WORLD WATER DAY

22ND MARCH 2006

Celebrated by

PAKISTAN ENGINEERING CONGRESS

In collaboration with

Water and Power Development Authority

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FOREWORD

By

ENGR. CH. GHULAM HUSSAIN*

ON

WORLD WATER DAY MARCH 22, 2006

The comity of nations in 1992 during the Conference of Environment and Development (UNCED), in Rio de Janeiro took a historic decision to observe **"World Water Day"** every year on March 22 in every country. Seminars/Workshops are held on this Day the world over to educate and muster consensus of the masses for finding ways and means to combat the impending menace of ever depleting water availability that could lead to annihilation of the very life on earth. As a follow-up UNO during the 58th Session declared 2005-2015 period as the international decade for action **"Water for Life"**.

Pakistan Engineering Congress rose to the occasion and on March 22, 2005 held the World Water Day in collaboration with Water and Power Development Authority (WAPDA). Six Technical papers were presented and discussed at that occasion which have since been published in the book form and have become as useful addition to the technically rich archives of the Pakistan Engineering Congress.

In the foreword of that booklet, it had amply been elaborated that **water is life** as has been revealed by the Almighty; as it is manifest from burgeoning living organisms at places where water is available and as it is evident from non-existence of life in great deserts which are devoid of water.

In that foreword it was suggested that there could be many more topics for technical papers which could be attended to in the future fora of **World Water Day**.

Thanks to the continued cooperation of WAPDA, Pakistan Engineering Congress managed to present eight more technical papers on World Water Day of 22nd March year 2006 also.

In his address of welcome President Pakistan Engineering Congress, on this eve, dwelt elaborately on all aspects of water requirements, its availability its influence on Society and Culture and our duty towards its judicious use and conservation for posterity.

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* Vice-President / Convener Publication Committee, Pakistan Engineering Congress and Managing Partner, National Development Consultants.

Engr. Muhammad Mushtaq Chaudhry, Member (Water) WAPDA in his introductory remarks compared tug of war between nations for sharing of waters of rivers flowing through their countries in Africa, Middle East etc. with Indus Water and the complications Pakistan was confronted with. He spoke of the efforts WAPDA is making, in conservation of water through construction of Large and Small Dams. His address to the audience can also be taken as a technical Paper in the context of World Water Day.

It is earnestly hoped that WAPDA will continue not only to explore and construct more water reservoirs but also remain associated with Pakistan Engineering Congress in this noble cause of holding regular **World Water Day** every year to come.

Engineers and Scientists are also expected to come up with their papers relating to water i.e. its surface and sub-surface availability and conservation; its management/mining and its judicious supply to all alike, environmental hazards in the context of water and in whatever form they appear relating to it viz-a-viz their solutions etc. etc.

Written discussions on the papers issued in the last Volume relating to March 22, 2005 were invited from engineers and scientists with the aim of publishing a **"Discussion Volume"** but the request failed to elicit any response. A similar written discussion would be welcome from engineers and scientists on the papers contained in this volume.

ADDRESS OF WELCOME

By

ENGR. RANA MUHAMMAD SAEED AHMAD KHAN*

ON

WORLD WATER DAY MARCH 22, 2006

Honourable Chief Guest Engr. Muhammad Mushtaq Chaudhry, Member (Water) WAPDA, distinguished Guests, Members of the Congress

Ladies & Gentlemen

It is my pleasure to welcome you all to this gathering for ceremonizing the World Water Day. I have also to thank the respected Chief Guest and all of you for finding some time to attend this event of global importance.

I am grateful for providing me an opportunity to be with you to address this august body of engineers and scientists all those are concerned with the protection and conservation of water.

Ladies & Gentlemen

Water is probably the only natural resource to touch all aspects of human civilization from agricultural and industrial development to the cultural and religions values embedded in society. I'he need and demand for water have been a driving force for health, for society, for economic prosperity, for cultural significance, and development, throughout human history. Water demand is hence increasing day by day due to growth in population and economic activities, which are all dependent, directly or indirectly on the exploitation of water as resource. In recent decades, water has fallen in our esteem. No longer an element to be revered and protected, it is a consumer product that we have shamefully neglected. Eighty percent of our bodies arc formed of water, and two thirds of the planet's surface is covered by water.

President Pakistan Engineering Congress.

Realising the fresh water problem globally in near future, the comity of Nations rose to the occasion and in 1992 during the United Nations Conference on environment and development (UNCED) in Rio-de-Janeiro took the initiative for observance of World Water Day starting on 22nd March of every year as of 1993.

Further, UN during its 58th session declared the period from 2005 - 2015 as the International decade for Action "Water for Life" for accomplishing task envisaged in UN Millennium Declaration, The World Water Day since then is being celebrated the World over. On this Day experts on "Water Resources" speak on the "Theme" (& its related issues) laid down for that particular year. This year the Theme is "Water &, Culture". And today in this assembly eminent Water Sector authorities will enlighten us on the relevant issues.

Ladies & Gentlemen

Whereas water is a source of life on earth, the large variety of cultures prevailing in this world are essentially the manifestation of the colors of this life. The anthropologists and other social scientists define the human culture as a learned behaviour acquired by the individuals as a member of the social group.

The human culture reflects the moral values, etiquettes, ethics, social customs, food and dress habits, religious beliefs and practices as well as the collective attitude of the society.

Water has also Religiso – Cultural Connotations. We the Muslims, use water for ablution (Wazu) for offering our prayers five times a day and are enjoined to make economic use of it. As the religion of Islam originated in the deserts of Arabia, the Muslims of those times knew the value of water and did not make wasteful use of it. This has also been emphasized on several occasions by the Holy Prophet ﷺ.

To further illustrate cultural, religious belief and practice I will draw your attention to the Hindu mythology. The River Ganges and its water is considered as "Sacred" as well as an instrument of purification. A dip in the "Ganges" washes away the sins as per ritual of Hindus.

The human culture is partly dependent upon the prevailing natural environment and the available physical and economic resources. This is evident from the water collection practices in different regions of Pakistan. The rural women folk have to travel long distances in water scarcity areas such as Cholistan and Thar as compared to in the central Punjab where abundant water is available. So their social customs, food and dress habits are appreciably different in these regions.

Besides the natural environments and resources, the availability of water has always played a significant role in the development of civilizations and enhancement

of their cultures. The people living in desert areas with scant availability of water, posses a different behaviour and attitude compared to those with easy and adequate access to water Similarly people facing excess water in the form of seasonal floods are bound to have different attitude in life. Thus there seems to be a close and definite relationship between water and human culture.

The culture of a society can undergo a significant change as a result of acquisition of knowledge and technology which *is* evident from our urban society culture.

The extent to which water can influence the human culture is a matter of detailed study and research.

Ladies & Gentlemen

We have assembled here to remind ourselves about the fast approaching water crisis which will effect our culture and the urgency of taking appropriate measures to combat such eventuality. I sincerely hope that this seminar on the World Water Day will discuss valuable ideas and recommendations to be presented by the participants realizing the importance of the matter and come forward with their active support for environmentally sustainable water storage projects which will not efface our cultural environment.

Papers being presented today deal with water and related issues to culture. I will request all of you to kindly participate till the close of the seminar and provide your valuable input.

Thanking you

Pakistan Zindabad

WORLD WATER DAY

MARCH 22, 2006

By

ENGR. MUHAMMAD MUSHTAQ CHAUDHRY*

President Pakistan Engineering Congress, distinguished Guests, Members of the Congress.

The annual "WORLD WATER DAY", as established by the United Nations, in view of the increasing importance that water is assuming in the face of its growing scarcity globally, is observed on 22nd March through out the World, after the 1993 convention of the International Commission on Irrigation and Drainage in The Hague. The conference had agreed that there was no substitute for water, without it humans and other living organisms could not survive, farmers could not grow food and business could not operate.

Providing Water Security is a key dimension of poverty reduction. Water Security "FOR ALL" is an achievable goal and there is enough water for everybody in the World, provided we change the way we manage it. The "WORLD WATER DAY" calls on each nation, and each one of US to maintain and improve the quality and quantity of fresh water available to future generation. The "World Water Day" event is now gaining importance. It is hoped that it will gradually make all nations and people of the World realize that availability of fresh water is something we cannot take for granted, and that water is indeed one of the earth's most precious as well as the most threatened resource.

Looking at world water resources there are signs for serious concern. In Nigeria, Lake Chad has reduced to 33% of its size in 30 years time. In Central Asia, the Aral Sea has reduced by 50% and its salinity has increased tremendously. In Delhi, parts of the city receive water only 4 hours per day. In Lahore, as you are all aware, the water table is going low. In Punjab and Sindh agricultural production is threatened by severe soil salinity, partly due to shortage of water. Gentlemen, the problem is clearly with us.

Looking at the global water resources, it seems there is far more water than human needs. However 97% of this water is contained in the oceans which is highly saline. Most of the fresh water on earth is in the shape of polar ice caps and the glaciers. Although water in all rivers and lakes in the World is in substantial

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* Member (Water), WAPDA.

quantity, there are two problems. First of all, the present World population of 6 billion is growing fast. So with time more and more people would need water and also water use per person would grow. Secondly, and this is even more serious, much of our waters are polluted. It is estimated that at present considerable part of the reliable runoff in the world is used to dilute and transport waste-water and that this portion is growing fast. Furthermore it should be realized, that in pre-industrial times rivers could purify themselves as a natural process. Today, many of our rivers are polluted from source to end.

