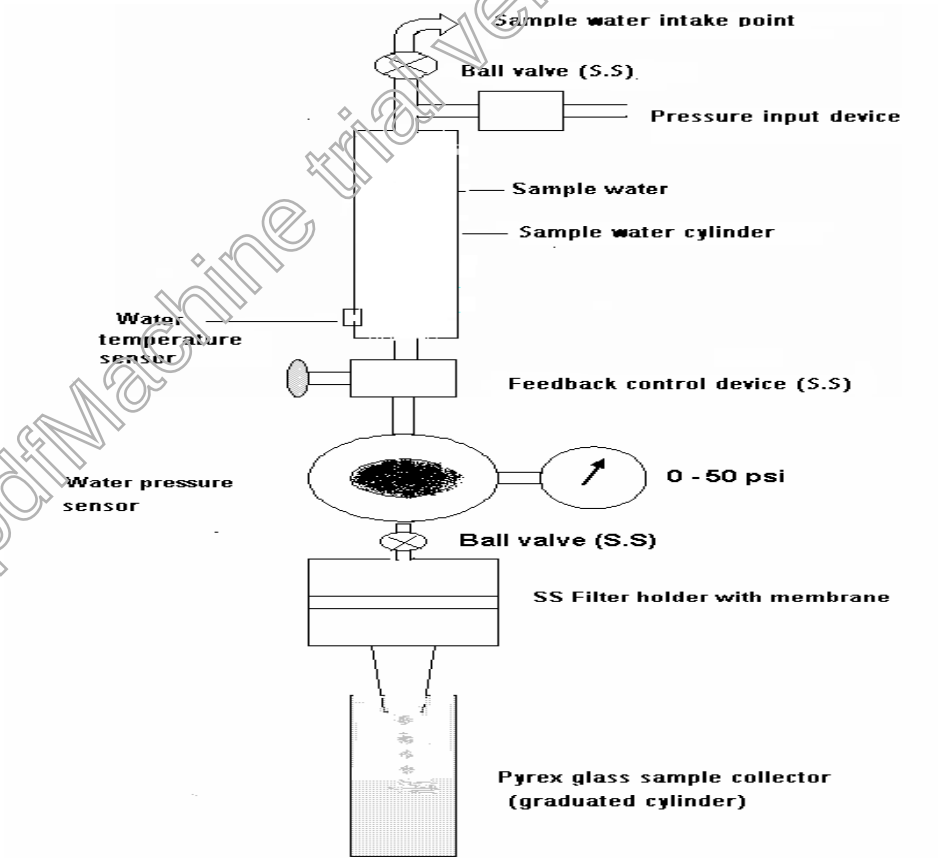
For example, when the test membrane plugs in 10 minutes, the modified SDI is 10. A 6-cartridge housing with 20" elements filter housing (manufacturer: Ahlfinger) was used to evaluate pre-RO filters. The output of the housing is 30 gpm, and 20 gpm of this goes through the RO membrane immediately downstream of the pre-RO filter housing. The SDI of the effluent water was measured immediately upon installation of the pre-RO filters and periodically afterwards, usually at intervals of 1 to 3 days. The throughput of water through the filters and the pressure drop across the filter housing were also monitored.

Table1: **Ranges of Silt Density Index (SDI) corresponding to various sources of waters in four cities**

City	Water Source	SDI
Albequerque	*Deep Wells (ground water)*	*3-5*
Lubbock, TX	*Lake Meredith*	*6-20*
Dallas, TX	*Mixed Well/Reservoir*	*6-20*
Juarez, Mexico	*Normal Wells*	*4*

Design Features of SDI Meter

The apparatus for measuring SDI essentially consists of a vertically erected stainless steel (SS) made flow through column assembly. The SS Ball valves are used to control the water flow into or out of the system. A pressure gauge (SS) measures the working



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Figure 1 :Schemetic diagram of the SGI-Meter

pressure with a precision of more than ±0.1 psi during SDI measurements. The pressure is provided with a mini air compressor and maintained at 30 ±0.1 psi with the help of a feed back pressure regulating device. A nitrocellulose membrane filter (0.45 micron grid type sterile membrane filter) is used to collect the silt fraction onto the filter paper placed on top of filter disk holder under a constant applied pressure, the sample water is allowed to flow and the filtered water is collected in a graduated 500-ml glass cylinder. The time for collection of 500ml water is measured with a stopwatch.

During experiment, the temperature of the system is maintained within ± 1 ^{o}C. For SDI measurements, the flow through column is calibrated using specially prepared standard non-plugging water.

Sampling Details and Calculation of SDI

a) Sampling Details

PINSTECH Cooling Tower water was selected to Study SDI for 5, 10 and 15 minutes. Water samples were also collected from Satellite Town Tube well, Filtration Plant situated at Cant area and Rawal Dam Filtration Plant. SDI of 12 groundwater samples from Lahore was also calculated[(1)].

b) Calculations

The Silt Density Index SDI_T at a specific temperature T is calculated using the following equation:

$$SDI_T = \% P_{30} / T$$

where:

$$\% P_{30} = [1 - (t_i / t_f)] \times 100$$

and

% P_{30} is percent at 30 psi feed backpressure. t_i is initial time required to collected 500 ml of sample water. t_f is final time required to collect additional 500 ml of sample water and T is the total elapsed time (15 minutes).

Results and Discussion

The results obtained for different water samples points of Lahore and Rawalpindi area are shown below (Table 2 and Table 3).

Table 2: **SILT DENSITY INDEX (SDI) RESULTS of Lahore area Using ASTM Method D4189-82 (Re approved 1987)**

Location of water source	Sample No	Electrical Conductivity (µS/cm)	Temperature (^{o}C)		Silt Density Index (SDI_{15})
			Before SDI Run	After SDI Run	
Ground water from tube well	1.	507	24.8	24.9	3.82
	2.	471	24.8	25.1	3.15
	3.	418	24.9	24.9	4.37
	4.	452	24.9	25.2	3.69
	5.	507	24.9	25.1	4.87
	6.	506	25.1	24.9	3.82
	7.	416	24.9	25.1	4.32
Water storage pond/pool	8.	452	25.1	24.9	5.96
	9.	506	24.9	25.1	6.59
	10.	507	24.9	25.1	5.96
	11.	412	24.8	24.9	5.92
	12.	451	24.8	24.9	5.90

** SDI_{15} = SDI calculated using 15 minutes total elapsed time.*

** * Samples analyzed between 08-12 Nov., 2001*

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Table 3: **SILT DENSITY INDEX (SDI) RESULTS of Rawalpindi area Using ASTM Method D4189-82 (Re approved 1987)**

Location of water source	Sample No	Electrical Conductivity (µS/cm)	Temperature (^{o}C)		Silt Density Index (SDI_{15})
			Before SDI Run	After SDI Run	
PINSTECH Cooling Tower	1.	223	8.04*	8.12	5.32
	2.	273	4.72*	4.90	2.35
	3.	202	6.27*	6.45	4.52
Satelilite Town Tubewell	4.	352	4.35	4.41	3.29
Filteration Plant Cantt.	5.	375	4.11	4.11	4.50
Rawal Dam Filtration Plant	6.	406	4.17	4.20	3.82

* Mean of 5 analysis.

SI after 15 minute time elapsed is the more precise than 10 and 5 minutes. As the esirable SDI value is less than 5, so most of tube well water tested was found to be suitable for Industrial use/process. The surface water should be filtered before its use for industrial purposes. For Lahore area SDI value depends on the depth of the sampling point, so water quality increases with depth of the sampling point

References

1) ASTM D4189-82, "Standard Test Method for Silt Density Index (SDI) of Water."

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HARVESTING OF RAIN WATER FOR AGRICULTURE, RAISING OF LIVE STOCK & RECHARGING AQUIFER

By

Engr. Adul Rauf Chaudhry *

Executive Summary

Water is essential to all life – human, animal and vegetation. It is important that adequate supplies of water be developed to sustain such life. Unfortunately, while Pakistan is blessed with adequate surface and ground water resources, rapid population growth, urbanization and un-sustainable water consumption practices have placed immense stress on the quality as well as the quantity of water resources in the country.

Per Capita water availability in Pakistan has decreased from 5000 cubic meter per annum in 1951 to 1100 cubic meter in 2004 - 2005.

Due to rapid urbanization, infiltration of rain water into the sub-soil has decreased drastically and over pumping of ground water resource has diminished.

Rainwater harvesting is dual purpose phenomenon which can facilitate methodology of irrigating cropped areas and storing excess water to be used later.

In order to provide livelihood and to feed the growing population, visionary planning has to be done to optimize the use of existing water resources, to add new water storages, to replenish the ground water and to adopt new water efficient technologies for agriculture.
In this paper, it is endeavoured to study the use of rain harvesting for agriculture, live stock and recharging of ground water aquifer.

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Present Status of Water Resources

It is sad to see the growing water crises in Pakistan while Indus Valley has been the center of some of the World's greatest civilization. Harappa & Mohenjo Daro (2600 to 1900 BC) and Gandhara. (1st – 5th Century AD) and their social, agriculture and economic systems were based on their interactions with rivers, (Indus & its tributaries, including the Indus, Jhelum, Chenab, Ravi, Bias, and Sutlej and Kabul river etc.,) which provided irrigation and created fertile land for farming.

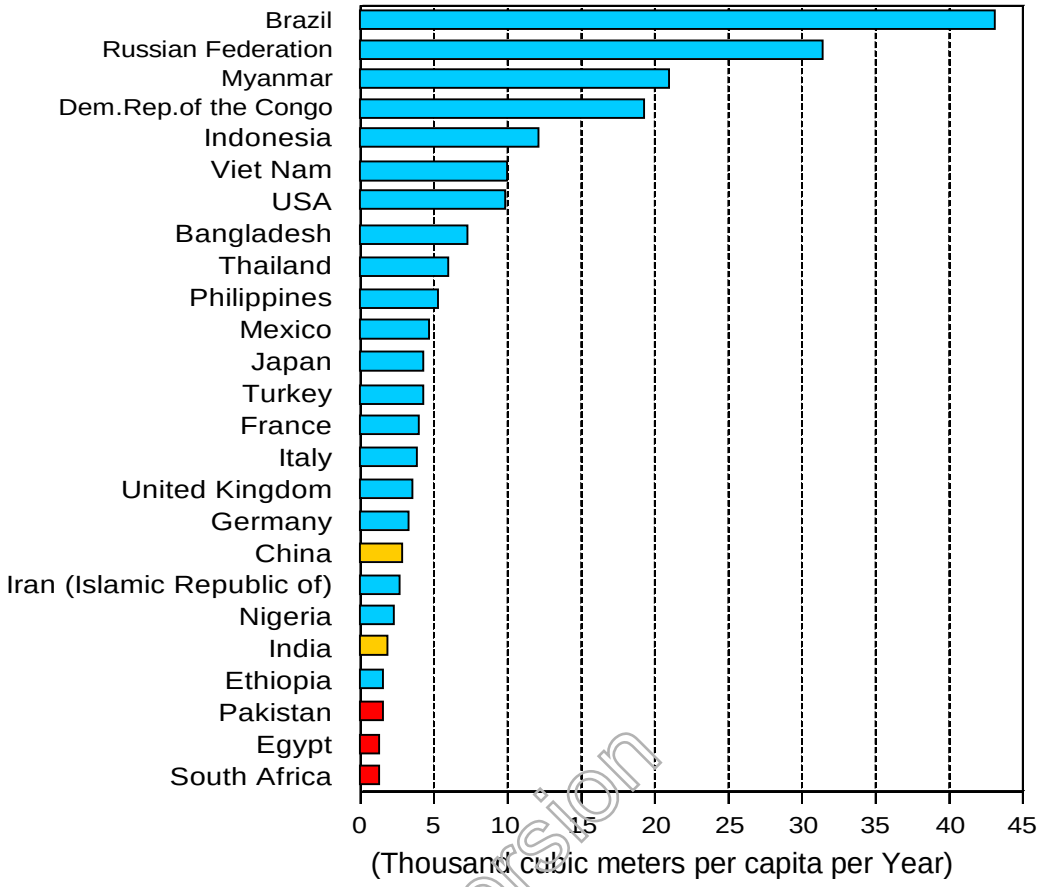
Pakistan is facing a severe water shortage and according to a 2006 World Bank report, the country is fast moving from being a "water stressed country to a water scarce country", and water is becoming the key development issue. The ground water is over exploited by tube wells, causing serious environmental problems in certain areas, where increased exploitation has caused water table to fall at an alarming rate of 0.3 m / year.

Among 25 most populous countries, shown above, South Africa, Egypt and Pakistan are the worst water limited nations. India and China are not far behind with per capita renewable water resources of only 1600 and 2100 m^3 per person per year [World Bank Report 2006].

According to the World Bank data, Pakistan only stores 30 days of river water, India stores 120 days, while Colorado River system in USA has storage capacity of upto 900 days of water usage (World Bank Data).

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The annual precipitation ranges from 100mm in parts of Lower Indus plain to more than 750mm near the foothills in upper Indus plain. Pakistan receives rainfall primarily in Monsoon season i.e. from July to September. Substantial part of the Monsoon run off is lost, which otherwise could be a great water resource especially in areas facing shortage. Besides constructing dams many developing countries have addressed their water shortage problem through innovations such as rainwater harvesting. Development in rainwater harvesting technologies helped the community to look for alternative sources that even allow the possibility of raising a second crop.

Many communities around the globe have harvested rainwater for their fresh water needs. Now communities affected by changing rainfall pattern are going for rainwater harvesting. The initial cost of installing rainwater harvesting systems looks expensive for an individual but it is beneficial in long run both economically and environmentally. It provides water at point of consumption and users have full control of their own system.

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Rain Water Harvesting

Rain water harvesting (RWH) is a method of inducing, gathering, sharing and storing local surface run off for specific purpose like agriculture, livestock, human consumption and ground water recharging.