There is competition for water, between countries, between sectors of the economy and between people. There are three notably dry areas in the world. Africa, the Middle East and South Asia. In all three areas water conflicts between countries occur. In 1948, half a year after partition, India started diverting water from the eastern rivers, which left rivers and canals in Pakistan dry. It took 12 years of hard work and the good offices of the World Bank to arrive at the Indus Water Treaty, and another two decades to complete all engineering works, including Tarbela. Living with a large neighbour is not easy and setting of these issues peacefully takes much time and effort. It is encouraging to see that during the conflicts between India and Pakistan, the Indus Water Treaty was always honoured. It is a good example for other river basins.

Due to the pressure of population on water, there have been numerous disputes for distribution of waters all over the World such as;

- International Cooperation was developed between Republic of South Africa, Swaziland and Mozambique for resolving water dispute of Komati River in November 1991.
- The Nile and its Head Waters flowed through nine African states viz. Burndi, Egypt, Ethopia, Kenya, Rwanda, Suddan, Tanzania, Uganda and Zaire. In 1955 Nile Waters Agreement formed the basis of sharing of waters on Nile River between all the riparians.
- The Euphrates originates in Turkey with 95% of its total flow. It flows through Syria with 4% addition only. There is a conflict about distribution of water between riparian countries for the use of Euphrates and Tigris Waters.
- There is a disputes on the Jordan river waters between Israel, Syria, Jordan and Lebanon and West Bank.
- In our own country where Water Accord was signed in 1991 there arise considerable disputes on water distribution especially during the shortages period, According to Water Accord, distribution among the provinces included a considerable volume of water from storages which are not being built for want of consensus. Demand of water per capita is on the increase due to increase in population and the present situation is that water availability per capita is just on the border line which will soon go below the base level.

In the present day Pakistan's rivers are playing an important role in industrial, agricultural and cultural developments in their surrounding area. Almost 75% of the Population of Pakistan is centered along the major rivers. The situation of water resources in Pakistan has changed. From water effluent country at the time of independence having about 5650 m^3 of water per capita, water availability has now decreased to less than 1350 m^3 per capita. In fact, shortages of water for domestic and industrial use are already being felt in Islamabad, Karachi and many other places. The situation can become worse in a few years due to growing need of water for domestic, industrial and agricultural uses.

Out of the total availability of 154.88 MAF of water, at present we are letting nearly 35.2 MAF on average basis to go to the Sea every year which is about 23% of our wealth of river waters. We need to store this water for ourselves and for our future generations. It is our collective responsibility to think for our future generations. By respecting our history and culture, we should start working for a gradual change from a water short country to a situation where sufficient water is available for domestic, industrial and agricultural use of every Pakistani citizen.

Wherever possible we should not only try to augment the available water, but also to adjust our use of water to what is or can be made available. Presently if we look at the pattern of our water use in agriculture, domestic and industrial sectors, a wasteful culture is frequently found in the society. We flood our fields- to irrigate crops and sometime taps of domestic water are running or leaking unnecessarily. In this regard better water management techniques need to be applied to reduce wasteful use of water. There is a task ahead for all of us in creating awareness about the water shortage and mobilizing support against wastage of the present culture.

I am glad to highlight that under WAPDA's Vision 2025 Programme a good number of water conservation and hydraulic projects are also in various stages of execution. In this regard, the President of Pakistan, General Pervaiz Musharaf, has recently announced the construction and completion of Basha, Munda, Kalabagh, Khurram Tangi and Akhori dams by the year 2016. WAPDA will not leave any stone unturned to timely complete these projects.

At the end I would like to complement the Pakistan Engineering Congress, for jointly organizing this event for observing World Water Day and I hope that the initiative will create awareness among the Pakistani people and raise public support for changing the present culture of water wastage. Meeting the challenges in the water sector requires public support and participation and the World Water Day 2006 will help to achieve the goal. In the end I wish, we — all the scientists, engineers and environmentalists — will be able to harness every available drop of water for the benefit of our present and future generations, in perfect harmony with nature.

Thank you.

WATER AS INSTRUMENT OF PEACE
THE VISION OF INDUS WATERS TREATY 1960

By

ENGR. JAMAAT ALI SHAH

Pakistan Commissioner for Indus Water

The Indus System of Rivers in the Indus Basin comprises the Indus and its five main rivers i.e. the Jhelum, the Chenab, the Ravi, the Beas and the Sutlej. They all combine into one river near Mithan Kot in Pakistan, which outfalls into Arabian Sea south of Karachi. The boundary of the Indus Basin is clearly defined on the West, the north and north-east, by mountain ridges (watersheds). However, the boundary on the south is not so clearly defined due to absence of hills and active rivers. The total area of the Indus Basin is roughly 350,000 square miles. Most of it lies in Pakistan and the rest is in occupied Jammu and Kashmir, India, China and Afghanistan. The climate in the Plains downstream of the rim stations ranges from semi arid to arid in the south. Annual rainfall ranges from about 30 inches to about 2 inches in the south. The total annual average discharge of these rivers at the rim stations (where measured) is about 170 MAF (Million Acre Feet).

2. In August 1947 when South Asia was divided into two independent countries there existed one of the most highly developed Irrigation System in the world and approximately 37 Million Acres received irrigation from the flow waters of the Indus System of Rivers. All of the available water supplies were allocated to the various princely States and Provinces in conformity with the principle of equitable apportionment of the waters with preferential right to existing uses. At the time of Independence major portion of the Indus Basin formed a part of Pakistan and out of 37 Million Acres which received irrigation, 31 Million Acres were in Pakistan. The boundary line between the two countries was drawn without any regard to the irrigation works. It was, however, affirmed by the Boundary Commission and expressly agreed by the representatives of the affected zones before the Arbitral Tribunal that the authorized shares of the two zones in the common water supply would continue to be respected.

3. The water dispute between Pakistan and India had risen soon after the winding up of the Arbitral Tribunal on 31st March 1948. India taking advantage of its being upper riparian at every river, stopped waters in all irrigation canals (irrigation 1.6 Million Acres in Pakistan) from 1st April, 1948, which crossed the India-Pakistan boundary and demanded that Pakistan should recognize that the proprietary rights on the waters of the Rivers in Punjab (India) wholly vested in that

Government and the Punjab (Pakistan) Government could not claim any share of these waters as a right. Pakistan's claim was based upon the time honoured formula that existing uses were sacrosanct and excess water, not previously finally committed, could be divided amongst the riparians according to area, population etc. This principle had the support of several treaties between nations, or states or provisions in the same country.

4. The Indians put forward a principle, which had sometime been advanced during international negotiations, but had nowhere been accepted. Under this principle the upper riparian has an absolute right to the water and the lower riparian can only get it under an agreement or treaty entered into between the riparians.

5. India agreed to restore some of the supplies in May 1948 when a very pro-Indian temporary agreement was signed. It was, however, generally realized that Pakistan could not live without a restoration of the full supplies and, on this question, there could be no compromise. Even internationally there was awareness that there could be a war on this issue.

6. After protracted negotiations, under the good offices of the World Bank, when the World Bank was convinced that the existing uses in Pakistan could not be met by transfer of flow waters from the Western Rivers and that Storages on the Western Rivers were required for the purpose, the Indus Waters Treaty was signed in 1960. The Bank Engineers had worked out their initial proposals on averages ignoring the special needs of the seasons for the sowing and maturing of the crops when the demands of water are maximum and the flow are minimum. It took Pakistan two years to convince the Bank that Pakistan's contentions were correct that the division of the waters put forward by the Bank would not accomplish the results visualized in its proposal. The Treaty consists of 12 Articles and 8 Annexures (A to H). It is based on the division of the Rivers between the two countries. The waters of the Sutlej, Beas and Ravi rivers named in the Treaty "Eastern Rivers" are for the unrestricted use of India and the waters of the rivers i.e. Indus, Jhelum and Chenab, named in the Treaty as "Western Rivers" are for the exclusive use of Pakistan except for certain specified uses allowed to India in their upper catchments.

7. Under the Treaty, Pakistan was required to construct and bring into operation a system of works, which would accomplish the replacement, from the Western Rivers, of water supplies for irrigation canals in Pakistan, which on 15th August 1947 were dependent on water supplies from the Eastern Rivers. These replacement works, comprising two storages Dams (One on Indus River and one on Jhelum River), six new barrages (diversion dams), remodeling of two existing barrages, seven new inter-rivers link canals and remodeling of two existing link canals, have since been completed. There was a Transition Period of 10 years during

which Pakistan was to receive waters from the "Eastern Rivers" for use in the aforementioned canals.

8. Such a division of Rivers was a distinct departure from the concept of international law of upper and lower riparian rights (protection of existing uses from the same source). In this way Pakistan had to forgo the entire perpetual flow of fresh waters of the three Eastern Rivers (24.00 MAF) which it used to historically receive for irrigation.

9. From Pakistan's point of view the settlement plan as envisaged under the Indus Waters Treaty 1960 had some defects as well as advantages. The advantages were:

i) After the completion of Indus Basin Replacement Plan Works each country became independent of the other in the operation of its supplies.

ii) Each country is responsible for planning, constructing and administering its own facilities in its own interests and free to allocate its supplies within its own territories, as it deems fit.

iii) This provides strong incentives to each country to make the most effective use of water, since any efficiency accomplished by works undertaken by either country for storage, transfer, reduction of losses and the like, accrues directly to the benefit of that country. The same is true of efficiency achieved in operation.

iv) The independence afforded by the programme also brought benefit of a different kind. The location of works serving each country or territories under its control, and the assurances against interference by either country with the supplies on which the other depends has reduced the chances of disputes and tension.

v) Before the completion of Indus Basin Project works after signing of the Treaty, the entire irrigation system in the Indus Basin was based on run-of-the river supplies. The hydrology of the Rivers is such that about 80% of the total water was produced during the monsoon period July-September. The winter supplies in drought periods became very critical. With the availability of assured supplies made available with the storage of waters in the Reservoirs, waters availability in winter has been assured and is insignificantly affected in drought conditions. Besides total withdrawals and canal heads in Pakistan has increased from about 67 MAF to 104 MAF.

10. The defects of the settlement plan broadly includes following:

i) The traditional sailab (Flood) irrigation which is the most ancient way of using river waters – on the Sutlej, Beas and Ravi would disappear, because when these rivers are fully developed by India the traditional floods would

decrease or disappear and the sailab areas would not get the seasonal water, which permitted cultivation. This area is quite considerable in extent.

ii) It was feared that when the Eastern Rivers lost their regular flow the channels would silt up and any subsequent flood would cause great havoc in Pakistan in additional to other environmental effects.

iii) The up-keep of the new link canals and storages would mean a very heavy additional burden on the cost of maintaining irrigation. Besides, storages are not substituted to perpetual flow water as the storages have limited life.

11. As an Institutional arrangements, under the provisions of Article VIII(1) of the Indus Waters Treaty 1960, both India and Pakistan have appointed a Commissioner for Indus Waters. Each Commissioner, unless either Government decides to take up any particular question directly with the other Government, is the representative of his Government for all matters arising out of the Treaty and serves as the regular channel of communication on all matters relating to the implementation of the Treaty. The two Commissioners together form the *PERMANENT INDUS COMMISSION.* The Purpose and functions of the Commission are to establish and maintain co-operative arrangements for the implementation of the Treaty, to promote co-operation between the Parties in the development of the waters of the 'Rivers', to make every effort to settle promptly any question arising between the Parties; and to undertake tours of inspection of the Rivers to ascertain facts.

12. Under the Treaty, restrictions have been placed on the design and operation of Hydroelectric Plants, Storage Works and other river works to be constructed by India on the Western Rivers. India is required to supply to Pakistan certain specified information relating to these works at least 6 months in advance of undertaking the river works, to enable Pakistan to satisfy itself that the design conforms to the criteria set out in the Treaty. Within a specified period ranging from two to three months of the receipt by Pakistan of the information, Pakistan has the right to communicate to India, in writing, its objections, if any, that it may have with regard tot he proposed design on the ground that it does not conform to the criteria specified in the Treaty. Under the Treaty there is no restriction on withdrawal of waters by India from the Western Rivers for Agricultural Use. However, restrictions have been placed on the irrigated cropped area to be raised by India in each river basin (Annexure C to the Treaty). The Treaty also provides for the regular exchange of the daily hydrological data and other data under Articles VI and VII(2) of the Treaty.

13. The nature of the ground water in the Indus Basin is such that there are adjoining pockets of both sweet water and brackish water. In some cases the water in upper layer is sweet and in the lower level is it brackish. If not carefully exploited there is always a fear of inter mixing of brackish water with sweet water zone. As

such its exploitation in conjunction with the river flow waters was not considered in working out the Replacement Plan under the Treaty.

14. The Treaty also provides for future cooperation and states in its Article VII(I) as under:

> "The two Parties recognize that they have a common interest in the optimum development of the Rivers, and to that end, they declare their intention to co-operate, by mutual agreement, to the fullest possible extent. In particular:
>
> (a) Each Party, to the extent it considers practicable and on agreement by the other Party to pay the costs to be incurred will, at the request of the other Party, set up or install such hydrologic observation stations within the drainage basins of the Rivers, and set up or install such meteorological observation stations relating thereto and carry out such observations thereat, as may be requested, and will supply the data so obtained.
>
> (b) Each Party, to the extent it considers practicable and on agreement by the other Party pay the costs to be incurred will, at the request of the other Party, carry out such new drainage works as may be required in connection with new drainage works of the other Party.
>
> (c) At the request of either Party, the two Parties may, by mutual agreement,
> co-operate in undertaking engineering works on the Rivers.
>
> The formal arrangements, in each case, shall be agreed upon between the Parties".

15. So far no matter requiring joint planning has been jointly referred by the two Governments to the Commission and, therefore, the mechanism and procedures for the discharge of planning responsibilities have not been evolved. However, the Commission is competent to determine its own procedure.

16. The Treaty provides for a self generating procedure for the settlement of differences and disputes. Any question which arises between the Parties concerning the interpretation of application of the Treaty or the existence of any fact, which, if established, might constitute a breach of the Treaty, is to be first examined by the Commission, which endeavours to resolve the question by agreement. In case of failure of the Commission in resolving the dispute, the matter may then be referred to the respective Governments and if required onwards to the World Bank for appointment of the Neutral Expert or the Court of Arbitration, as the case may be.

17. The Treaty also provides that if either Party plans to construct any engineering work which would cause interference with the waters of any of the Rivers and which, in its opinion would effect the other party materially, it shall notify the other party of its plans and shall supply such data relating to the work as

may be available and as would enable the other party to inform itself of the nature, magnitude and effect of any work. If a work would cause interference with the water of any of the Rivers but would not, in the opinion of the Party it, affect the other Party materially, nevertheless the Party planning the work shall, on request, supply the other Party with such data regarding the nature, magnitude and affect, if any, of the work as may be available.

18. So far most of the controversies which has arisen between the Parties, relate to supply of data requested/required by Pakistan due to the restrictive interpretations placed by India (Upper riparian) on these provisions of the Treaty. These are still to be resolved.

19. In the Indus Waters Treaty 1960 the two Parties have recognized that they have a common interest in the optimum development of the Rivers, and, to that end, they have declared their intention to co-operate by mutual agreement,

to the fullest possible extent. In this regard the Preamble of the Indus Waters Treaty also states:-

> "The Government of India and the Government of Pakistan, being equally desirous of attaining the most complete and satisfactory utilization of the waters of the Indus System of rivers and recognizing the need, therefore, of fixing and delimiting, in a spirit of goodwill and friendship, the rights and obligations of each in relating to the other concerning the use of these waters and of making provision for the settlement, in a cooperative spirit, of all such questions as may hereafter arise in regard to the interpretation or application of the provisions agreed upon herein, have resolved to conclude a Treaty in furtherance of these objectives, ...".

20. Having inferred from the discussion above that the Indus Waters Treaty 1960 is a unique Treaty, as it has divided the rivers between the two countries, whereas such treaties in general accounts for sharing of the waters. However, to make an attempt for the balance, that framers of the Treaty intended to. limit the capacity of India (being upper riparian) to manipulate, at will, the waters of Western Rivers. This is evident from the following excerpts from the proposal of the World Bank dated 5th February, 1954:

i) It is desirable, so far as practicable, to avoid control by India over waters on which Pakistan will be dependent and to enable each country to control the works supplying the water allocated to it and determine in its own interests the apportionment of waters within its own territories.

ii) The Chenab river rises in India, and before it enters Kashmir, provides a substantial flow that could be diverted for use by India. Assurance by India that the flow of this river will not be disturbed, is essential.

21. Since its signing in 1960, the Indus Waters Treaty has stood the test of time. It has worked well even during the times of high political and military tensions between the two countries. No major obstacle has so far been created in the implementation of the Treaty by either side. A review of the major issues which have cropped up between the two countries since 1960 is given hereunder:

Issues Resolved

i. Irrigated Cropped Area as on Effective Date

ii. Salal Plant on river Chenab

22. Following are major disputes are pending resolution between the Parties have been resolved bilaterally:

Issues Under Resolution

iii. Baglihar Hydroelectric Plant on river Chenab

iv. Wullar Barrage and Storage Project/Tulbul Navigation Project on river Jhelum

v. Kishenganga Storage-cum-Hydroelectric Project on river Neelum

23. Brief description of the above issues is given hereunder:-

i. Irrigated Cropped Area as on Effective Date

The provisions of Article III (2) of the Indus Waters Treaty 1960 allow India certain restricted Agricultural Uses from the waters of Western Rivers, as set out in Annexure C to the Treaty. Under Paragraph 4 of Annexure C, India may withdraw, in addition to the existing uses as on Effective Date, i.e. 1-4-1960, waters from Western Rivers for irrigating new areas to the extent of 70,000 acres from The Indus, 400,000 acres from The Jhelum and 231,000 acres from The Chenab. However, until India can release waters from the conservation storage, the new areas developed from supplies of The Jhelum and The Chenab are not to exceed 150,000 acres and 75,000 acres respectively. So far, India has not developed any conservation storage for Agricultural Use.