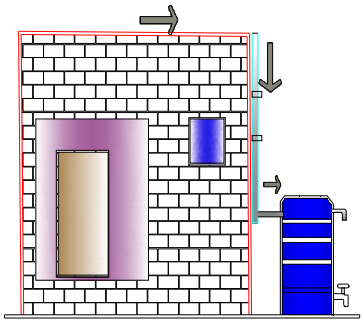
Rainwater harvesting is an efficient and economic method. Management through rainwater harvesting leads to soil and water conservation which have a positive effect on maintenance of soil nutrients and organic matter.

Rain water harvesting is on the revival in the World as it traces its history to biblical times. Extensive rain water harvesting apparatus existed 4000 years ago in Palestine and Greece. In ancient Rome, residences were built with individual cistern and paved courtyards to capture rain water to augment water from city's aqueducts.

There are two main techniques for rainwater harvesting.

1-Storage of Rainwater on Surface for future use.
2-Recharge to Ground Water.

1- Storage of rainwater on surface for future use:



Different water harvesting techniques like domestic roof water harvesting; terracing, ponds and cisterns etc., can be used. Water collected on roofs is directed into an underground storage tank for domestic use. The first flush of rainwater after a dry season should be allowed to run waste as it will be contaminated with dust, bird droppings etc .Roof area (2000sq.ft) of one kanal house will collect 1200 gallons of water after one inch of rainfall ,which is equivalent of 24 days of water demand for this house. This method has been in use in hilly areas (Murree) where rain water from sloping roofs is collected though vertical pipes to storage barrels for domestic use.

Terracing is especially effective in mountainous areas whereby terraced fields provide sufficient time for rainwater to intercept the soil. Ponds are used for agricultural purposes. These can be either excavated ponds, embankment ponds or excavated – cum – embankment ponds while the cisterns are underground masonry tanks used for drinking and domestic purpose.

Water harvesting is appropriate for large scale landscapes i.e. parks, schools, commercial sites, parking lots & apartment complexes.

Rain water harvesting can also be done in cultivated fields . Deep tillage increases soil moisture holding capacity, thus providing moisture for infiltration, and it increases the crop yields. Storage can be additional element. Rain water from roof tops, parking lots can be channelized to landscape holding area. Most important factor for amount of runoff is being amount of rainfall & its duration. The amount of water harvested depends on the amount of rainfall & its duration and on size, surface texture & slope of the catchment area.

Hillsides provide a perfect situation for moving water from a catchment area to a holding area. Channels, ditches can be used to move water. Perforated pipes, or drip irrigation systems can be designed to distribute water more efficiently. Parking lot curb cutout can direct runoff into planted area as being used in main dual carriage ways of Gulberg, Lahore.

One holding area or a series of holding areas can be designed to fill-up and then out-flow into adjacent holding areas through outlets for surplus water, which could be used for irrigation purposes.

Rainfall is the only fresh water source in Cholistan desert. [1] Cholistan is one of the main deserts covering an area of 2.6 millions hectares where water scarcity is the fundamental problem for human and livestock population as most of the ground water is highly saline. Therefore , rainwater harvesting in desert has special significance. Pakistan Council of Research in water resources (PCRWR) has been engaged since 1989 and developed ponds with different storage capacities ranging between 3000 and 15000 m^3. These ponds have been designed to collect maximum rainwater and to minimize seepage, polyethylene Sheet (0.127mm) is placed at bed level and plastering on side walls. These ponds are called “tobas” which are about 6 m deep. Pakistan Council of Research in Water Resources (PCRWR) has developed 92 rainwater harvesting systems in Cholistan desert. This brought socio – economic uplift to the community, saving millions of Rupees during drought period which otherwise would have proved catastrophic for the area.

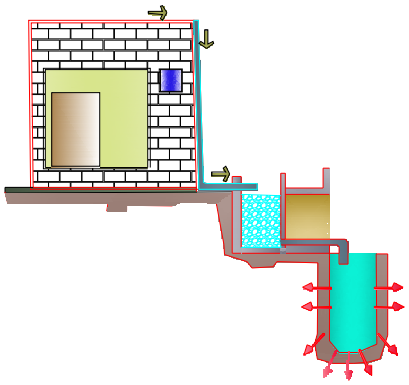
This project has saved 6000 million rupees per drought in the form of livestock production due to reduction in livestock migration, mortality, diseases and damage to crops. Increase in

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production of livestock has also been observed in the form of meat, milk and other products besides reduction of migration of human and livestock from desert towards irrigated area.[1]

2- Recharge to ground water:

It is a process by which the ground water reservoir is augmented at a rate more than the natural conditions of replenishment. Any man-made facility which adds water to an aquifer is termed as artificial recharge system; new concept of rain water harvesting & the structures used are generally as under:-



Recharge Pit: 1m to 2m wide & 3m deep, filled with boulders, gravels, and course sand are made to recharge shallow aquifer.

Trenches: Such trenches are 0.5m to 1m wide & 1m to 1.5m deep & 10m to 20m long filled with course filter materials.

Dug Wells: These are normal existing wells in use where run-off is collected and fed in these dug wells after passing through filter materials.

Recharge Wells: These are constructed to recharge deeper aquifers & water is passed through filter media to avoid choking of these 100mm to 300mm diameter wells.

Recharge Shafts: These are used for recharge of shallow aquifer which are located below clayey surface and the shafts can be 0.5m to 3m diameter and 10m to 15m deep. These are also back filled with filter materials.

Lateral Shafts with Bore Wells: It is a system where recharging of upper as well as deeper aquifers are envisaged. The lateral shafts of 1.5m to 2m wide & 10m to 30m long depending on quantum of run-off and one or two bore wells are also constructed to feed the aquifer from the lateral shafts, which are also filled with filter materials.

SPREADING TECHNIQUES:

It is used where permeable strata starts from top and run-off is spread in Streams / Nalas by making check dams, Nala Bunds, cement plugs, gabion structures or a percolation pond may be constructed

Recommendations:

- Strategy to implement the groundwater recharge in a way forward to be encouraged by Government and non-government agencies, housing authorities at large to build up the water table and to make the groundwater a reliable and sustainable resource.

- Concerted efforts are required to educate the public by print and electronic media to safe guard the interest of future generation for better water resource management and utilization by community participation. Since the problem with water resource happen to be a product of people's own ignorance, they happen to be real sufferers, therefore, they would be in a better position to develop and conserve water resources.

- Better law enforcement and compliance are necessary for the protection of fresh water resources.

- It should be made mandatory for large buildings where plot area is more than 1000 sq yards , that rainwater run off from roof tops and open area to be collected in tanks for

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use after appropriate treatment to decrease dependence on water from municipal supply.

- All drinking water wells in rural areas should have recharge trenches.

- In hilly areas, every streamlet with catchments area of 2 to 3 sq. km to have at least one check dam / weir / subsurface dyke , subject to technical feasibility.

- School / college curriculum should include subjects to inculcate awareness to use water very judiciously.

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ASSESSMENT OF SURFACE AND GROUND WATER QUALITY AT SOME SELECTED SITES IN RAWALPINDI CITY

By

Lt. Col Islam-Ul-Haq (R)*, Harmain Rukh, Ghalib Husnain and Shahid Durez

KEY WORDS
Water quality, ground water, parameters, pollutants, contamination, chemicals.

ABSTRACT
Water contamination is on the increase now days. Un-planned urbanization, domestic & industrial waste water are the major causes of water contamination. Surface water and ground water samples were collected from different localities in Rawalpindi city and were analyzed for their physio-chemical characteristics. The water quality assessment study was designed to gather as much information possible in the shortest span of time. In this way it was ensured that the hydrologic conditions of the sites remained unchanged, hence it was made possible that reliable comparisons can be made between sites. The analysis result was also compared with WHO standards for drinking water quality parameters with the water quality parameters such as temperature, pH, Alkalinity, hardness as $CaCO_3$, conductance, calcium, TDS, Chlorides, nitrite as NO_2 As and Fe. The usefulness of these parameters for assessing the water quality was discussed. Thus an attempt has been made to gain in depth knowledge of quality of surface water as well as ground water suitable for drinking purpose or not.

1. INTRODUCTION

The rapid increase in population in Pakistan has exerted enormous pressure on existing water resources both in quantitative and qualitative terms. The water supply coverage of Pakistan is continuously improving as 66% of its population has now access to drinking water (GoP, 2006). Under the Millennium development goal number-7 Pakistan has to achieve its target of 93% of population having access to drinking water by 2015. Where the adequate supply of water is important it is equally important that water being supplied is safe and of high quality. WASA completely recognizes its responsibility of supplying water to its consumers and it is among the top goals of WASA to improve the quality of water for consumption. In maintaining the quality of water, either it is ground water or surface water, it is important to get rid of potentially dangerous microorganisms and chemicals. The bacteriological contamination and pollutants from agricultural and industrial areas pose major threats to quality of drinking water in Pakistan. These contaminations are attributed to leakage of pipes, untreated municipal wastes, pesticides, nitrogen fertilizers, and other industrial effluents. The quality of groundwater and surface water is dependent on different chemicals and their concentration. In fact the water pollution due to effluents from catchment areas of Rawal Lake has greatly affected the surface water quality. The municipal waste either in the form of waste water or solid waste is reducing the quality of ground water as well. The ground water table in the city is depleting due to excessive abstraction. The cost of producing ground water from tube wells is about Rs 35/1000 gallons (nine times more expensive than the cost of production at Rawal treatment plant and twice the cost of water purchased from the CDA) (GOP ,2006). Ground water is the main water supply source in Rawalpindi city. Increasing population and pollution has exerted enormous pressure on ground and surface water reservoirs.

The water distribution systems and water treatment systems are of main importance since, if they are not properly operated and maintained can become a source of disease outbreak affecting large populations specially children. Therefore, the monitoring and surveillance of quality of raw water sources as well as of treated water is very important.

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*Water and Sanitation Agency, Rawalpindi Pakistan.

For effective management of water resources it is essential to have clear cut understanding and base line data regarding the quality and quantity of water, the causes and effects of groundwater contamination along with knowledge of possible risks, vulnerabilities to this rapidly declining water supply source. Ground water quality comprises the physical chemical and biological qualities of ground water. Physical water quality parameters are color, taste, odor, turbidity and temperature. Usually ground water is colorless, tasteless and odorless, therefore, the chemical and biological qualities are of primary concern. (Harter, 2003)

This research was carried-out to make sure that WASA is supplying quality water to its consumers and if any parameter is exceeding the national / WHO standards what is the cause and what immediate measures can be taken. According to 2008 data, the population served by WASA was 1.10 million expanding on total area of 35 sq km. The planned consumption was 40 GPCD (Gallon per Capita per Day) where as the demand was 44 MGD (Million Gallons per Day). The total production from all water sources was 42 MGD.

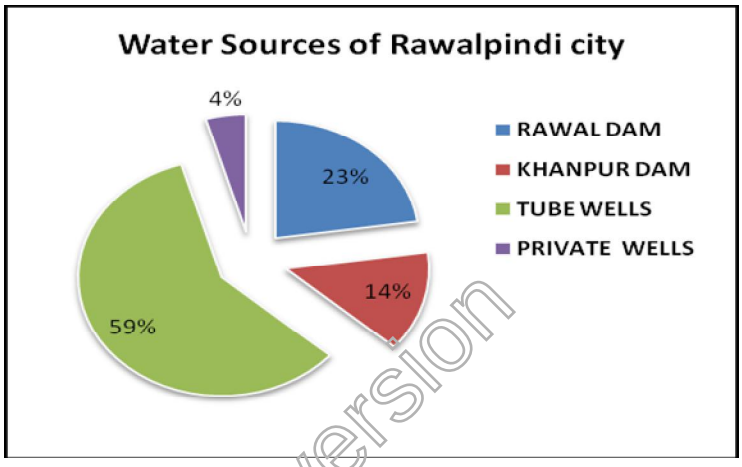


Figure 1 : Water Sources of Rawalpindi City

The Figure (1) shows different sources from which the water demand of citizens of Rawalpindi is met. It is clear from the figure (1) that the main source is ground water. Water samples from various public water supply sources were monitored for water quality parameters over a period of 1 month**.**

2. Objectives

a) To analyze water quality parameters in selected locations

b) Comparison between different public water supply sources for various physical and chemical parameters.

c) Comparison with WHO drinking water quality parameters

d) Form a foundation for establishing long term monitoring and water purification plans.

3. Materials and methods

The study was designed to characterize the surface water and ground water quality in Rawalpindi city. The methodology consisted of sample collection from selected locations, their chemical analysis, analytical methods etc.

i) Study area

a) Surface water

The Rawal Lake is the main source of water supply, therefore, the raw water of the lake was analyzed first. Then the filtered water before chlorination was analyzed against selected parameters. Later on the water after chlorination was analyzed. Further samples were also collected from consumer end. Total 20 samples were collected.

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b) Ground water

The main study areas were katarian market, Shamsabad, Bilal colony sixth road, Liaquat bagh and raja bazaar of Rawalpindi city. These tube-wells are located around Nullah Lai. The tube-wells from these UC's were selected because they were feared to be more polluted as compared to other tube-wells. The total number of samples was 17.

ii) Sample analysis

The water samples from the selected sites were collected during December 2009 and January 2010. The samples were taken in clean polyethylene bottles and after collection they were immediately placed in dark boxes and processed within 4-6 hours of collection. First the samples were tested in lab for parameters of water quality. Then the results were analyzed through various statistical techniques to find out comparisons and trends of parameters.

The analysis was done for major physical, chemical, toxic and bacteriological water quality parameters including pH, Conductance, Total Dissolved Solids (TDS), hardness as Calcium Chloride, Calcium, Nitrites, Arsenic and fecal Coliform count. The pH, conductance and TDS of the sample was determined at site using pH multi-meter .For measuring turbidity, the turbidity photo meter was used. Titration method was used for measuring hardness and Calcium. The FerooVer method with photo spectro-meter was used for Iron. For chlorides the mercuric Nitrate method along with digital titrator was used. Diazotization method was used for Nitrite and readings were taken on photo spectrometer. Samples were collected in clean glass bottles and stored at 4 C, before carrying out the test warmed at room temperature. No acid preservatives were used. Visual comparison Arsenic kit was used for detecting arsenic in the collected samples. Merk ready cult kit was used for bacterial contamination.

4. Social Aspects

The social impacts of water borne diseases on humans are creating problems in their social life. There are divorce & separation cases amongst the patients of Arsenocosis in Bangladesh & Pakistan as well. Not only the environment be of concern, but the society inhabiting the surrounding environment is also affected due to drinking water contamination. One major concern regarding society is to protect the health of the community. However, for the past 20 years there has been a severe shortage of water used for irrigation of farmlands and the farmers have been using untreated waste water (municipal combined with industrial) for agricultural purposes (Ching Wu,X et al., 1995). Municipal and industrial waters contain chemicals, organic, thermal wastes, and sewage consisting of human wastes. Most of these municipal pollutants contribute to transmissions of water borne diseases. Water borne illnesses have been a major problem due to polluted waters. Within China alone, epidemics of water borne diseases are cholera, typhoid, and dysentery (Cholera Epidemics in Shanghai & Hongkong, n/d). These epidemics have affected the lives of many Chinese by consuming or being exposed to the polluted waste water. These epidemics lead to either severe hospitalization or death.

Another factor that concerns the health factors of the community is the drinking water obtained from the groundwater systems. By introducing waste water into the small streams, these existing pollutants can seepage into the groundwater system. Not only is ground water used for irrigation, industry, and rural home and stock watering, it is mainly used as a drinking source for the community (Benarde, 1989). With a population size of 2.8 million people in a near-by city such as Xian City, the consumption of contaminated ground water for drinking purposes can be severely damaging to the populations health. If groundwater is contaminated with pesticides, this can affect the human health in terms of cancer or as endocrine disrupters. Ground water becomes polluted when contributions of polluted waters from agriculture, farming and industrial wastes are entered into the water systems (Benarde, 1989). For health reasons, waste water flowing into the water systems is not healthy for the community. By proposing a waste water treatment plant where possible polluted waters are discharged, this can help reduce the risks of contaminating viable water resources within society.

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Polluted waste water not only affects humans, but it also affects the farmlands using the polluted waste water. Since most of the waste water is used for irrigation of farmlands, the pollutants can affect and contaminate the crops such as grain production. Most of the water systems run through more than 25% of the agricultural farmlands and supports about a third of the population in the country. Cropland provides one of the major food supplies for China. With a decrease in the food supply from crops, starvation and a decrease in agriculture can impact the society.

5. Gender role in reduction of water contamination

Women can play a vital role in reduction of water contamination as they are the major users of water at household level. They can easily manage cleanliness of water storage tanks and they can also boil water for drinking purposes. Besides ensuring safe drinking water at household level they can also contribute towards water conservation and reuse.

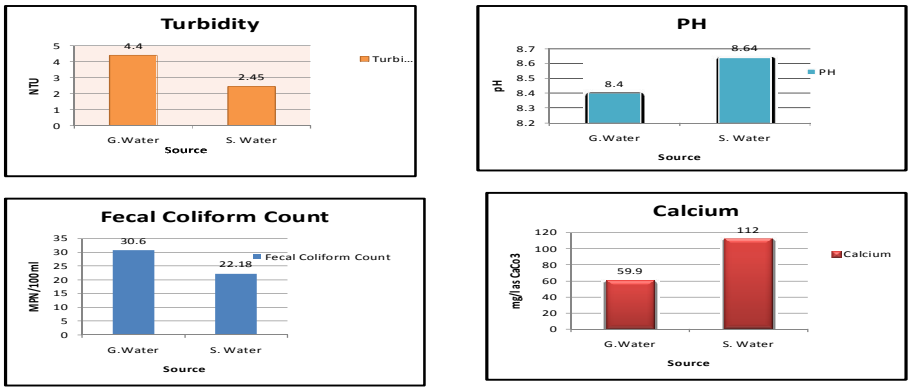
6. Result and discussions

The values of parameters for surface and ground water were provided in Annexure-A and-B respectively. The results indicate that quality of water is different for different locations and varies for different sources of water. The mean of fecal coliform count was higher in ground water as compared to surface water. Normally it is believed that ground water has less bacteriological contamination as compared to surface water. However the reverse situation was encountered in this study. This high contamination shows that waste water has contaminated the ground water reservoirs and natural ability of soil to retain contaminants was also not able to reduce the level of bacteriological contamination. The mean value of TDS (Total Dissolved Solids) of surface water was more than ground water. The appearance of water with a turbidity of less than 5 NTU (National Turbidity Unit) is usually acceptable to consumers, although this may vary with local circumstances. Particulates can protect microorganisms from the effects of disinfection and can stimulate bacterial growth. In all cases where water is disinfected, the turbidity must be low so that disinfection can be effective. Turbidity is also an important operational parameter in process control and can indicate problems with treatment processes, particularly coagulation/sedimentation and filtration. No health-based guideline value for turbidity has been proposed; ideally, however, median turbidity should be below 0.1 NTU for effective disinfection, and changes in turbidity are an important process control parameter. Cool water is generally more palatable than warm water, and temperature will impact on the acceptability of a number of other inorganic constituents and chemical contaminants that may affect taste. High water temperature enhances the growth of microorganisms and may increase taste, odour, colour and corrosion problems, (WHO, 2008).

The concentrations of chloride were in limits both in ground water as well as in surface water.

The higher concentrations of chloride give a salty taste to water. Taste thresholds for the chlorides are in the range of 200–300 mg/litre for sodium, potassium and calcium chloride. No health based guideline value is proposed for chloride in drinking-water.

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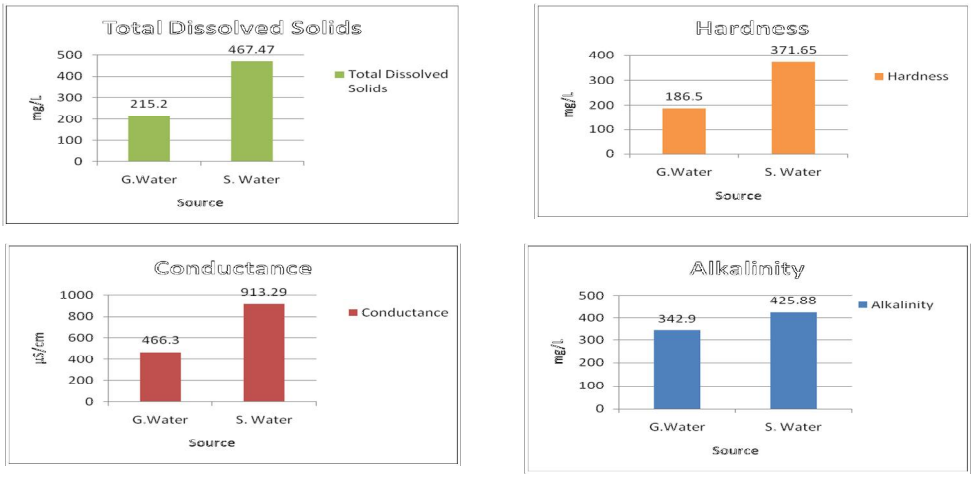
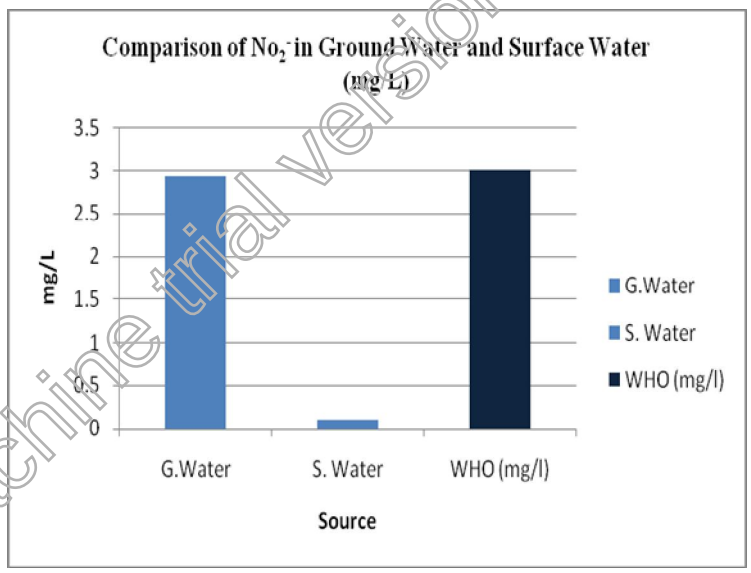


Figure 2: Graph (A) showing mean values of water quality parameters

Figure 3 : Graph (B)

The analysis of ground water showed higher concentration of nitrite compared with WHO limits of nitrite in drinking water**.**



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Figure 4 : Graph showing mean values of nitirite levels (mg/l)

High concentration of nitrite is mainly associated with agricultural activities around the water source. The nitrites are carcinogenic and also responsible for blue baby syndrome (methaemoglobinaemia).In humans, methaemoglobinaemia forms as a consequence of the reaction of nitrite with haemoglobin in the red blood cells to form methaemoglobin, which binds oxygen tightly and does not release it, so blocking oxygen transport. Although most absorbed nitrite is oxidized to nitrate in the blood, residual nitrite can react with haemoglobin. High levels of methaemoglobin (greater than 10%) formation can give rise to cyanosis, referred to as blue-baby syndrome. Methaemoglobinaemia has most frequently been associated with private wells, (WHO, 2008). It is particularly important to ensure that the septic tanks and pit latrines should not be sited near a well. Also it must be ensured that animal manure is kept at a sufficient distance to ensure that runoff cannot enter the well or the ground nears the well. This could be achieved through public awareness campaigns.

It was found that surface water does not contain any arsenic. However noticeable amounts of Arsenic were found in ground water. Adverse health effects of arsenic depend on the type and amount of arsenic that has entered the body, the length of exposure time and the response of the exposed body. Unborn babies, young children, people with long-term illnesses and elderly people are at greatest risk due to arsenic exposure. Studies in other countries have shown that drinking water containing elevated levels of arsenic can cause the thickening and discoloration of the skin. Sometimes these changes can lead to skin cancer, which may be curable if discovered early. Numbness in the hands and feet and digestive problems such as stomach pain, nausea, vomiting, and diarrhoea can also occur due to the elevated levels of arsenic. (GoP, 2008)

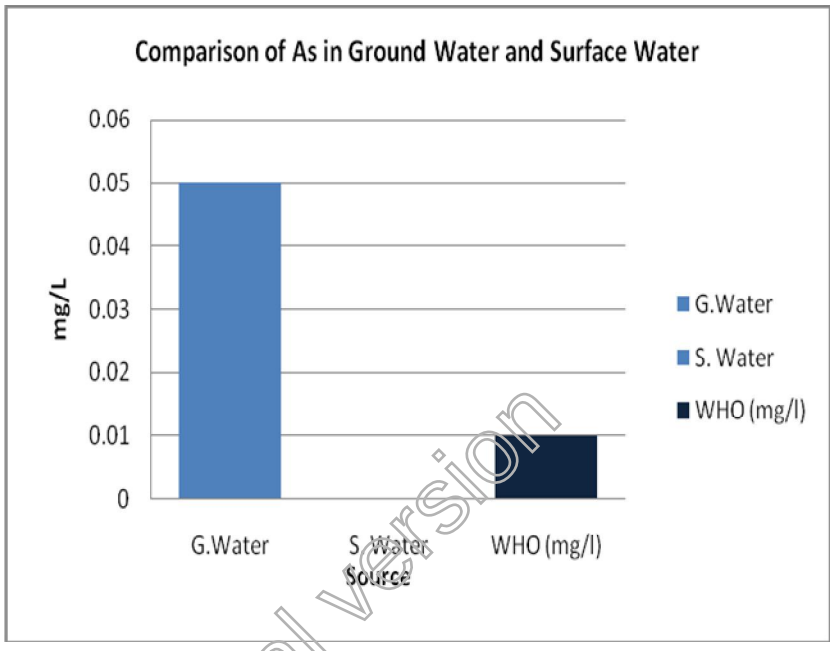


Figure 5 :

The supply of water in terms of quality and quantity is becoming a challenge for water supply agencies in Pakistan due to ever increasing population, lack of infrastructure and rapidly accelerated pollution levels in water bodies. The provision of safe drinking water to people is the top most priority of government and many organizations monitor their water supply in light of WHO guidelines and national drinking water quality standards.

Table 1: Future demand and supply of water in Rawalpindi.

Description	Year						
Average Annual Growth rate	3.5 % up to year 2010		3 % from 2011 to 2020		2.5 % from 2021 to 2030	2 % from 2031 to 2050	
	2008	2010	2015	2020	2030	2040	2050
Projected population (million)	1.10	1.285	1.465	1.698	2.173	2.649	3.230
Water demand @ 40 gped MGD	44	51.40	58.6	67.92	86.92	105.96	129.20
Present water availability (MGD)	42	46	46	46	46	46	46
Net deficit (MDG)	2	3.6	18.6	27.92	46.92	65.96	69.25

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The table shows the future increase in population and increase in water demand. It is important to plan the water supply schemes accordingly as pressure on ground water resources is likely to increase manifold. For the supply of quality ground water further plans are required.

7. Conclusion

The surface water samples collected from various sources were analyzed and it was found that water quality parameters like pH, conductance, Alkalinity, turbidity, calcium, hardness lies within the maximum permissible limits prescribed by WHO. One main parameter of concern i-e fecal coliform count is exceeding the limits both in case of surface and ground water and requires immediate actions. The exceeding levels of nitrite and Arsenic in ground water are of immediate concern and collaborative efforts on part of local government and industry is required. As ground water is main source of drinking water in Rawalpindi, its contamination is likely to affect more people. The surface water should be provided to more and more people so that pressure on ground water reservoirs can be reduced.