24. In accordance with Paragraph 10 of Annexure C to the Treaty, India was obliged to furnish to Pakistan a statement showing Irrigated Cropped Area as on Effective Date not later than 31st March, 1960. India supplied on said date the total Irrigated Cropped Area to the tune of 694,567 acres, which was later revised to 692,477 acres. After examining the details provided by India, Pakistan Commissioner objected to the authenticity of the area and sought certain clarifications. The matter remained under correspondence for a long period. Ultimately, the issue was taken up in the meeting of the Commission. After detailed deliberations from both sides, India, in the 55th meeting of the Commission in 1982, furnished a statement reducing the Irrigated Cropped Area to 642,477 acres. It was agreed that this statement will be taken as the statement that has been furnished

by India under the provision of Paragraph 10 of Annexure C to the Treaty. Thus, Pakistan succeeded in getting the Irrigated Cropped Area as on Effective Date reduced by 50,000 acres.

ii. Salal Hydroelectric Plant on river Chenab

25. The design of Salal Hydroelectric Plant received from India in 1974 was not found conforming to the criteria laid down in the Treaty in the following respects:-

(i) Works proposed appeared to be capable of artificially raising the water level in the reservoir beyond the full reservoir level in contravention of Paragraph 8(a) of Annexure 'D' to the Treaty.

(ii) A gated spillway had been provided in the design, although the site permitted the provision of ungated spillway, in contravention of Paragraph 8(e) of Annexure 'D' to the Treaty.

(iii) Outlets had been provided below the Dead Storage Level which are not necessary in terms of Paragraph 8(d) of Annexure 'D' to the Treaty.

(iv) The intakes for the turbines are proposed to be located at a level lower than required in contravention of Paragraph 8(f) of Annexure 'D'.

26. Indian Commissioner disagreed with the Pakistan Commissioner's views and despite protracted correspondence and discussions at the meetings of the Permanent Indus Commission (comprising Indian and Pakistan Commissioners for Indus Waters) the differences could not be resolved. In December 1974, the Indian Commissioner expressed his inability to proceed further in the matter under the provisions of the Treaty as Government of India wished to take up the matter directly with the Government of Pakistan.

27. Subsequently, at the invitation of the Indian Foreign Secretary, the matter was discussed between the delegations of the two countries headed by the two Foreign Secretaries in May 1975 at New Delhi. This led to the supply of substantial additional information regarding the Project by India and subsequently holding of four meetings between the two Commissioners. However, no headway towards resolution could be made and on 19th July, 1976, PCIW invoked proceedings for appointment of a Neutral Expert.

28. On the receipt of Pakistan Commissioner's letter, the Indian Foreign Secretary suggested that the two Governments should make another attempt to resolve the matter through bilateral discussions. As a consequence, two meetings at the level of Foreign Secretaries were held during October 1976, one at New Delhi and the other at Islamabad. At the New Delhi meeting, the Indian Foreign Secretary ultimately offered the closing of all the six low level outlets after one year of the operation of the Project and to reduce the height of the Spillway gates from 40 feet to 30 feet. The Indian delegation maintained that this was their final offer and they

could not improve upon it. At the Islamabad meeting, the Indian delegation did not agree to any further reduction in the height of the gates.

29. The negotiations between the two Governments were resumed in April 1978, and the agreement was signed at New Delhi on 14th April 1978. Important features are given hereunder:-

(i) The height of the spillway gates should not exceed 30 feet.

(ii) All the 6 low level outlets should be plugged within one year of the completion/operation of the Project.

(iii) Intakes for the turbines may be located as proposed in the present design.

(iv) Pakistan may agree to the diversion programme as proposed by India.

iii. Baglihar Hydroelectric Plant on river Chenab

30. India supplied information about the Plant in May, 1992 under the relevant provision of the Treaty. The Plant is located on river Chenab about 147 Kilometers upstream of Marala Headworks. The design of the Plant supplied by India envisages construction of 317 meter long and 144.5 meter high concrete gravity dam with Gross Storage of 0.32 Million Acre Feet (MAF) and Live Storage of 0.03 Million Acre Feet. In Stage-I of the Project, three units of 150 Megawatt (MW) each would be utilizing 15475 Cusecs of water. Three similar units have been proposed in Stage-II. The orifice type gated spillway is provided in the middle of the dam with Crest Level at elevation of 808 meter.

31. Pakistan raised objection on the design of the orifice type gated spillway, excessive pondage/operating pool behind the dam and higher water seal at the intake of the power tunnel. India did not agree to the objections raised by Pakistan and maintained that design was in conformity with the Treaty provisions. A study made on the effects of Indian design revealed that the low level gates will provide India a manipulatable capacity of about 164,000 Acre Feet of Storage behind the dam. If maloperated for stoppage, it may reduce/stop supplies of river Chenab reaching Marala for about 26-28 days during winter months. This may harm our uses from Marala-Ravi (MR), Bambanwala-Ravi-Badian-Depalpur (BRBD) link canal and upper Chenab Canal (UCC).

32. After having discussed Pakistan's objections on the design of the Plant in various meetings of the Commission, Pakistan Commissioner for Indus Waters (PCIW) recorded failure of the Commission in resolving the questions framed by Pakistan in February, 2003. This was followed by a notice to India on 8th May, 2003 about Pakistan's intention to proceed with the resolution through a Neutral Expert under the Treaty. Since the two Governments were unable to appoint the Neutral Expert as per request by PCIW of 20th June, 2003, the World Bank was requested on 15th January, 2005 to appoint a Neutral Expert.

33. World Bank appointed Mr. Raymond Lafitte from Switzerland as a Neutral Expert on 10 May, 2005, who called both the Parties for first meeting on 9-10 June, 2005 for determining the procedure to be adopted by him.

iv. *Wullar Barrage and Storage Project/Tulbul Navigation Project on river Jhelum*

34. The construction of Wullar Barrage was started by India on river Jhelum in 1985 under the garb of Tulbul Navigation Project without informing Pakistan. A strong protest was lodged by Pakistan and India was asked to stop the work and supply information as per Treaty provisions. India supplied information in March, 1986. The project envisages construction of a barrage at the outfall of natural Wullar Lake on the Jhelum Main. Wullar Barrage would be 439 feet in length having a gated weir and under sluices, and a 40 feet wide navigation lock. It would have a maximum discharge capacity of 50,000 cusecs. Thus, it might be possible to store about 0.30 Million Acre Feet of water in the Lake behind the Wullar Barrage. If India is allowed to go by the project, the Wullar Lake, being a natural lake, would become a man-made reservoir/storage. Further, the Wullar Barrage would enable India to have a control on the waters of river Jhelum. The Commission made efforts to resolve the issue but did not succeed. Then, on the request of India, the matter was taken up by the two Governments. India agreed to stop the construction and bilateral talks started in 1987, which are inconclusive so far.

35. The Indian posture of bringing about improvement in the navigability between Srinagar and Baramula for transportation of fruits hardly justifies the construction of Wullar Barrage, because already a very good road link exists between Srinagar and Baramula. Moreover, the terrain is also not hilly but almost plain. India's actual design appears to augment storage in the Wullar Lake for use during the lean period for her downstream hydroelectric projects. The augmentation was to be further strengthened through diversion of water from Kishenganga Hydroelectric Plant, located on river Neelum, a tributary of river Jhelum.

36. Todate, 11 rounds of talks have been held at level of Secretaries of the two Governments. Last round of talks on the issue of Wullar Barrage was held on 28-29 June, 2005 as a part of composite dialogue with India on all outstanding issues, in which both the Parties agreed that the discussions would continue at the next round of the dialogue process with a view to finding a solution to the issue consistent with the provisions of the Treaty.

v. *Kishenganga Storage-cum-Hydroelectric Project River Neelum (Kishenganga Hydroelectric Plant)*

37. This is a Storage Work of 0.14 MAF capacity for which information/data was supplied to Pakistan in June, 1994 under Annexure-E to the Treaty. India is allowed to construct storage work of 0.75 Million Acre Feet on the tributaries of river Jhelum. The Kishenganga Project envisages construction of concrete gravity dam on

river Neelum near Kanzalwan with gated spillway and low level outlets. Flows of Kishenganga river are to be diverted into the Wullar Lake through 28 KM tunnel after generating 330 MW of power. The Power House is located near Bunkot.

38. Pakistan raised objections on the Indian project as under:-

(i) It contravenes the provisions of Paragraph 10 of Annexure E to the Treaty.

(ii) Diversion of flow of one tributary (Kishanganga) to another tributary (Bunar-Madmati Nallah) of river Jhelum is not provided for in Annexure E to the Treaty.

(iii) It does not conform to design criteria (a), (c), (e), (f) and (g), mentioned in Paragraph 11 of Annexure E to the Treaty.

39. The diversion of flows from one Tributary to another Tributary (river Neelum to Madhumati Nallah of river Jhelum) as proposed by India is not allowed under the Treaty. In addition, this is likely to harm our power potential and Agricultural Uses in the Neelum Valley and would have a direct bearing on the socio-economic life and ecological aspects in the area downstream Kanzalwan. Pakistan has also started work on a hydroelectric plant (named as Neelum-Jhelum Hydroelectric Project) at Nauseri in 1989 by utilizing the waters of river Neelum to generate 969 MW power. The Indian project, if constructed as per their proposed design, will result into 21% reduction in the average annual inflows of river at Neelum-Jhelum Dam site and 9.25% reduction in the power generation potential of the Neelum-Jhelum Hydroelectric Project.

40. India started construction of Kishenganga Project in year 2002-2003 and work on Head Race Tunnel (HRT), Power House and temporary diversion is being carried out. The present status of works at Kishenganga HEP is reportedly as under:-

(i) Gurez Valley Works

41. Diversion tunnel work presently held up due to climatic reasons. The activities that interfere with the flow of water (construction activities related to dam and power intake) are yet to be taken up.

(ii) Bandipura Works

42. Excavation for underground works (Power House Complex and adjoining reaches) is in progress. The enabling works related to Head Race Tunnel are also going on. Some additional underground excavation has been carried out.

43. The Commission has had four exclusive meetings on the issue so far. India has, however, not changed its stated position that their project is designed as per Treaty provisions. PCIW has given the intention to invoke Article IX(1) and supplied questions arisen between the Parties. Deliberations on these questions are

continuing in the meetings of the Commission being held from time to time. The outcome of these deliberations would decide future course of action by Pakistan.

44. The recent developments in Indo-Pakistan relations have again provided an opportunity to both the countries to address the water related issue with the spirit of goodwill. And once the issues related to water are settled, it can prove to be a turning point and pave the way for other major issues to be resolved amicably. However, it should be borne in mind that for such a track, implementation of the Indus Waters Treaty 1960, in its true spirit and intent would be the bare minimum. As Pakistan has already lost the waters of its three major rivers, no further compromise would now be affordable in the shape of any encroachment by India on the waters of western rivers. Hence, the peace in the subcontinent now distinctively relates to the honour which India should extend to the Indus Waters Treaty 1960. This Treaty, thus is an instrument for peace between the two countries and any vested attempt by India to jeopardize his intent and spirit would only result in hampering of peace process being envisioned for the region.

WATER RESOURCES DEVELOPMENT IN PAKISTAN

By

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ABSTRACT

Pakistan is a country of over 145 million people which is expected to grow to about 225 million by the year 2025. The most pressing need over the next quarter century in Pakistan will be the management of the rapidly increasing population and provision of basic amenities. The increasing population will have a major impact on food and domestic water requirements.

Agriculture is the back bone of Pakistan's economy. It contributes 30% of GDP. About 70% population lives in rural area and agriculture provides 55% job opportunities. This sector provides 60% of country's exports. The development of agriculture means prosperity and up lift of 70% of total population which is growing at 3% per annum.

The climate of Pakistan is arid to semi-arid. Its agriculture is dependent on irrigation. About 80% of agriculture is irrigated. The availability of assured quantity of good quality water is the major factor on which the development of agriculture sector depends. Therefore it is a dire need to use the available water resources in the most effective way and to develop new water reservoirs to meet the growing demand.

An annual average of over 35 MAF water escapes below Kotri. However, this surplus water in the river system is available in about 70-100 days of summer only. To save and utilize this water, construction of additional storage facilities is essential.

PAKISTAN'S WATER RESOURCES

Surface Water

According to the 1960 Indus Water Treaty, signed between India and Pakistan, India was allowed exclusive right to use the waters of Ravi, Sutlej and Beas rivers, whereas the waters of the Western Rivers, Indus, Jhelum and Chenab were assigned to Pakistan.

i) Indus and its western tributaries

The average annual inflow of the Western Rivers during post Tarbela period (1976-2005) at the rim stations (Indus at Kalabagh, Jhelum at Mangla and Chenab at Marala) is 140.76 MAF. Of this 115.40 MAF or 82% of the total

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flows are in the Kharif season (April – September) and 25.34 MAF i.e 18% of the total flows during the Rabi season (October-March).

The flows of the Indus and its tributaries vary widely from year to year. High inflow of 172.10 MAF was recorded in 1991-92 and a low of 97.17 MAF was recorded in 2001-02.

ii) Indus and its Eastern Tributaries

The three eastern tributaries of the Indus-Ravi, Sutlej and Beas have been allocated to India for its exclusive use. India has constructed dams on these rivers. The spills from these dams and unutilized flows enter Pakistan at Madhopur on the Ravi and below Ferozpur on the sutlej. During the post Tarbela, the inflows from the Eastern rivers have average about 6.66 MAF in Kharif and 1.88 MAF in Rabi.

Table-1 shows that the total surface water available is 154.88 MAF. By subtracting the 105.00 MAF water required for canal diversion and 15.00 MAF for system losses, the net available surface water is 34.88 MAF.

Fig-1 Shows that the average escapages below Kotri is 35 MAF. Subtracting from the water flowing d/s of Kotri, the requirement for the ongoing projects and the below Kotri requirement, 21.5 MAF is available for future development.

Ground Water

The Indus Basin is formed by alluvial deposits carried by the Indus and its tributaries and is underlain by an unconfined aquifer covering about 15 million acres in surface area. In the Punjab about 79% of the area and in Sindh about 28% of the area is underlain by fresh groundwater, which is mostly used to supplement irrigation. Water from the saline tubewells is generally put into drains and where this is marginally fit for use, it is mixed with the canal water for use in irrigation.

Before the introduction of irrigation system the groundwater table in the Indus Basin varied from about 40 feet in depth in Sindh and Bahawalpur areas to about 100 feet in Rechna Doab (the area between Ravi and Chenab Rivers). After the introduction of weir-controlled irrigation the groundwater table started rising due to lack of drainage facilities and the resulting recharge from the canals, distributaries, minors, water courses and irrigation fields. At some locations the water table rose to the ground surface or very close to the surface causing waterlogging and soil salinity, reducing productivity. In the late 1950s the Government embarked upon a program of Salinity Control and Reclamation Projects (SCARPS) wherein large deep tubewells were installed to control the groundwater table. Over a period of about 30 years some 13,500 tubewells were installed by the Government to lower the groundwater table. These projects initially proved quite effective in lowering the water table but with time the performance of SCARP tubewells deteriorated.

The development of public tubewells under the SCARPS was soon followed by private investment in shallow tubewells. Particularly in the eighties the development of private tubewells received a boost, when locally manufactured inexpensive diesel engines became available. Most of these shallow tubewells are individually owned. Now more than 500,000 tubewells supply about 48 MAF of supplemental irrigation water every year mostly in period of low surface water availability. These tubewells compensated the loss of pumping capacity of SCARP tubewells and helped in lowering the water table. The ground water in all sweet water zone canal commands is falling while in saline water zones it is rising. The provinces wise detail of existing uses of ground water is given in Table-2.

The groundwater use is nearing the upper limit in most parts of Pakistan. Therefore the potential of further groundwater exploitation is very limited.

EXISTING INDUS BASIN IRRIGATION SYSTEM

Pakistan has one of the world largest contiguous irrigation system known as Indus Basin irrigation system Fig-2. This system mainly comprises the Indus main river and its five major tributaries.

Table-3 give detail of the irrigation system that comprised of two large reservoirs Mangla and Tarbela Dam, 23 barrages, 12 inter-river link canals and 44 perennial & non-perennial canal commands. The total length of main irrigation canals including distribution system is 60,000 km. The whole canal system serves about 107000 water courses with approx length of 1 M km. With the completion of Indus Basin Project, including three on-line storages, Indus Basin Irrigation System (IBIS) has now a significant facility for integration of river supplies. As a consequence, the canal head diversions in IBIS attained a peak of 107.73 MAF in Post-Tarbela period as compared to 67 MAF at the time of independence. In addition to this there are about 8 dozen small dams built, operated and maintained by the provincial Small Dams organizations. These dams supply water in the local areas both for Irrigation and drinking.

Annual canal diversion prior to construction of reservoirs was 87.91 MAF which has been increased to an average of 104 MAF. After the construction of Mangla, Tarbela and Chashma reservoirs, the canal diversions increased as:

Province	Pre-Dams	Post-Dam	% Increase
Punjab	47.69	54.02	13.27
Sindh	35.56	44.47	25.06
NWFP	4.66	6.16	32.19
Balochistan	0.62	1.80	190.32
Total	88.53	106.45	22.24

This indicates that dams have played a vital role in increasing provincial canal diversions.

Since the stored water is already insufficient even to meet the needs of the existing cropped area and there is going to be a gradual reduction in stored water because of siltation of the reservoirs, the water availability for agriculture will further reduce.