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pdfMachine trial version

Water Quality Tests of Surface Water Sources

Annexure-A

S.No.	Parameters	Units	PSCQA standards	WHO Limits			
Date	21-Dec-09						
Location					**Filtration plant Rawal Lake**	**Filtration plant Rawal Lake**	**Filtration plant Rawal Lake**
Source					**surface water**	**surface water**	**surface water**
	Physical and chemical parameters						
1	Appearance		Clear	Clear	Turbid	Clear	Clear
2	Temperature	℃			12	12	12
3	Turbidity	NTU	5	5 NTU	22.5	2.5	2.5
4	PH		7-8.5	6.5-8.5	9.04	8.77	8.89
5	Alkalinity	mg/L		500 mg/L	215	210	210
6	Hardness as CaCO3	mg/L	< 500 mg/l	500 mg/L	208	192	192
7	Conductance	µS/cm		2000µS/cm	452	465	464
8	Calcium	mg/L	75 mg/l	75 mg/L	69.2	56	54.4
9	Total Dissolved Solids	mg/L	1000 mg/l	1000 mg/L	226	223	225
10	Chlorides	mg/L	200 mg/l	200 mg/L	9	9	9
11	Nitrite as NO_2	mg/L	3 mg/l	1 mg/L	0	0	0
12	Iron as Fe	mg/L	.3 mg/l	0.3 mg/L	0	0	0
	Bacteriological parameters						
13	Fecal Coliform Count	Colonies/100ml	Nil/100 ml	Nil /100ml	120	150	0
14	Total Coliform Count	Colonies/100ml	Nil/100 ml	Nil/100ml			
	Toxic substances						
15	Arsenic as $As^{-3\ -5}$	mg/L	0.01	0.01	0	0	0

For Machine trial version

Water Quality Tests of Surface Water Sources

Annexure-A

S.No.	Parameters	Units	PSCQA standards	WHO Limits			
Date	21-Dec-09						
Location					**UC 46**	**UC 46**	**UC 41**
Source					**Surface water**	**surface water**	**surface water**
	Physical and chemical parameters						
1	Appearance		Clear	Clear	Clear	Clear	Clear
2	Temperature	°C			10	10	10
3	Turbidity	NTU	5	5 NTU	3.5	3.4	3.4
4	PH		7-8.5	6.5-8.5	8.3	8.3	8.31
5	Alkalinity	mg/l		500 mg/L	392	388	385
6	Hardness as CaCO3	mg/L	< 500 mg/l	500 mg/L	190	172	171
7	Conductance	µS/cm		2000µS/cm	400	388	399
8	Calcium	mg/L	75 mg/l	75 mg/L	54	52	52
9	Total Dissolved Solids	mg/L	1000 mg/l	1000 mg/L	202	194	196
10	Chlorides	mg/L	200 mg/l	200 mg/L	10	10	9
11	Nitrite as NO_2^-	mg/L	3 mg/l	1 mg/L	0.2	0.3	0
12	Iron as Fe	mg/L	.3 mg/l	0.3 mg/L	0	0	0
	Bacteriological parameters						
13	Fecal Coliform Count	Colonies/100ml	Nil/100 ml	Nil /100ml	19	19	0
14	Total Coliform Count	Colonies/100ml	Nil/100 ml	Nil /100ml			
	Toxic substances						
15	Arsenic as As^{-3-5}	mg/L	0.01	0.01	0	0	0

Non-Machine trial version

Water Quality Tests of Surface Water Sources — Annexure-A

S.No.	Parameters	Units	PSCQA standards	WHO Limits			
Date	21-Dec-09						
Location					**UC 46**	**UC 34**	**Mr. Malik**
Source					**surface water**	**surface water**	**surface water**
	Physical and chemical parameters						
1	Appearance		Clear	Clear	Clear	Clear	Clear
2	Temperature	°C			10	10	10
3	Turbidity	NTU	5	5 NTU	3.5	3.2	3.5
4	PH		7-8.5	6.5-8.5	8.3	8.3	8.3
5	Alkalinity	mg/L		500 mg/L	393	402	392
6	Hardness as CaCO3	mg/L	< 500 mg/l	500 mg/L	175	190	196
7	Conductance	µS/cm		2000µS/cm	401	420	398
8	Calcium	mg/L	75 mg/l	75 mg/L	52	54	52
9	Total Dissolved Solids	mg/L	1000 mg/l	1000 mg/L	198	203	196
10	Chlorides	mg/L	200 mg/l	200 mg/L	9	9	10
11	Nitrite as NO_2^-	mg/L	3 mg/l	1 mg/L	0	0	0.1
12	Iron as Fe	mg/L	.3 mg/l	0.3 mg/L	0	0	0
	Bacteriological parameters						
13	Fecal Coliform Count	Colonies/100ml	Nil/100 ml	Nil/100ml	0	0	38
14	Total Coliform Count	Colonies/100ml	Nil/100 ml	Nil/100ml			
	Toxic substances						
15	Arsenic as $As^{-3\,-5}$	mg/L	0.01	0.01	0	0	0

Demo machine trial version

Water Quality Tests of Surface Water Sources

Annexure-A

S.No.	Parameters	Units	PSCQA standards	WHO Limits			
Date	21-Dec-09						
Location					**Mr. Rizwan**	**UC 6**	**Kali tanki**
Source					**surface water**	**surface water**	**surface water**
	Physical and chemical parameters						
1	Appearance		Clear	Clear	Clear	Clear	Clear
2	Temperature	°C			10	10	10
3	Turbidity	NTU	5	5 NTU	6.2	4.4	2.9
4	PH		7-8.5	6.5-8.5	8.4	8.4	8.1
5	Alkalinity	mg/L		500 mg/L	388	394	380
6	Hardness as CaCO3	mg/L	< 500 mg/l	500 mg/L	188	220	168
7	Conductance	µS/cm		2000µS/cm	402	805	384
8	Calcium	mg/L	75 mg/l	75 mg/L	52	98	50
9	Total Dissolved Solids	mg/L	1000 mg/l	1000 mg/L	230	290	190
10	Chlorides	mg/L	200 mg/l	200 mg/L	10	11	9
11	Nitrite as NO_2^-	mg/L	3 mg/l	1 mg/L	0.3	0.1	0
12	Iron as Fe	mg/L	.3 mg/l	0.3 mg/L	0	0	0
	Bacteriological parameters						
13	Fecal Coliform Count	Colonies/100ml	Nil/100 ml	Nil/100ml	220	27	0
14	Total Coliform Count	Colonies/100ml	Nil/100 ml	Nil/100ml			
	Toxic substances						
15	Arsenic as $As^{-3\,-5}$	mg/L	0.01	0.01	0	0	0

Draft Machine final version

Water Quality Tests of Surface Water Sources

Annexure-A

S.No.	Parameters	Units	PSCQA standards	WHO Limits			
Date	21-Dec-09						
Location					**UC 46**	**UC 6**	**Pirwadahi**
Source					**surface water**	**surface water**	**surface water**
	Physical and chemical parameters						
1	Appearance		Clear	Clear	Clear	Clear	Clear
2	Temperature	°C			10	10	10
3	Turbidity	NTU	5	5 NTU	3.3	4.2	3
4	PH		7-8.5	6.5-8.5	8.3	8.3	8.2
5	Alkalinity	mg/L		500 mg/L	384	380	380
6	Hardness as CaCO3	mg/L	< 500 mg/l	500 mg/L	190	192	168
7	Conductance	µS/cm		2000µS/cm	390	788	770
8	Calcium	mg/L	75 mg/l	75 mg/L	52	96	94
9	Total Dissolved Solids	mg/L	1000 mg/l	1000 mg/L	192	282	260
10	Chlorides	mg/L	200 mg/l	200 mg/L	9	10	10
11	Nitrite as NO_2^-	mg/L	3 mg/l	1 mg/L	0	0.1	0
12	Iron as Fe	mg/L	.3 mg/l	0.3 mg/L	0	0	0
	Bacteriological parameters						
13	Fecal Coliform Count	Colonies/100ml	Nil/100 ml	Nil/100ml	0	19	0
14	Total Coliform Count	Colonies/100ml	Nil/100 ml	NIL/100ml			
	Toxic substances						
15	Arsenic as $As^{-3\,-5}$	mg/L	0.01	0.01	0	0	0

pdfMachine trial version

Water Quality Tests of Surface Water Sources

Annexure-A

S.No.	Parameters	Units	PSCQA standards	WHO Limits			
Date	21-Dec-09						
Location					**UC 35**	**UC 17**	**UC 18**
Source					**surface water**	**surface water**	**surface water**
	Physical and chemical parameters						
1	Appearance		Clear	Clear	Clear	Clear	Clear
2	Temperature	°C			10	10	10
3	Turbidity	NTU	5	5 NTU	3.4	3.5	3.34
4	PH		7-8.5	6.5-8.5	8.4	8.4	8.3
5	Alkalinity	mg/L		500 mg/L	392	402	3.9
6	Hardness as CaCO3	mg/L	< 500 mg/l	500 mg/L	192	202	173
7	Conductance	µS/cm		2000µS/cm	390	413	401
8	Calcium	mg/L	75 mg/l	75 mg/L	52	54	52
9	Total Dissolved Solids	mg/L	1000 mg/l	1000 mg/L	195	207	194
10	Chlorides	mg/L	200 mg/l	200 mg/L	9	9	9
11	Nitrite as NO_2^-	mg/L	3 mg/l	1 mg/L	0	0	0
12	Iron as Fe	mg/L	.3 mg/l	0.3 mg/L	0	0	0
	Bacteriological parameters						
13	Fecal Coliform Count	Colonies/100ml	Nil/100 ml	Nil/100ml	0	0	0
14	Total Coliform Count	Colonies/100ml	Nil/100 ml	Nil/100ml			
	Toxic substances						
15	Arsenic as $As^{-3\,-5}$	mg/L	0.01	0.01	0	0	0

Not Machine-final version

Water Quality Tests of Surface Water Sources

Annexure-A

S.No.	Parameters	Units	PSCQA standards	WHO Limits			Mean
Date	21-Dec-09						
Location					**UC 13**	**UC 20**	
Source					**surface water**	**surface water**	
	Physical and chemical parameters						
1	Appearance		Clear	Clear	Clear	Clear	Clear
2	Temperature	°C			10	10	10.3
3	Turbidity	NTU	5	5 NTU	3.4	3.2	4.4
4	PH		7-8.5	6.5-8.5	8.5	8.1	8.4
5	Alkalinity	mg/L		500 mg/L	384	383	342.9
6	Hardness as CaCO3	mg/L	< 500 mg/l	500 mg/L	180	170	186.5
7	Conductance	µS/cm		2000µS/cm	405	390	466.3
8	Calcium	mg/L	75 mg/l	75 mg/L	52	50	59.9
9	Total Dissolved Solids	mg/L	1000 mg/l	1000 mg/L	210	190	215.2
10	Chlorides	mg/L	200 mg/l	200 mg/L	9	9	9.4
11	Nitrite as NO_2^-	mg/L	3 mg/l	1 mg/L	0	0	0.1
12	Iron as Fe	mg/L	.3 mg/l	0.3 mg/L	0	0	0.0
	Bacteriological parameters						
13	Fecal Coliform Count	Colonies/100ml	Nil/100 ml	Nil/100ml	0	0	30.6
14	Total Coliform Count	Colonies/100ml	Nil/100 ml	Nil/100ml			
	Toxic substances						
15	Arsenic as $As^{-3\ -5}$	mg/L	0.01	0.01	0	0	0.0

Trial Machine trial version

Water Quality Tests of Ground Water Sources

Annexure-B

S.No.	Parameters	Units	PSCQA standards	WHO Limits			
Date	21-Dec-09						
Location					**tube well 2**	**tube well 59**	**tube well 70**
Source					**ground water**	**groundwater**	**groundwater**
	Physical and chemical parameters						
1	Appearance		Clear	Clear	Clear	Clear	Clear
2	Temperature	℃			16	16	15
3	Turbidity	NTU	5	5 NTU	3.25	2.5	2.18
4	PH		7-8.5	6.5-8.5	8.54	8.4	8.54
5	Alkalinity	mg/L		500 mg/L	480	580	440
6	Hardness as CaCO3	mg/L	< 500 mg/L	500 mg/L	360	570	356
7	Conductance	µS/cm		2000µS/cm	1076	1221	866
8	Calcium	mg/L	75 mg/L as CaCo3	75 mg/L as CaCo3	116	172.8	108.6
9	Total Dissolved Solids	mg/L	1000 mg/L	1000 mg/L	538	620	434
10	Chlorides	mg/L	200 mg/L	200 mg/L	21	26	16
11	Nitrite as NO_2^-	mg/L	3 mg/L	1 mg/L	5	2	1
12	Iron as Fe	mg/L	0.3 mg/L	0.3 mg/L	0	0	0
	Bacteriological parameters						
13	Fecal Coliform Count	Colonies/100ml	Nil/100 ml	Nil/100ml	12	0	0
	Toxic substances						
14	Arsenic as $As^{-3\,-5}$	mg/L	0.01	0.01	0.05	0.05	0.1

pdfMachine trial version

Water Quality Tests of Ground Water Sources

Annexure-B

S.No.	Parameters	Units	PSCQA standards	WHO Limits			
Date	21-Dec-09						
Location					**tube well 64**	**tube well 63**	**tube well 15A**
Source					**groundwater**	**groundwater**	**groundwater**
	Physical and chemical parameters						
1	Appearance		Clear	Clear	Clear	Clear	Clear
2	Temperature	°C			15	16	13
3	Turbidity	NTU	5	5 NTU	4.87	2.05	1.83
4	PH		7-8.5	6.5-8.5	8.55	8.45	8.58
5	Alkalinity	mg/L		500 mg/L	480	530	520
6	Hardness as CaCO3	mg/L	< 500 mg/L	500 mg/L	470	516	400
7	Conductance	µS/cm		2000µS/cm	1270	1236	858
8	Calcium	mg/L	75 mg/L as CaCo3	75 mg/L as CaCo3	140.8	168.8	120
9	Total Dissolved Solids	mg/L	1000 mg/L	1000 mg/L	614	619	428
10	Chlorides	mg/L	200 mg/L	200 mg/L	24	24	16
11	Nitrite as NO_2^-	mg/L	3 mg/L	1 mg/L	1	2	5
12	Iron as Fe	mg/L	0.3 mg/L	0.3 mg/L	0	0	0
	Bacteriological parameters						
13	Fecal Coliform Count	Colonies/100ml	Nil/100 ml	Nil/100ml	0	0	0
	Toxic substances						
14	Arsenic as As^{-3-5}	mg/L	0.01	0.01	0.1	0.05	0

pdfMachine trial version

Water Quality Tests of Ground Water Sources

Annexure-B

S.No.	Parameters	Units	PSCQA standards	WHO Limits			
Date	21-Dec-09						
Location					**tube well 17**	**tube well 8**	**tube well 11**
Source					**Groundwater**	**ground water**	**Groundwater**
	Physical and chemical parameters						
1	Appearance		Clear	Clear	Clear	Clear	Clear
2	Temperature	°C			13	13	13
3	Turbidity	NTU	5	5 NTU	2.45	2.3	2.09
4	PH		7-8.5	6.5-8.5	8.81	8.8	8.61
5	Alkalinity	mg/L		500 mg/L	410	510	480
6	Hardness as CaCO3	mg/L	< 500 mg/L	500 mg/L	336	440	402
7	Conductance	µS/cm		2000µS/cm	448	964	935
8	Calcium	mg/L	75 mg/L as CaCo3	75 mg/L as CaCo3	104	120	136
9	Total Dissolved Solids	mg/L	1000 mg/L	1000 mg/L	423	483	468
10	Chlorides	mg/L	200 mg/L	200 mg/L	16	18	18
11	Nitrite as NO_2^-	mg/L	3 mg/L	1 mg/L	5	5	5
12	Iron as Fe	mg/L	0.3 mg/L	0.3 mg/L	0	0	0
	Bacteriological parameters						
13	Fecal Coliform Count	Colonies/100ml	Nil/100 ml	Nil/100ml	12	0	0
	Toxic substances						
14	Arsenic as $As^{-3\ -5}$	Mg/L	0.01	0.01	0.05	0.05	0

pdfMachine trial version

Water Quality Tests of Ground Water Sources

Annexure-B

S.No.	Parameters	Units	PSCQA standards	WHO Limits			
Date	21-Dec-09						
Location					**tube well 22**	**tube well 7A**	**tube well 74**
Source					**ground water**	**ground water**	**ground water**
	Physical and chemical parameters						
1	Appearance		Clear	Clear	Clear	Clear	Clear
2	Temperature	°C			14	15	14
3	Turbidity	NTU	5	5 NTU	2.54	2.01	1.87
4	PH		7-8.5	6.5-8.5	8.6	8.85	8.55
5	Alkalinity	mg/L		500 mg/L	230	280	420
6	Hardness as CaCO3	mg/L	< 500 mg/L	500 mg/L	200	200	388
7	Conductance	µS/cm		2000µS/cm	441	858	1030
8	Calcium	mg/L	75 mg/L as CaCo3	75 mg/L as CaCo3	48	56	112
9	Total Dissolved Solids	mg/L	1000 mg/L	1000 mg/L	218	427	515
10	Chlorides	mg/L	200 mg/L	200 mg/L	8	16	20
11	Nitrite as NO_2^-	mg/L	3 mg/L	1 mg/L	0	2	5
12	Iron as Fe	mg/L	0.3 mg/L	0.3 mg/L	0	0	0
	Bacteriological parameters						
13	Fecal Coliform Count	Colonies/100ml	Nil/100 ml	Nil/100ml	145	0	22
	Toxic substances						
14	Arsenic as $As^{-3\ -5}$	mg/L	0.01	0.01	0.01	0	0.05

Provisional trial version

Water Quality Tests of Ground Water Sources

Annexure-B

S.No.	Parameters	Units	PSCQA standards	WHO Limits			
Date	21-Dec-09						
Location					**tube well 75A**	**tube well 74 A**	**tube well 17B**
Source					**ground water**	**ground water**	**ground water**
	Physical and chemical parameters						
1	Appearance		Clear	Clear	Clear	Clear	Clear
2	Temperature	°C			15	15	14
3	Turbidity	NTU	5	5 NTU	3.33	2.39	2.17
4	PH		7-8.5	6.5-8.5	8.72	8.62	8.98
5	Alkalinity	mg/L		500 mg/L	380	420	290
6	Hardness as CaCO3	mg/L	< 500 mg/L	500 mg/L	348	340	280
7	Conductance	µS/cm		2000µS/cm	1150	865	694
8	Calcium	mg/L	75 mg/L as CaCo3	75 mg/L as CaCo3	96	105	80
9	Total Dissolved Solids	mg/L	1000 mg/L	1000 mg/L	575	432	346
10	Chlorides	mg/L	200 mg/L	200 mg/L	22	16	14
11	Nitrite as NO_2^-	mg/L	3 mg/L	1 mg/L	2	0	5
12	Iron as Fe	mg/L	0.3 mg/L	0.3 mg/L	0	1	0
	Bacteriological parameters						
13	Fecal Coliform Count	Colonies/100ml	Nil/100 ml	Nil/100ml	0	0	186
	Toxic substances						
14	Arsenic as As $^{-3\ -5}$	mg/L	0.01	0.01	0.05	0.05	0.05

Nitro Machine trial version

Water Quality Tests of Ground Water Sources Annexure-B

S.No.	Parameters	Units	PSCQA standards	WHO Limits			Mean
Date	21-Dec-09						
Location					**tube well 25A**	**tube well 25**	
Source					**groundwater**	**ground water**	
	Physical and chemical parameters						
1	Appearance		Clear	Clear	Clear	Clear	Clear
2	Temperature	°C			14	14	14.41
3	Turbidity	NTU	5	5 NTU	1.8	2.02	2.45
4	PH		7-8.5	6.5-8.5	8.56	8.76	8.64
5	Alkalinity	mg/L		500 mg/L	380	410	425.88
6	Hardness as CaCO3	mg/L	< 500 mg/L	500 mg/L	372	340	371.65
7	Conductance	µS/cm		2000µS/cm	898	716	913.29
8	Calcium	mg/L	75 mg/L as CaCo3	75 mg/L as CaCo3	112	108	112.00
9	Total Dissolved Solids	mg/L	1000 mg/L	1000 mg/L	448	359	467.47
10	Chlorides	mg/L	200 mg/L	200 mg/L	17	14	18.00
11	Nitrite as NO_2^-	mg/L	3 mg/L	1 mg/L	5	0.05	2.94
12	Iron as Fe	mg/L	0.3 mg/L	0.3 mg/L	0	0	0.06
	Bacteriological parameters						
13	Fecal Coliform Count	Colonies/100ml	Nil/100 ml	Nil/100ml	0	0	22.18
	Toxic substances						
14	Arsenic as $As^{-3\ -5}$	mg/L	0.01	0.01	0.1	0	0.05

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VORTEX TYPE SILT EJECTORS

By

B. A. Shakir*

Comparison of a frontal type silt ejector e.g. silt tunnels laid in the bed of a canal, with the Vortex type ejector, indicated that for similar working conditions, vortex type gives more efficiency at less discharge extraction ratio.

1. The vortex type ejector is designed on following parameters;

i) The velocity of flow across the raised weir be based on Froud No.

ii)

$$\frac{V}{\sqrt{gd}} = 0.8$$

iii) Diameter of the main vortex tube be equal to water depth at crest.

iv) The two lips of the opening slit should be at the same level.

v) The opening of slit should be 1/6 of the diameter of the tube.

vi) Fluming at the throat of the canal across the silt ejector, be between 60% and 70%. Results on model tests have shown that efficiency slightly increases with fluming but then the problem of flow expansion in the canal at downstream of the ejector weir at Froud No. 0.8 are more and so are the problems of energy dissipation in the canal on the downstream side. Fluming recommended therefore is less i.e. about 66% or so.

vii) Flaring and opening out of canal on downstream be smoother.

viii) Under conditions of very heavy silt concentration, it may be possible that some part of the longer silt ejector pipe may not work as efficiently as the other, therefore the main vortex pipe is split in two parts at the middle and two delivery pipes are provided one for each half of vortex tube. (See figure-1)

2. The above parameters were conformed while carrying out model tests at the Irrigation Research Institutes Lahore relating to design of Vortex Silt Ejector on D.G. Khan Canal. The report No. 168/Hyd/1957 by Dr. Mushtaq Ahmed refers.

The series of tests for the efficiency of the vortex ejector showed that for sand the maximum efficiency of the tube occurs when Froud No. of flow in the canal at the section of ejector is 0.8. This fact has been made use of while studying the effect of fluming of canal at the section of vortex ejector and helps to ascertain the crest level of the vortex tube, which is determined as under:

$$B \times d \times v = Q$$

$$\frac{V}{\sqrt{gd}} = 0.8$$

$$0.8 \times B\, d^{3/2} \times \sqrt{g} = Q$$

pdfMachine trial version

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*B.Sc. Engg. (Pb.) F.I.E. (Pak), D.I.C. (Conc. Struct.) London.

B = width of channel at ejector cross section.

d = Depth of water at the crest of ejector.

V = mean velocity at the section of ejector.

Q = Total discharge in the canal'd' is established from the above equations, which also fixes velocity head at the ejector.

It is observed here that $V^2/2g$ does not give the true picture of all the point velocities in such a case and $V^2/50$ being a closer approximation, takes into account the losses due to friction as also the velocity error factor.

The crest at the ejector = F.S.L. – Velocity head - d

3. A graph of working of Vortex Ejector against extraction percentage and fluming is given in Figure-2.

3. EXAMPLE OF VORTEX EJECTOR DESIGN

3.1 Data of canal

F.S.L. in Canal = 802.84

Bed Level = 793.24

F.S. Depth = 9.60

Bed Width = 215

F.S. Discharge = 11,000 cusecs.

The vortex type silt ejector should be designed for an extraction ratio of 10% of which is the best efficiency point;

Extraction = 11,000 x 0.1 = 1,100 cusecs

Total discharge = 11,000 +1100 = 12,100 cusecs

$Q = KD^{5/3}$ "D" is the designed water depth in canal

$11000 = K \times 9.6^{5/3} = K \times 43.35$

$K = 11000/43.35 = 254$

If Q = 12,100

$12,100 = 254 \times D^{5/3}$

$D = (1200/25)^{3/5} = 10.16'$ increased water depth

F.S.L. at increased discharge = 793.24 +10.16 = 803.40

Bed width is the same = 215'

Best fluming is around 66% but at the increased discharge, let us take it at 70%

= 215 x 0.7 = 150.5

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Say = 156

3.2 The Silt Ejector works best when velocity at crest of VORTEX Tube has a Froud No. 0.8.

$$\frac{V}{\sqrt{gd}} = 0.8$$

At the crest $V = 0.8\sqrt{gd}$

$$Q = A \times V = B \times d \times V$$
$$= B \times d \times 0.8\sqrt{gd}$$
$$= 0.8 \times 155 \times d^{3/2} \times \sqrt{g}$$
$$= 0.8 \times 155 \times d^{3/2} \times 5.67$$

$$d = \left[\frac{12100}{0.8 \times 5.67 \times 156}\right]^{3/2}$$

$$d = 6.65 \quad \text{(A)}$$

Head due to velocity of approach $= \frac{V^2}{2g} = \frac{V^2}{64.4}$

However, allowing for losses due to friction and velocity error factor, it is recommended in the Research Institute report that these losses can be accommodated by increasing the factor by reducing denominator in above equation from 64.4 to 50

$$= \frac{V^2}{50} \quad \text{(B)}$$

Losses $= \frac{V^2}{50} = \frac{0.8^2 \times gd}{50}$ (from A & B above)

$$= \frac{0.64 \times 32.2 \times 6.65}{50} = 2.74$$

Assessed velocity of flow over the weir crest would be

$V = \sqrt{2gd} = \sqrt{64.4 \times 2.74} = 13.28$'/sec

Crest level of ejector = FSL – losses – head at weir crest
= 803.40 – 2.74 - 6.65
= 794.01'

Diameter of Vortex tube is also taken equal to d
= 6.65'

Instead adopt a diameter of 7.0',

The delivery pipes shall also be of 7.0' diameter

Half of the discharge will go to each delivery pipe
Velocity in delivery pipe $\frac{Q}{A} = \frac{550}{\sqrt{\frac{d^2}{4}}} = \frac{550}{3.14 \times 49/4}$

$= 14.3$'/sec

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To reduce losses in delivery pipes, increase the diameter to 8' to reduce velocity

$$V = \frac{550 \times 4}{3.14 \times 64} = 10.95'/sec.$$

or say = 11'/sec.

3.3 The layout of the vortex pipe and delivery pipes is given in Fig-1. It may be noted that half of the vortex pipe supplies discharge to one delivery pipe and the other half to second delivery pipe as recommended in Para 1-(vii). The vortex pipe is divided in the middle for this purpose. The outlet to one delivery pipe is located in the centre of first half while the inlet to second delivery pipe is in the second half of the vortex pipe. Flow to the delivery pipes approaches from two sides, thus reducing the velocity in the vortex pipe by 50%, as also the friction loss.