WATER SHORTAGE

Water availability Vs population growth

With increasing population, Pakistan is fast heading towards situation of water shortage Fig-3 shows that per capita water availability was 5260 cubic meters in 1951, which reduced to 1126 cubic meters in 2005. The minimum water requirement to avoid being a "water short country" is 1,000 cubic meters. In the year 2020, Pakistan will reach the stage of "acute water shortage".

Fig-4 gives the per capita water available in different countries of the world, where Pakistan is the second lowest country in per capita water availability.

Present Water Shortage in the System

Table-4 shows that due to excessive sediment influx in the rivers, all the three storages (Tarbela, Mangla and Chashma) are rapidly losing their capacities. By the year 2012 these storages would lose 34% (6.22 MAF) of their capacities, this virtually means loss of one mega storage project.

According to National Water Policy, the additional water requirements for agriculture sector by the year 2025 would be around 37 MAF at canal heads. In addition, domestic water supply, environmental protection and industrial sector would require another 7.7 MAF. Table-5 Shows that with the increase of population with time about 44.7 MAF of additional water would be required in the year 2025.

WAPDA'S VISION 2025 PROJECTS

After completion of Tarbela Dam project since 1976, the development of water storages has been at stand still. Although Ranking study of Hydropower Projects on river Indus & its tributaries was carried out in early eighties and Detailed Engineering Design & Tender Documents of Kalabgha Dam Project were prepared in mid eighties yet no project came up for implementation. Storage capacity of on line reservoirs is reducing due to siltation. The present storage capacity is only 9% of total surface flows.

The installed hydropower is only 16% of the total identified potential. In Nineties private thermal power projects were inducted in the generation system. Although this eliminated the load shedding but disturbed the hydel thermal ratio from 65:35 to reverse. Fossil fuel being imported, the electricity became expensive. The Independent Power Producers (IPPs) which supplied about less than one third

of the total power supply of Wapda had to be paid more than half the revenue of Wapda.

The drought, failure of monsoon, which started in 1999 continued for more than three years. Severe water shortages were experienced in the irrigation system. Realizing the situation Wapda prepared a 25 years programme of development of water and Power resources of Pakistan which was presented to the Federal Cabinet on August 30, 2000. A part of this to be implemented on fast track was approved by the Chief Executive of Pakistan in Jan. 2001.

The objectives are:

- Development of 22 MAF of storages and complimentary irrigation schemes.
- Development of 23,000 MW of Hydro, coal and gas power stations.
- Encourage private sector investment (foreign/local) and private/public sector joint ventures.
- Support economy and poverty alleviation in backward areas.

Table-6 gives status of on going projects.

Table-7 gives dams in different countries of the world for comparison.

DAMS PROPOSED FOR CONSTRUCTION

The President of Pakistan on January 17, 2006 announced to complete the construction of the following five Dams in Pakistan by 2016. Their location is shown in Fig. 5. They are briefly described as follows:

Diamer Basha Dam Project

The project is located on Indus River, about 315 km upstream of Tarbela Dam, 165 km downstream of the Northern Area capital Gilgit. The proposed dam would have a maximum height of 270 m, and impound a reservoir of about 7.4 million acre feet (MAF), with live storage of 6.4 MAF. Mean annual discharge of Indus River at the site is 50 MAF. Thus the dam will impound 15% of the annual river flow. The dam project would cover an area of 110 km^2 and extend 100 km upstream of the damsite upto Raikot Bridge on Karakoram Highway (KKH). Salient features are given in Table-8. Fig-6 presents layout of the project. Feasibility of the project was upgraded in 1974. Presently Designed and Tender Documents are under preparation. Work on KKH upgradation is going to start soon.

Munda Dam

It is located on Swat river about 5 Km u/s of Munda Head works in Mohamand Agency, (FATA). It is a 213 m high dam. The reservoir would be developed having a gross storage of 1.30 MAF. It has installed capacity of 740 MW. The project would irrigate 15097 acres of land on left and right side of the Swat

river, beside this it will supplement the shortage of irrigation in Lower as well as Upper Swat Canals. The project will also provide flood mitigation to Nowshera and Swabi. Salient features are given in Table-9. Fig-7 presents Location of the project. Presently feasibility of the project is being upgraded by AMZO.

Kalabagh Dam

Kalabagh Dam Project site is located 210 Km downstream of Tarbela Dam on the river Indus. The project envisages construction of 79 m high rock-fill dam. With its maximum retention level at 279 m SPD it will create a reservoir with usable storage of 6.1 MAF. The project has two spillways on the right bank for disposal of flood water. In the event of the highest probable flood, these spillways will have a discharge capacity of over 2 million cusecs. On the left bank is the power house which will be connected to twelve conduits each 11 m in diameter, with ultimate generation capacity of 3600 MW. Salient features are given in Table-10. Layout of the project is given in Fig-8. The Design and tender documents of the project were prepared by the Consultants in 1987. The projects could not be taken up due to provincial differences.

Akhori Dam

It is located on Nandana Kas river about 6 Km u/s of Attock District near Akhori Village. Storage of surplus water of Indus river from Tarbela Dam. Salient features are given in Table-11. Layout of the project is shown in Fig-9.

Kurram Tangi Dam

It is located on Kurram river in North Waziristan Agency about 14 Km upstream of Kurram Garhi Headworks and 30 Km North of Bannu City in NWFP. Salient features are given in Table-12. Layout of the projects is shown at Fig.10. Feasibility and Design is ready. The project is being negotiated for construction with FWO.

Conclusions and Recommendations

(i) Storage capacity of existing reservoirs is reducing with time due to sedimentation.

(ii) Country is heading to face serious water, food and Power shortages with increasing population.

(iii) Surface water of at least 21.5 MAF is available for development of big storages on the Indus.

(iv) If cheap hydropower is not added to the system, the electricity would become more expensive.

(v) Water resources development projects on Indus river are the key to prosperity, and to avert looming water crisis.

RISK PERCEPTION TOWARDS FLOODING AND ENVIRONMENT IN LOW INCOME URBAN COMMUNITIES

Dr. S. M. Saeed Shah[1], M. Kaleem Sarwar

ABSTRACT

This study aimed to investigate individual and group perceptions of, and adaptations to flooding as an environmental risk and mode of sickness before, during and after flooding. The study was conducted during monsoon in mid of June upto end of September 1998, and based on low income community in Lahore walled city.

The research carried out using qualitative methods. Case studies of individuals and families living in the study area were undertaken. The study employed, in-depth interviews with 34 residents (17 men & 17 women of different age, education, ethnic etc) and 17 shop owners with key informants and also by observation of adaptations made in the private and public environments. 11 focus group discussions were also conducted. Pictures of local newspaper reporting of flooding was collected during the study period. Visiting clinics and dispensaries as well as Hakims during this time was part of the job.

All interviews and focus groups were conducted in an informal environment and were guided by an interview checklist developed and piloted after translation by the author. This includes the advantages and disadvantages of living in the area, definitions of flooding, effects of flooding on their lives and environments and the importance of flooding in relation to other problems. The research was conducted during monsoon season, constant visiting were done before, during and after flood events in the community.

The social and economic risks of flooding and inundation are not evenly distributed across the city or across susceptible communities. Poorer households and those which are poorly adapted to flooding appear to be most affected. Businesses are also differentially affected depending on the type of product sold and the nature of service provided. The health risks of flooding and inundation, as understood by respondents, relate to classification of water "types" according to measures of quality such as composition and clarity. Flood water is used in different depending on its perceived quality. Residents feel that the after effects of flooding and inundation, such as standing water, contaminated mud and noxious odours are more important than the immediate effects, which may include water entering homes and, loss of possessions in nullah bank areas.

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The predictability of changes in water levels and the rate of rise of water levels are seen by residents as more important than the actual duration or depth of the flood. Residents have developed sophisticated flood prediction and protection system and contingency plans for evacuating person and possessions. Short term predictability can be reduced or vanishes by engineering interventions or maintenance. The community is able to use and manage the documents to receive funds while the residents of flood community are to reduce the effects of flooding on their household and family.

Within flood-prone areas a differentiation is made between "public" and "private" spaces and this in turn affects resident's perceptions of the distribution of responsibility for the maintenance of these spaces. This differentiation varies between the different areas studied and to an extent between individuals. Concerning the health 90 percent of community suffers from fever during monsoon. Bacteria, viruses and diseases are activated and growing rapidly and transferring from one area to another through water and/or air. The print media within Lahore appears to be an important player in creating, filtering and distributing perceived risk. Most of the media concern walled city as a critical.

1. GENERAL

In this research we tried to evaluate the perceptions of people inside the Lahore walled city and its vicinity about the flood and the consequences and affects of flooded water.

Combine sewerage system is one of the most problems in this area, conveying sewage through an open canal system not only looks faulty, but is a big threat to the health of community specially the elders and children. Rise of bad odor, mosquitoes, flies etc. are common within the area.

An open sewerage system made job of sweepers easy, they sweep every thing into the canal and pick up heavier particles at the flatter area. Garbages are carried out early morning by ox-cart and the carrier does not care if any left or drop.

At the most hazard area the houses are connected by a narrow corridor at the end which is used as an emergency exit. Front walls of these houses are built right over the side wall of nullah and a four feet wide wooden slabs over the nullah on front of each door is connecting these range of houses to the city.

Being centre of distributary and carrying all goods by donkey, horse, mule and ox-carts, floods and inundations are a big threat to these animals, the owners are prefer not to work on these days rather than loosing them.

2. PROBLEM SCENARIO

Continued population and economic growth have caused the resources that once were free, or at least relatively so, to become limited, and consequences facilities are less effective and new problems arise.

Residents of the area specially adjacent to the nullah may or may not be aware of the problem, some living groups that born there, grow up with the problems others recognize the hazard at the time they move in to the area. They choose the site because they believe the advantages to exceed the cost and are willing to pay a flood damage bill to achieve something they want. Others enter ignorant of the hazard. After each major flood, some from all groups still see too many advantages in the site to want to leave, but others from all groups re-evaluate the advantages and costs and seek another location.

3. CATEGORIES OF DAMAGES

i) Direct damages: Most structural problems are:

- structure (roofs, plaster, paints)
- Public facilities (utilities shot down, pit and puts of the roads, no vehicles and public services)

ii) Indirect Damages:

- Less business (major damages are to the vegetable sellers in Sabzi Mandi, other business are very slow upto 70%).
- The cost of alleviating hardship (in flood prone area has seen more than the rest of the area)
- Safeguarding health (every body in the area expect sickness during monsoon);
- Re-routing traffic (interregional connection including Masrishah, Lakshmi Chowk and Urdu Bazar are flooded and no car can get through, only way of out is station)

iii) Intangible damages: As an environmental quality and aesthetic values, during flood the contaminated water raises bad smell, after inundation contaminated mud causes problems, than dust pollutes the area.

iv) Uncertainty Damages: The occupants of the flood hazard area, they have to wash and clean their places each time without knowing when will

4. AIM AND OBJECTIVES

Flood is one of the major scourges of mankind which has always sought protection from them by either evacuating threatened areas and with drawing into zones outside the area affected by the torrent or staying and fighting against this natural event, the second group have dipper experience toward flooding hazard. However, elder residents are more aware and have better perceptions and adaptations then new one.

The main objective was to investigate individual and group perceptions of/and adaptations to, flooding as an environmental risk, specially:

a) To asses community perceptions of flooding as a risk to quality of life, particularly in relation to other environmental and/or socio-economic circumstances.

b) To analyze community perceptions of risks and problems associated with flooding in relation to specific aspects of the risk (including depth, duration, intensity of rain, velocity of flow and quality of water)and specific aspects of impact (on health, works, convenience, livelihoods etc.

c) To examine individual and group responses to flooding, including long and short-term modifications to individual and community environments.

5. RESULTS AND DISCUSSION

Relating to the study all aspects of physical phenomenon of inundation under all categories has been investigated as following.

a) COMMUNITY AND INDIVIDUAL PERCEPTIONS OF FLOODING AS A RISK

i) HOW IS FLOODING PERCEIVED?

Flooding is primarily perceived as a natural, seasonal and God willing (merciful of God) event. Residents believe that rain is an important and life-sustaining phenomenon (it has to come) and particularly important for agriculture, and therefore food supply. Respondents living next to the nullah (he is a carpenter) also commented that, "the water may rise and our house be flooded but it will later flow off and they would be able to continue with their daily lives". A Barber noted that "I have a peace of land in my village growing wheat and grains, without rain there is no food". Thus flooding is tolerated as a natural event with positive attributes, even though it may have some problematic effects for the individual or household.

How is flooding perceived in terms of risk? It has already been mentioned that flooding is seen as a natural annual event and that the perceived risks of minimized by local coping responsed. Relative to other risks or problems, flooding did not rank high, and was sometimes not ranged at all, as is shown in the box below:

Respondent	Problem
An ordinary man	Mix. of bazar and residential area, noise, damping garbage, flooding
An old lady	Smelly discharge of sewage, mosquitoes, danger of nullah
Local community leader	Lack of education, poverty, town planning, responsibility of people, drainage system

Box: Rankings of local environmental problems [from highest to lowest priority].

The risk of flooding are not only- ranked low compared with other problems in the areas studied, but are also borne as part of a 'trade-off of the risks and benefits of living in the area. These benefits or advantages can be divided conveniently into economic and social aspects.

It is interested to note through data analysis that 100 percent of the people recognizes that floods are a serious problem but only 20 percent refer to it spontaneously when asked about the problems faced by their neighborhood. It is like a problem that people recognize as being important but don't want to think about or don't want to face.

As it could be expected, the people that experienced severe flood problems are more likely to thinking that serious floods are not likely happen, a bit likely, a lot likely and extremely likely. The signs (+) and (-) denote people with and without experience of serious floods, respectively. It is interesting to note that 90 percent of the shop owners that experienced floods think that it is a lot or extremely likely that it happens again. For residents in the same circumstances, the percentage is 61 percent. For those that never V, experienced a flood event, the perception of the likelihoods is much smaller, namely 43 percent for shop owners answering a lot likely and 31 percent of residents considering a bit likely. Experience is definitely a convincing argument (Fig. 1).

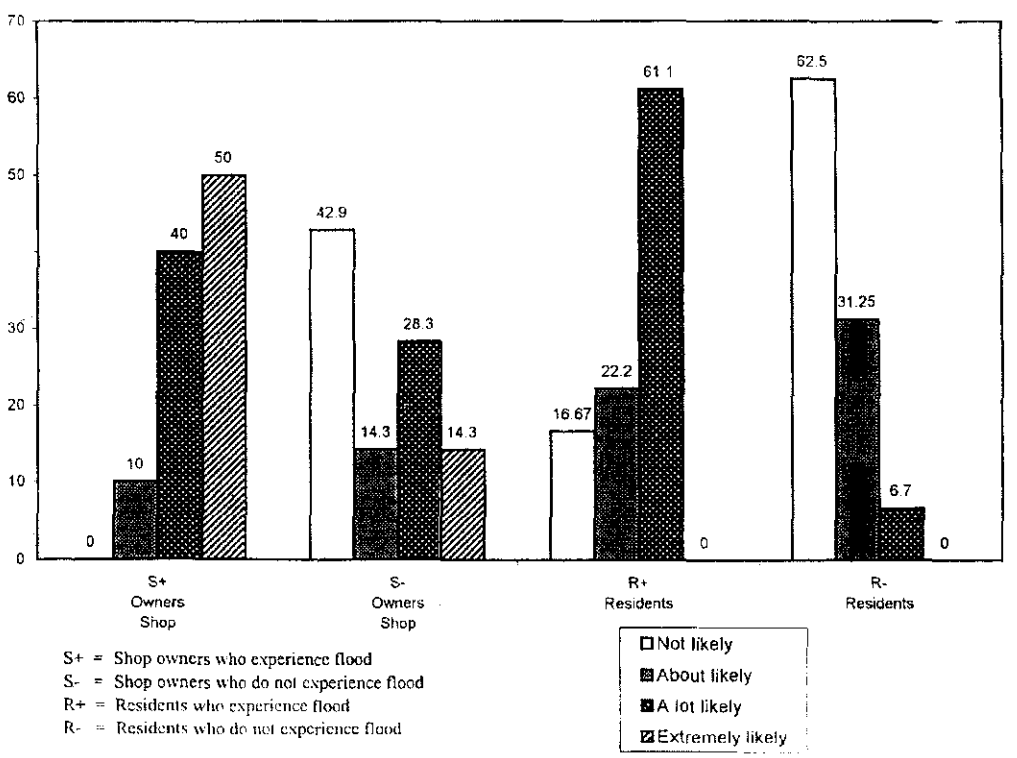

Figure 1: Perception of the likelihood of a serious flood event.

ii) *HOW IS INUNDATION PERCEIVED?*

In the study area the word 'flooding' is used to refer to the experiences of nullah dewellers while 'inundation' is used for the rise in water level in flat areas.

b) WHO IS MOST AT RISK?

The social and economic effects of flooding are not distributed evenly across the city or across susceptible communities. In the proceeding paragraph the differential effects of flooding on households and businesses of the study area have been examined.

i) *Households:*

Householders assessment of the risk of flooding appears to be determined by a number of factors; familiarity with seasonal flood patterns, the degree-of physical adaptation in the household, the extent of community and municipal support and the economic resilience of the household to flood losses. Poorer households are affected most by flooding for a number of reasons. Firstly, as the communities are situated on margins of nullah and sometimes illegally occupied land, due to the low cost of this land and its poor marketability, they are more likely to be composed of low-income and low caste families.

ii) *Business:*

The type of product sold also determines the status of the customers who frequent the business and this in turn, will influence the impact of flooding on the enterprise.

The nature of the services provided also impacts on susceptibility to flooding with vendors and causal sellers being unable to play their trade during heavy rains. However, they also see some benefits of rainwater and storm water in that the water cleans the roads. Shopkeepers with permanent premises generally see heavy rains as a temporary inconvenience and their income loss is minimal. Shopkeepers or vendors with a lower income are also more likely to experience difficulties if their business are closed than those with higher incomes, for example, a vendor in a resturant complained that the combination of rain, which decreased his number of working days and the effects of the flood, have left short of money for food.

c) HEALTH RISKS OF FLOODING

The health risks of flooding as understood by respondents are related to their classification of water 'types'. These are classified according to composition and clarity and residents are fairly knowledgeable regarding their potential health risk and, there by their household usability.