Velocity in vortex pipe is thus.

$$Q = \frac{1100}{4} = 275cs$$

$$A = \frac{\sqrt{D^2}}{4} = \frac{\sqrt{7^2}}{4} = 38.4$$

$$V = \frac{275}{38.4} = 7.15'/sec.$$

The opening of the slit at the top of Vortex pipe is 1/6th its diameter

$$= 7/6 = 1.1'$$

Say = 1.2'

4.0 HEAD LOSSES IN THE SYSTEM

4.1 i) Head loss due to entrance in the vortex tube.

$$= 0.5 \frac{V^2}{2g}$$

$$= 0.5 \times \frac{7.15^2}{2 \times 32.2}$$

$$= 0.39'$$

ii) Velocity head in vortex pipe $= \frac{V^2}{2g} = \frac{7.15^2}{64.4} = 0.78$

iii) Head loss due to friction in the vortex pipe in a length equal to one quarter.

$$= = 39'$$

By Manning's Formulae

$$V = \frac{1.486}{n} R^{2/3} S^{1/2}$$

$$\frac{155}{4}$$

$$\frac{1.486}{0.016} \left[\frac{\sqrt{D^2}}{4\sqrt{D}}\right]^{2/3}$$

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$7.15 = \quad x \quad S^{1/2}$

$$R = \frac{\text{Area}}{\text{Wetted perimeter}}$$

$$7.15 = 92.8 \times \left[\frac{7}{4}\right]^{2/3} S^{1/2}$$

$S = 0.0028$

Hence loss due to friction in 39' length of pipe.

$S \times 39 = 0.0028 \times 39 = 0.11'$

(iv) Head loss due to double bend from Vortex to Delivery tube;

$$(0.5 \times \frac{V2^2 - V1^2}{2g}) \times 2 = (0.5 \times \frac{11^2 - 7.15^2}{64.4}) \times 2$$

$= 1.08'$

(v) Head loss due to friction in delivery pipe from point of water entry and exit.

Velocity $V = 11'/sec$

$$11 = \frac{1.486}{0.016} \times \left[\frac{8}{4}\right]^{2/3} \times S^{1/2}$$

$S = 0.0056'/foot\ length$

Loss in shorter delivery pipe length = 39 + 60 = 99'

$= 0.0056 \times 99 = 0.55'$

Loss in longer delivery pipe = 39 + 78 + 60 = 177'

$= 0.005 \times 177' = 0.99'$

(vi) Velocity head in delivery pipe

$$= \frac{V^2}{2g} = \frac{11 \times 11}{64.4} = 1.87'$$

Total Losses through pipes

i) 0.39'
ii) 0.78'
iii) 0.11'
iv) 1.08'
v) 0.99' in the longer delivery pipe (it is only 0.55' in the shorter pipe)
vi) 1.87'

Total 5.22'

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Adding loss at creating vortex velocity = 2.74'

Depth 'd' over vortex tube = 6.65'

The W.L at exit of longer delivery pipe = 803.4 - (5.22 + 2.74 + 6.65)

= 803.4 - 14.61 = 788.79

This will be the W.L in outlet well and the F.S.L. in the tailrace at this point should be some what lower for easy evacuations of silt.

5.0 STRUCTURAL DESIGN

5.1 a) The vortex pipe shall be designed for external loading of highest water depth in the channel.

b) Delivery pipe will be designed for extra loading of earthen embackment on its exit end under which it will pass, plus traffic load if it is being used as a road.

c) Internal pressure in the pipes will also be due to water, but it will be mostly balanced.

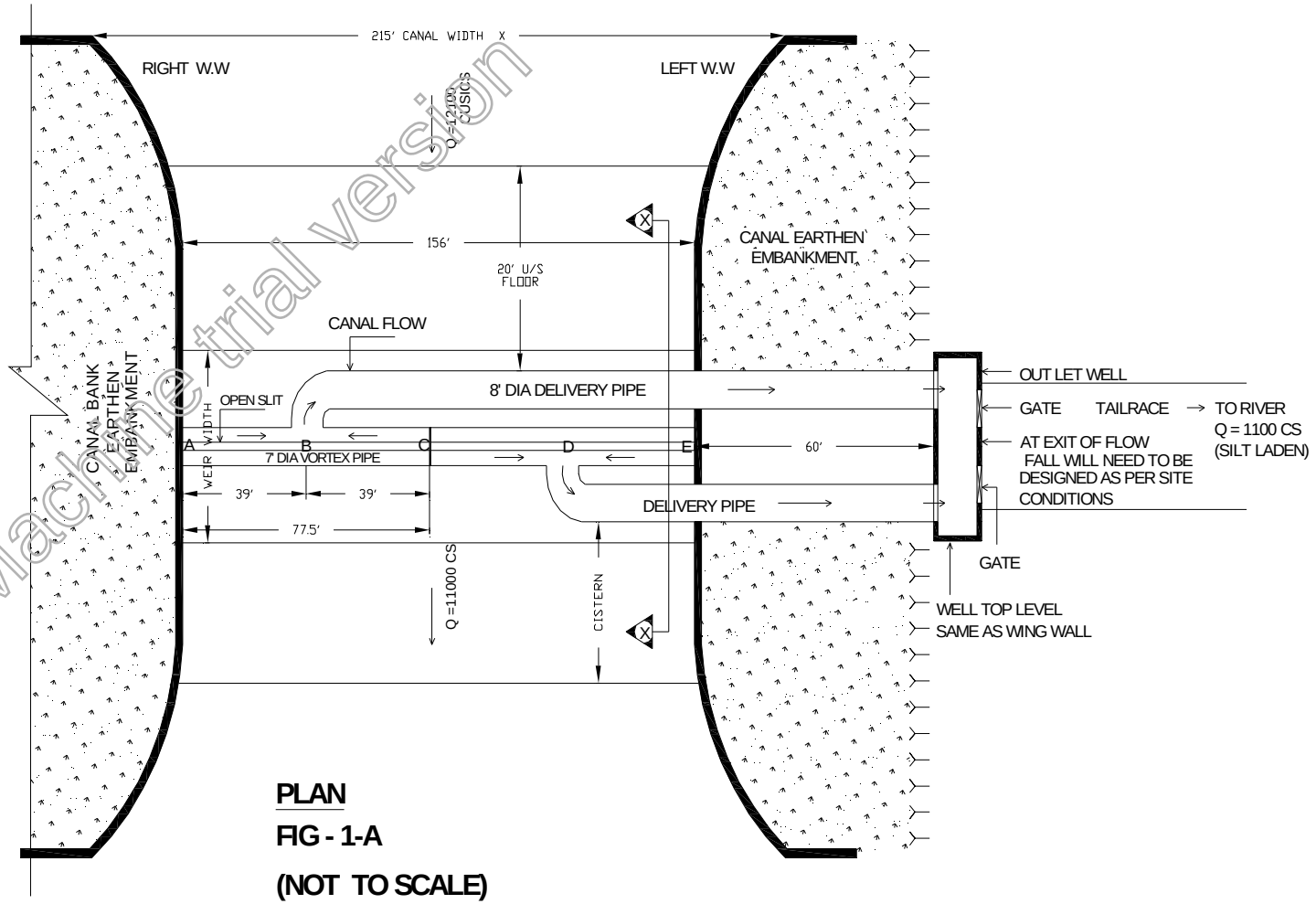
d) No water hammer is expected as the closing and opening of well gates will be gradual.

5.2 During full and more during partial flow in the canal some drop will be created across the raised weir for which the structure should be designed as a fall with some hydraulic jump formation. The downstream floor thus provides a cistern and impact blocks. This aspect may be checked and properly designed.

5.3 Beyond the outlet well the water carrying silt has to be bypassed through a tail race channel back to the river. Generally there would be a drop at this point which has to be properly designed as a drop structure for dissipation of energy.

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VORTEX SILT EJECTOR

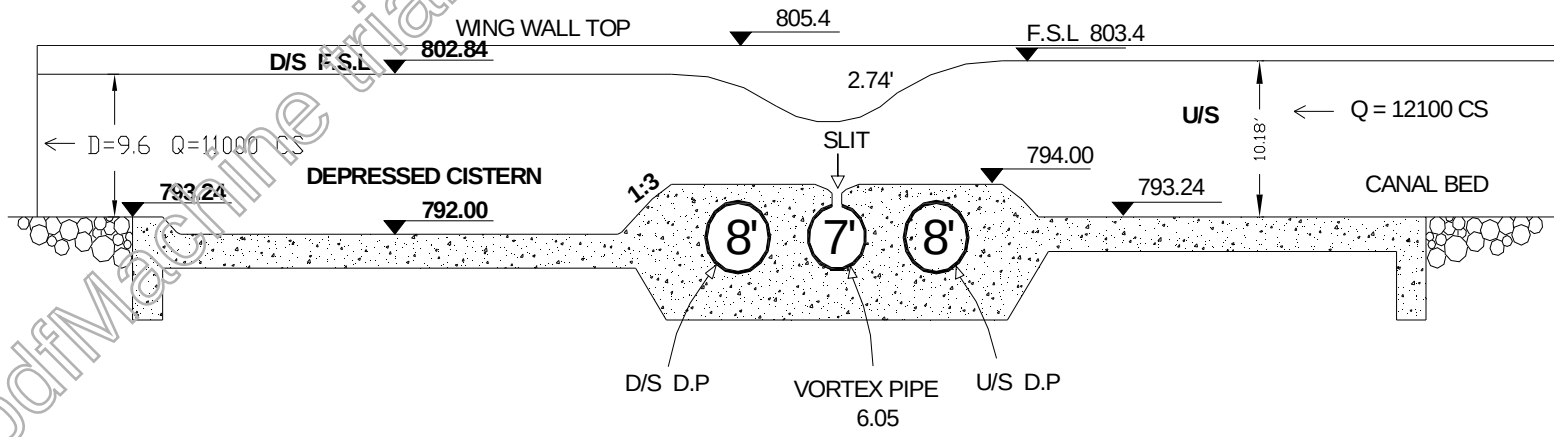


PLAN

FIG - 1-A

(NOT TO SCALE)

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SECTION AT X-X

FIG - 1-B

(NOT TO SCALE)

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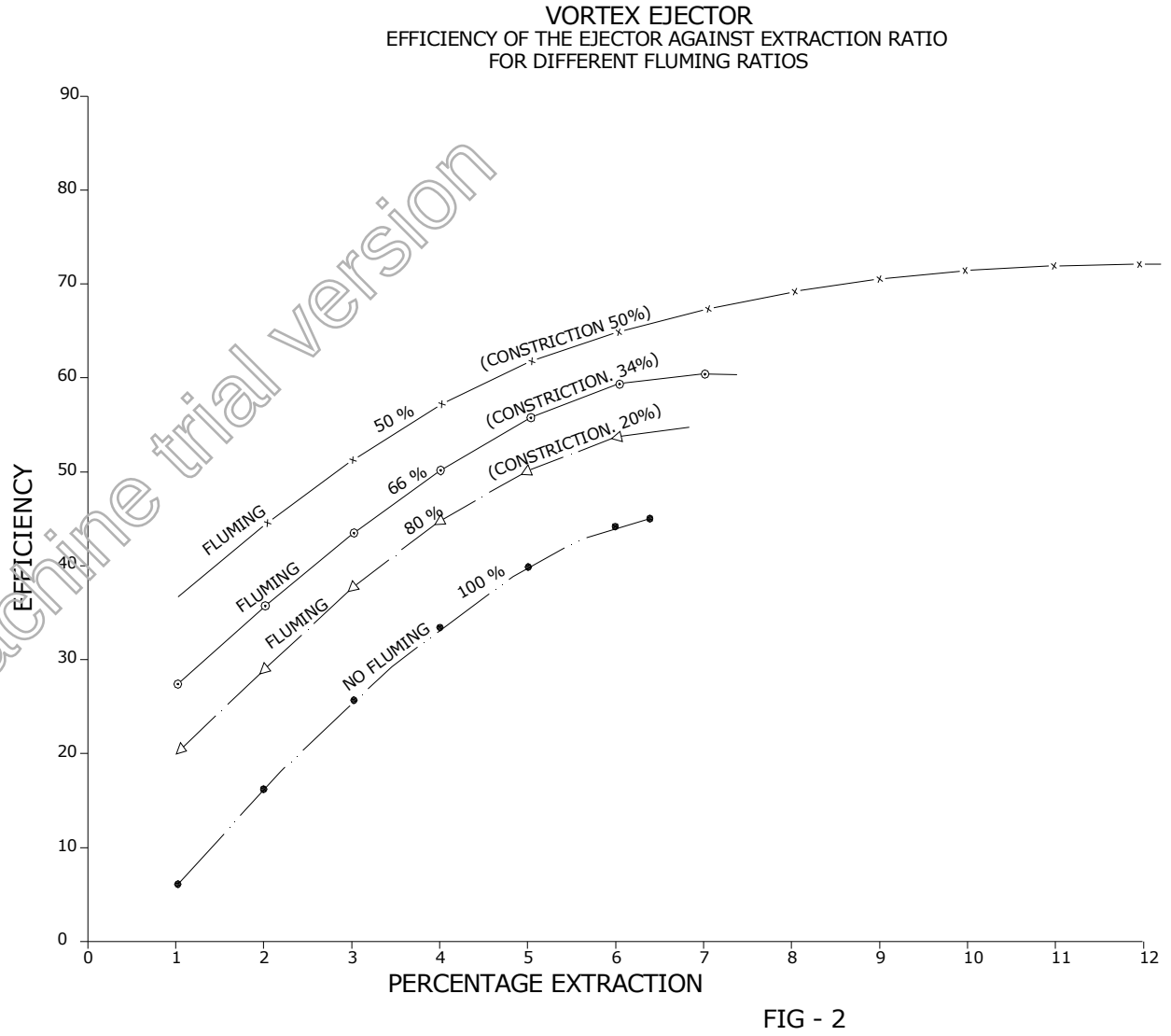


FIG - 2

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2. Authors design of Vortex Silt ejector on Upper Jhelum Canal up-stream of Shadiwal Hydel Station in 1960, when I was working in the Central Design Office. As the Author left the Irrigation Department soon after it is not known whether the structure was built and is functioning.

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Climate Change : Are South Asia's ecosystems at the brink of extinction?

December 2, 2009 – South Asia is endowed with an exceptional array of biodiversity. Its vast geography spans several diverse ecosystems, from the mountains of the Himalaya-Hindu Kush, to the Thar Desert, and the coral reefs and atolls of Maldives. The United Nations Environment Programme (UNEP 2001) notes that the regions' ecosystems occupy about 3.6% of the world's area but contain 16% and 12% respectively of the floral and faunal species found in the world. "But today *South Asia's natural resources face tremendous pressure from rapid population growth,"* said **Richard Damania***,* World Bank Lead Environmental Economist for the South Asia Region speaking ahead of the United Nations Climate Change Conference **in Copenhagen, Denmark** from December 7 to 18, 2009. *"In addition, rapid economic expansion has led to unsustainable extraction of natural resources and accelerating levels of air and water pollution*."

Contributions of Ecosystems

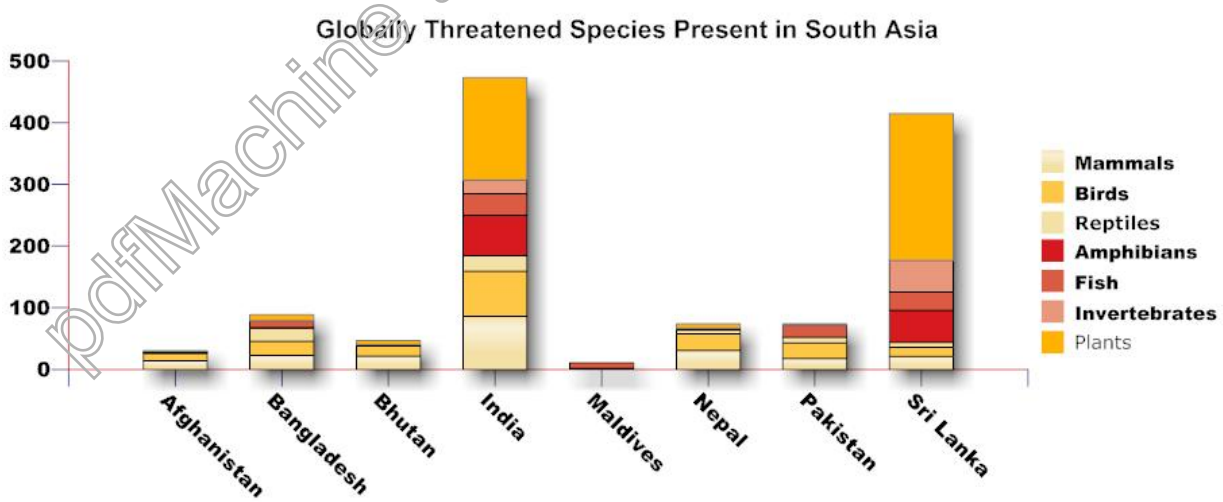
It is seldom recognized, nor adequately acknowledged that the region's ecosystems underpin the economic fortunes of its poorest and most vulnerable people. Poverty through much of South Asia has re-treated to the rural hinterland and has become deeply intertwined with resource degradation.

The region's ecosystems support critical life-sustaining services (through soil formation, nutrient cycling, primary production, oxygen production, and habitats) and regulate processes crucial to well-being (air quality, climate, water flow, soil retention, water purification, and biological and disease control). Yet 10–30% of the region's faunal species are currently under threat of extinction.

"*Biodiversity has been crucial in ensuring food security, nutrition, access to water, good health, and the environmental sustainability of the region*," said **Damania**. "*Appropriate management of natural systems can, therefore, play a critical role in the development choices of the region.* "South Asia Region, The World Bank Group".

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Conservation Status



Impacts of Climate Change

Climate change and biodiversity are closely linked and each impacts the other. Biodiversity is threatened by human-induced climate change, but biodiversity reduces the impact of climate change. The presence of healthy biodiversity builds natural resilience to climate extremes: as an example, forests are nature's social security check in times of disaster and crisis; additionally forests also act as a sink for harmful greenhouse gas emissions.

“The loss of iconic species like the tiger are highly visible if we choose to look,” said **Damania**. “But *there are more subtle impacts of degradation as ecosystems lose their ability to perform sequestration. This could aggravate the impacts of climate change.*

This degradation can be managed and reduced through adaptive and mitigation strategies. This calls for a greater investment in protecting and enhancing ecosystem services, managing habitats for endangered species, creating refuges and buffer zones, and establishing networks of terrestrial, freshwater and marine protected areas that take into account projected changes in climate.

Risks to grazing, mountains and forests

Forests account for about 20–30 % of the total land area of India, Nepal, and Sri Lanka and about 68% in Bhutan. Savannas and dry forests are grazing areas for the region’s large population of livestock, which is essential to food security and agricultural draught. Climate change will affect the vegetation, productivity, and biodiversity of these ecosystems.

While climate change could improve forest productivity in the short to medium term, the resulting transformation of vegetation systems is likely to result in a loss of biodiversity and productivity as critical thresholds are reached.

The 2007 IPCC Fourth Assessment Report projects that carbon fertilization may likely lead to net primary productivity gains in the short and medium term with the gains experienced in some forest types outweighing the losses in others. Some vegetation types are likely shift to higher elevations as a result of global warming. Some vegetation types may disappear in the process, together with dependent species and ecosystems.

Challenges facing marine ecosystems and coastal communities

Coral reefs are not unlike tropical rainforests in biodiversity and are important sources of tourism revenue. Along with mangroves they also protect coastal areas against erosion, sedimentation, floods, and storm surges. “*Climate change will alter these ecosystems through changes in hydrology, sea level, sea temperature, and water chemistry*,” said **Damania.**

The irreversible losses to biodiversity would adversely impact economic opportunities in coastal communities. Coral coverage in the Indian Ocean islands and South Asia combined has declined from more than 40% in 1997 to just over 20% in 2002. This is translating into losses to fisheries, mangrove ecosystem productivity, and tourism.

Future Directions

Damania stressed that the impact of climate change on ecosystems and biodiversity is a key development concern to be integrated into development programs and responses to climate change. He cautioned though there were significant gaps in knowledge about these systems and the impact of changes within them. “Making good development choices *now requires a considerable investment in knowledge building*.”

Also critical would be vastly expanding the protected area networks that have been heavily degraded and fragmented in much of South Asia.

So how does this agenda attract funding? **Damania** said donor development giants and funding for climate change adaptation are some obvious source but market-based instruments and the revenue-generating value of biodiversity itself are full of potential.

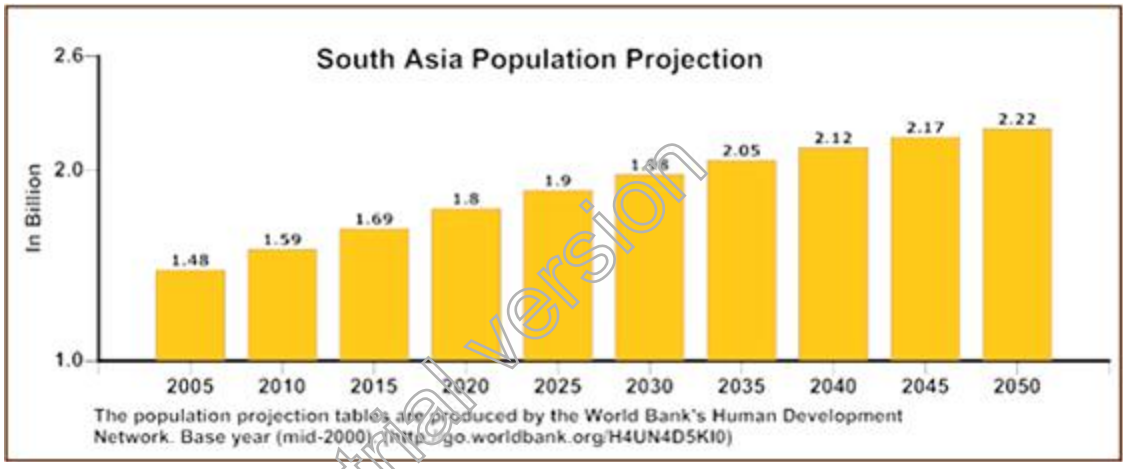
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Why is South Asia Vulnerable to Climate Change?

December 1, 2009 - Geography coupled with high levels of poverty and population density has made South Asia especially vulnerable to the impacts of climate change.

Speaking ahead of the **United Nations Climate Change Conference in Copenhagen, Denmark** from December 7 to 18, 2009, **Richard Damania**, World Bank Lead Environmental Economist for the South Asia Region said the region faces daunting climate-related development challenges. "*Impacts ranging from of higher temperatures to more variable precipitation and more extreme weather events are already being felt in South Asia*. *It has been projected that these will intensify*."

High population levels mean greater pressure on an already stressed natural resource base. By 2050, South Asia's population is likely to exceed **2.2 billion from the current level of 1.5 billion**. "*With an estimated 600 million people currently subsisting on less than $1.25 a day in South Asia, even small climate shocks can cause irreversible losses and tip a large number of people into destitution*," said **Damania**.



About 70% of South Asians live in rural areas and account for about 75% of the poor. Most of the rural poor depend on agriculture for their livelihoods. **Damania** said agriculture employs about 60% of the labor force, but contributes only 22% of regional GDP. "*With their rural economies closely tied to climate sensitive sectors such as agriculture, the poor are likely to be disproportionately affected by climate change*."

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Mountains and Rivers

South Asia is endowed with great rivers, which are the lifelines of the regional economy. The ice mass covering the Himalaya-Hindu Kush mountain range is the source of the nine largest rivers of Asia, including the Ganges, Brahmaputra, and Indus. **The Himalayan system shapes the critical and often unpredictable monsoon dynamics.** It acts as a natural reservoir for sustaining crops and providing groundwater recharge.

The Himalayan ecosystem also sustains some 1.5 billion people who live directly in the floodplains of its many rivers.

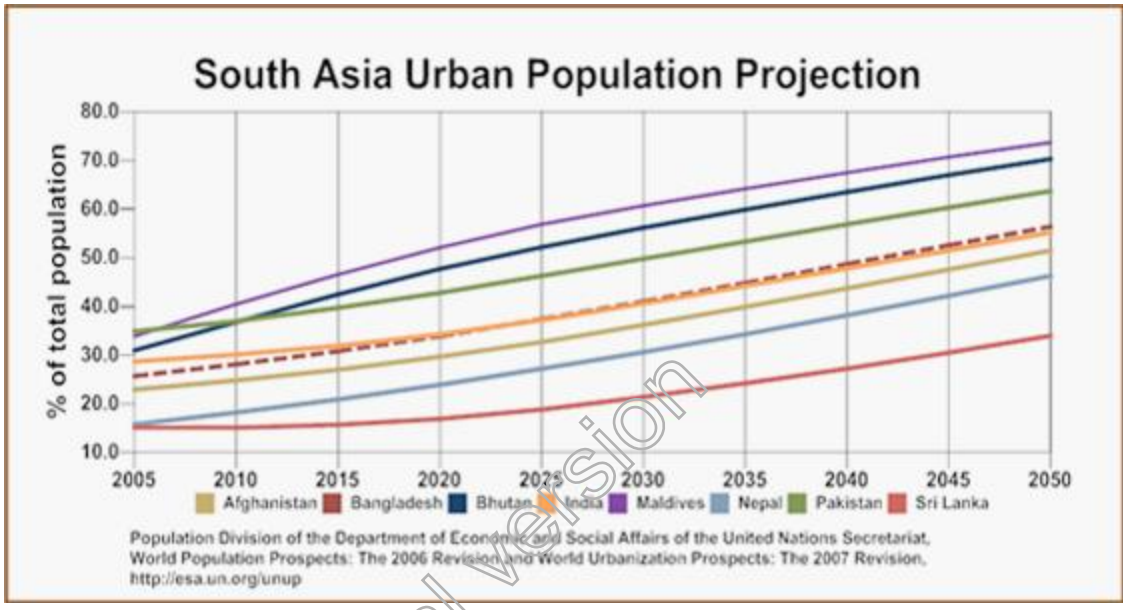
There is general agreement that widespread retreat of the global ice cover has been occurring since at least the early 1800s. "*With rising temperatures the ice mass of the Himalaya - Hindu Kush could retreat more rapidly than the global average in some locations*," said **Damania**.

The receding trends of some glacier masses could threaten water supplies, livelihoods and the economy of the region. With melting of some glaciers, flood risks would increase in the near future. "*In the long term, there can be no replacement for the water provided by glaciers, and this could result in water shortages at an unparalleled scale*," warned **Damania**.

Rapid urbanization

South Asia is home to some of the fastest growing cities in the world. **By 2020, Mumbai will be the second largest city in the world, closely followed by Delhi, and Dhaka.** With Karachi and Kolkata, **5 of the world's 11 megacities (10+ million) will then be in South Asia**.

In Mumbai, more than half the population is crowded into about 2,000 densely populated slums that are at risk from flooding and where settlements lack basic protective infrastructure. There are particular challenges in making cities climate resilient. "*This requires improving infrastructure, governance and finance*," said **Damania**. "*Without a substantial investment in basic amenities and infrastructure in these large cities, climate change will exacerbate existing vulnerabilities*."



In sum, high population densities, a large concentration of poverty, and climate variability have all combined to make South Asia highly sensitive to the consequences of climate change. "*Climate change will likely compound the pressures on key resources associated with growth, urbanization and industrialization*," said **Damania**.

Vulnerability to natural disasters

South Asia suffers an exceptionally high number of natural disasters. Between 1990 and 2008, more than 750 million people—50% of the region's population—were affected by at least one weather-related disaster, leaving almost 60,000 dead and resulting in about $45 billion in damages. As climate-related risks intensify, there will be a need to respond proactively to build resilience through prevention and preparedness rather than through relief and response.

Need for regional cooperation

Regional cooperation can play a key role in adaptation and development in the Himalayan region. With climate change, the monsoons and their associated droughts and floods are expected to become more intense and less predictable. Coping with these mounting extremes in the river basins of South Asia will require more basin-wide information to predict and warn against calamity. It will also call for more basin-wide river management, with coordinated capacity to lower flood peaks and augment low-season flows.

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Dead Sea needs world help to stay alive

Ahmad Khatib – Wed Nov 25, 2009.



The Dead Sea may soon shrink to a lifeless pond as Middle East political strife blocks vital measures needed to halt the decay of the world's lowest and saltiest body of water.

The surface level is plunging by a metre (three feet) a year and nothing has yet been done to reverse the decline because of a lack of political cooperation as a result of the Arab-Israeli conflict.

The shoreline has receded by more than a kilometre (around a mile) in some places and the world-famous lake, a key tourism destination renowned for the beneficial effect of its minerals, could dry out by 2050, according to some calculations.

"It might be confined into a small pond. It is likely to happen and this is extremely serious. Nobody is doing anything now to save it," said water expert Dureid Mahasneh, a former Jordan Valley Authority chief.

"Saving the Dead Sea is a regional issue, and if you take the heritage, environmental and historical importance, or even the geographical importance, it is an international issue."

Landlocked between Jordan, Israel and the West Bank, the Dead Sea is rapidly vanishing because water which previously flowed into the lake is being diverted and also extracted to service industry and agriculture.

Jordan decided in September to do it alone and build a two-billion-dollar pipeline from the Red Sea to start refilling the Dead Sea without help from proposed partners Israel and the Palestinian Authority.

However, that project is controversial and Mahasneh stressed that Jordan alone is not capable of solving the Dead Sea's problems.

The degradation began in the 1960s when Israel, Jordan and Syria began to divert water from the Jordan River, the Dead Sea's main supplier.

For decades, the three neighbouring countries have taken around 95 percent of the river's flow for agricultural and industrial use. Israel alone diverts more than 60 percent of the river.

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The impact on the Dead Sea has been compounded by a drop in groundwater levels as rain water from surrounding mountains dissolved salt deposits that had previously plugged access to underground caverns.

Industrial operations around the shores of the lake also contribute to its problems.

Both Israel and Jordan have set-up massive evaporation pools to vaporise Dead Sea water for the production of phosphate, while five-star hotels have sprung-up along its shores, where tourists flock for the curative powers of the sea mud and minerals.

The salty lake is currently 67 kilometres (42 miles) long and 18 kilometres (11 miles) wide.

The top of the water was already 395 metres (1,303 feet) under global sea level in the 1960s but the drying out has lowered the surface further to minus 422 metres (1,392 feet), according to Friends of the Earth Middle East (FoEME).

Mahasneh says climate change is aggravating the crisis. "Climate change affected everything," he said. "It's an umbrella for many problems, including short rainfall.

"Nothing is being seriously done to tackle climate change. Sustainable and integrated solutions are needed."

The World Bank has funded a two-year study of the plan for a pipeline from the Red Sea to replenish the Dead Sea.

The project, agreed in outline by Israel, the Palestinian Authority and Jordan in 2005, aims to channel two billion cubic metres (70 billion cubic feet) of water a year via a 200-kilometre (120-mile) canal to produce fresh water and generate electricity as well as raise the Dead Sea.

But some environmentalists say the scheme could harm the Dead Sea further by changing its unique chemistry by introducing Red Sea water.

"We are dealing with at least two sensitive and different ecosystems: the Dead Sea and the Red Sea. We also need to keep an open mind about other possible alternatives," said Munqeth Mehyar of FoEME.

Mahasneh supports the plan, saying: "The Dead-Red project is like a salvage plan -- there is no other option. But it won't be an easy task for political and economic reasons."

Jordan's Environment Minister Khaled Irani said: "Let's wait and see the results of the study of the environmental impact."

"We might not go ahead with the project if it is going to create a major mess with the ecosystem, but if we can bring water to the Dead Sea and maintain the same ecological quality of the Dead Sea, why not?"

Friends of the Earth's Mehyar believes saving the Jordan River is key to the Dead Sea.

The waterway is under severe ecological strain because large amounts of raw sewage gush untreated at various locations into the relative trickle left after the diversion of most of the Jordan River.

During the past 50 years, the river's annual flow has dropped from more than 1.3 billion cubic metres (46 billion cubic feet) to around 70 million cubic metres (around 2.5 billion cubic feet), according to FoEME.

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"We are working hard to push for rehabilitating the Jordan River by increasing and maintaining its flow in order to save it and save the Dead Sea," Mehyar said.

"The Dead Sea is in danger and that's for sure. I can't claim that we can prevent the level of the Dead Sea from dropping more, but I think we can control the problem and cooperation from all sides is a must."

Most of the springs in the Jordan Valley which flow directly into the Dead Sea are currently dammed, according to water experts.

Jordan, where the population of around six million is expanding by 3.5 percent a year, is a largely desert country that depends greatly on rainfall. It needs every drop of water to meet domestic, agricultural and industrial requirements.

The tiny kingdom, forecasts that it will need 1.6 billion cubic metres (56 billion cubic metres) of water a year by 2015, is one of the 10 driest countries in the world, with desert covering 92 percent of its territory.

"We need to make sure that there is always running water flowing into the Dead Sea," Irani said.

"The Dead Sea is unique in many aspects, not only for Jordan, but also for the Israelis and Palestinians."

One side effect of the lake's falling water volumes is the appearance of large sinkholes along its shores, creating serious problems for farmers and businesses.

There are an estimated 100 sinkholes in Ghor Haditha alone. They can open up at any time and swallow up everything above ground like a devastating earthquake.

"These sinkholes are time bombs. They can appear any time and eat everything up," said Fathi Huweimer, a field researcher with FoEME.

"Farmers do not feel secure and are anticipating more trouble. This problem is because of the degradation of the Dead Sea."

A factory for Dead Sea products in the area has had to relocate after a large sinkhole appeared beneath it, threatening the lives of more than 60 workers, Huweimer said.

The Dead Sea may soon shrink to a lifeless pond as Middle East political strife blocks vital measures needed to halt the decay of the world's lowest and saltiest body of water. Environmentalists will plead for help at the Copenhagen summit on climate talks next month.

Mian Iftikhar Ahmad
Environmental Consultant

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PARTICIPATION OF PAKISTAN DELEGATION

In 60th IEC Meeting and 5th Asian Regional Conference, New Delhi, India (from 6-11 December 2009)

Pakistan Engineering Congress is the Premier Professional Body of Engineers in Pakistan since 1912, pursuing its main objective of promoting Science, Profession and Practice of Engineering by providing its members maximum opportunities for meeting periodically, discussing, propagating and taking up matters of professional concern. It has always been a specialized institution in the intellectual activities and there can be no two opinions about the great utility of the organization for making the most valuable and significant contribution to enhance the engineering knowledge and research especially in the water sector. Building on its past experience, and accomplishments, such as presentation of the research of Kennedy and Khosla from its platform, which are considered to be the master piece of applied research in the field of Irrigation Engineering, it continues to engage itself in much wider prospective. Pakistan Engineering Congress has not only confined it self to a local level but being committed for enrichment and up-gradation in the field of Engineering and Technology has taken many initiatives, including digitization of entire research work since 1912 till to date and making it available free of cost on web apart from active collaborative participation in other technical organizations / forums.

International Commission on Irrigation & Drainage (ICID) is one of such organizations, where Pakistan Engineering Congress has been a participant in different sessions, and regional conferences, addressing and discussing important, current, regional and global issues. ICID was established as a Scientific, Technical and Voluntary Not-for-profit Non-Governmental International Organization (NGO) with headquarters in New Delhi, India. ICID started its operations on June 24, 1950, dedicated to enhancing the worldwide supply of food and fiber for all people by improving water and land management and the productivity of irrigated and drained lands through appropriate management of water, environment and application of irrigation, drainage and flood management techniques. This year, International Commission on Irrigation & Drainage (ICID) celebrated its Diamond Jubilee year, completing 60 years of its experience in the transfer of water management technology and in the handling of related issues.

This event was even more significant for Pakistan Engineering Congress, as the Pakistan delegation participating in this Mega Event, was competently led by its President, Engr. Husnain Ahmad.

In this historic occasion for ICID, the 60th International Executive Council (IEC) meeting and 5th Asian Regional Conference (ARC) were held during 6-11 December 2009 at Vigyan Bhawan in New Delhi, India. The 5th Asian Regional Conference highlighted the theme of "**Improvement in Efficiency of Irrigation Projects through Technology Up-gradation and Better Operation & Maintenance".** During above events, over 32 ICID work body meetings and 6 Special Sessions were held. The papers received for 5th Asian Regional Conference were presented in 20 technical sessions.

The Mission of ICID is to stimulate and promote the development and application of the arts, sciences and techniques of engineering, agriculture, economics, ecological and social sciences in managing water and land resources for irrigation, drainage, flood management and river training applications, including research and development and capacity building for achieving sustainable irrigated agriculture. Starting with 11 founding member countries in June 1950, today 107 countries have so far been admitted to the fold of ICID for sharing its efforts in the direction of sustainable irrigation. Currently, 66 countries are actively participating in the activities of ICID, including Pakistan as one of its founding members.

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The event brought together 740 delegates from 47 countries across the world, of which about 440 local delegates and representatives from international organizations participated in various events to make it practically successful.

The ICID event stood glorified with joining of the Honorable Prime Minister of India **Dr. Manmohan Singh**, who inaugurated the 5th Asian Regional Conference held alongside of 60th International Executive Council Meeting. **Mr. Pawan Kumar Bansal**, Hon'ble Union Minister of Water Resources, **Mr. Vincent H. Pala**, Hon'ble Minister of State for Water Resources, **Mr. U.N. Panjiar**, Secretary of Ministry of Water Resources, **Mr. A.K. Bajaj**, Chairman, Central Water Commission / Indian National Committee of ICID, **Prof. Dr. Chandra A. Madramootoo**, President of ICID and **Er. M. Gopalakrishnan**, Secretary General, ICID also graced the occasion.

Hon'ble Union Finance Minister **Mr. Pranab Mukherjee** was the chief guest for the closing ceremony. **Dr. Montek Singh Ahluwalia**, Deputy Chairman, Planning Commission, **Mr. Sachin Pilot**, Hon'ble Minister of State for Communications & Information Technology and **Mr. S. Manoharan**, Additional Secretary, Ministry of Water Resources, also honored the occasion.
Special postal cover marking the 'Diamond Jubilee Year' (1950-2009) of ICID was released during the closing ceremony.

The six member delegation, led by **Engr. Husnain Ahmad, *President of Pakistan Engineering Congress***, along with;

- **Engr. Syed Mansoob Ali Zaidi**
  Senior Vice-President Pakistan Engineering Congress / Former Secretary Irrigation & Power Govt. of Punjab and Life Member of American Society of Civil Engineers (ASCE)

- **Mr. Hassan Javaid Afridi**
  Vice President (Water Resources Division)
  National Engineering Services Pakistan (Pvt.) Ltd

- **Mr. Bashir Ahmed Sial**
  General Manager (Water Resources Division)
  National Engineering Services Pakistan (Pvt.) Ltd

- **Prof. Dr. Rai Niaz Ahmad**
  Chairman Irrigation & Drainage Department
  University of Agriculture
  Faisalabad

- **Dr. Muhammad Arshad**
  Associate Professor Irrigation & Drainage Department
  University of Agriculture
  Faisalabad

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Participation of the Pakistan delegation, compared to other delegations attending the occasion was considered as the most effectual and exceptionally commendable, not only because of its active participation in each and every session of Working Groups (WG's), Task Forces, and various Committee meeting(s) but also for its valuable contributions. It was the most sought after delegation and especially came into the glare of publicity when:

- Prof. Dr Rai Niaz Ahmad's *'Wheat Bed Planter'* won him the WatSave Technology Award 2009. The bed planting machine develops two beds and three furrows in single operation. This machine is the result of Dr. Rai's individual research spanning more than a decade. It is designed to plant furrows on one bed. A furrow for irrigation separates each bed.

There is a buffer zone in the center of four rows on the bed. The machine develops two lines of crop on both sides of the furrow. Each furrow irrigates only 20 cm (8 inches) of the adjacent bed. The center to center distance of two beds is 90 cm (36 inches) with a bed of 60 cm (24 inches). Thus, the machine has provision to plant 4 lines in 90 cm (36 inches) width while maintaining the traditional plant population. This saved 45% of water compared to traditional methods, with 17% increase in yield. The machine has been used for other crops (cotton, maize and rice with different but similarly impressive results). The water productivity improvements were achieve don 815 ha at four locations, but the technology has great potential (8.4 Mha of wheat in Pakistan alone). The work of Dr. Ahmad can be more succinctly termed as "*Bed Planting Machine*". Engr. Husnain Ahmad on his behalf received the **WatSave Award-2009** during 60 IEC meeting in a prestigious ceremony from the president ICID Prof. Dr. Chandra A. Madramootoo,

- Due to his credentials, **Engr. Husnain Ahmad**, President, Pakistan Engineering Congress & head of the delegation was selected as member for "**Permanent Committee for Technical Activities**" (PCTA).

- In addition to Engr. Husnain Ahmad's nomination on PCTA, the Pakistan delegation comprising of 6-members bagged:

    - 5-Nominations on Working Groups
    - 1-Nomination on Task Force

The Pakistani contingent being the forefront fraction of the mega event, won appreciation of the World, by receiving great recognition through its achievements. It was a remarkably laudable feat of the professionals from Pakistan, to be a highlighted part of such prestigious event, building the esteem and honor of their Country.

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President Pakistan Engineering Congress, Engr. Husnain Ahmad, receiving a memento from President ICID, Prof. Dr. Chandra A. Madramootoo