Breeding of mosquitoes and contaminated mud (ganda gee) caused by storm water is seen as most problematic as it is also a perceived source of mosquitoes and noxious smells.

Records of Al-e-Imran Dispensary as well as Alshafa showing that no. of patients raise upto 60% most of the mare age under 12 and over 35. An interesting point is most of those under 12 are male and over 35 years old are females. 90% of sickness is due to water impurity. Also mode of sickness before, during and after monsoon is different.

d) CAUSES OF FLOOD HAZARDS

Several causes for flood hazards are identified by the population. The main causes that are spontaneously mentioned are displayed in Fig.2. Deficiencies in the urban drainage system is the most common explanation. This is partially true, but it may be also emphasized because of some reconstruction that is taking place calling the attention to this specific aspect.

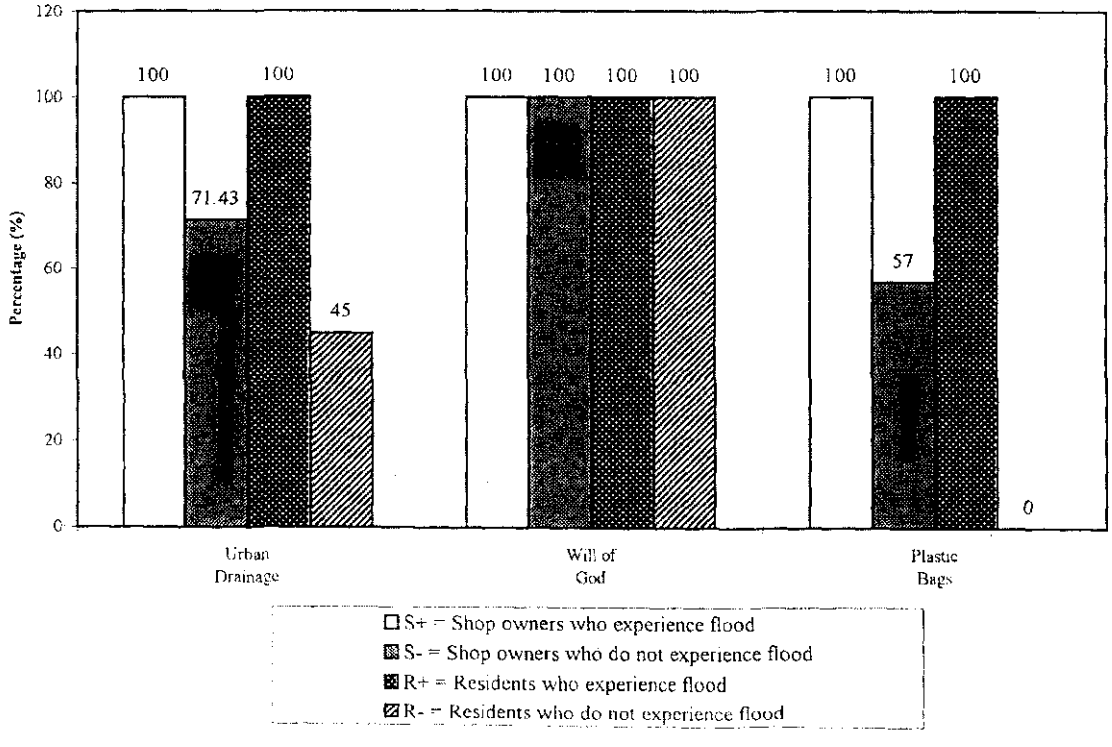

Figure 2: Main causes of flood hazards as perceived by the population.

e) MODIFICATIONS TO THE LOCAL ENVIRONMENT

The modifications necessary to prevent inundation or damage due to flooding in the areas studied, with householders in the area having made adaptations in their home environments. These can be divided into structural or permanent adaptations and temporary or household adaptations. In flat area, structural change have been made to houses and the 'private' environment by wealtheir residents who

can afford the cost of building and by those constructing new homes. Houses tend to have high plinth-levels to keep water out and paved courtyards which reduce the accumulation of ganda pani and gandgee, extensive land fill is also used to raise the level of the property to prevent the influx; of flood or storm water. Poorer residents, tenants and inhabitants of older houses have low plinth levels but have adapted by building raised door steps and house fronts. Small amounts of landfill are also used to create paths through standing water around houses. Adaptation have also been made to improve access to business premises.Most of the shops inside the study area are elevated about 2-3 feet above the roadand those around the circular road some have built a step of 1-2 feet in the front dependson the material which selling.

With respect to possible solutions to the problems, the most frequent answers refer to the drainage system. However, other solutions are mentioned, like restrictions to construction, cleaning and opening the nullah bed, and improving the system.

Residents of areas beside nullah make permanent structural adaptations to their environment, including houses mad of mud brick and inside with the cement plaster as these are less likely to be severely damaged by flooding. One of these residents said that after each flood they have to repair and this cost them about Rs. 3000 Wooden roofs been often eaten by termites and during rainy season became heavy and collapse. Other structural adaptations include high internal shelving, raised storage platforms for valuables and electricity connections at head height. Temporary adaptations include using metal rather then the cheaper wooden, floor level storage and furniture. This is more durable and resistant to immersion. Grains are stored in metal containers on high shelves to protect them from damp, many households' own trunks which are useful for saving valuables during flood.

The same population was inquired about the measures that they eventually have taken to face possible flood hazards. Results are displayed in Fig. 3. Again, experience seems to be a good adviser with 83 percent of residents and shop owners with previous experience having adopted some type of measures.

f FLOOD PREDICTION AND PROTECTION SYSTEMS

A major concern mentioned by residents of area relates to the predictability of the changes in water levels and rate of rise in water levels. To an extent these factors outweigh in perceived importance the actual duration or depth of the water inundation, itself In other words, even extensive inundation is bearable if expected (in relation to observed intensity and duration of rainfall), and if the rate of rise is not high. Both the rate of rise and the velocity of flow are seen by residents as determinants of the damage caused by water to housing and other possessions. As mentioned earlier flooding is seen to be part of a natural and necessary process and is tolerated within its season.

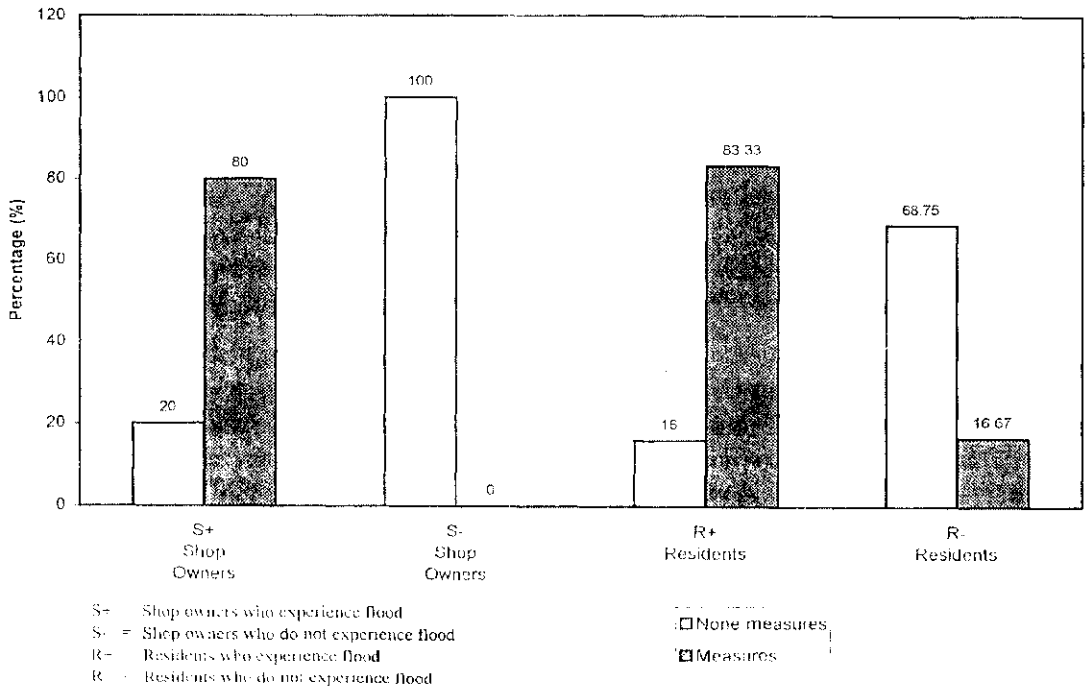

Figure 3: Percentage population having adopted measures for flood protection.

The ability to predict flooding diminishes the fear that might exist in the context of severe floods. People believe that they have control over flooding because they have developed mechanisms to cope with it. If inundation is unexpected however due to engineering factors or due to unusually high intensity rainfall, possessions may be lost, if the rate of rise of water is high, children and the elderly are considered particularly at risk. Respondents commented that sometimes we get caught by floods especially at the most beginning of flood and those which occurred at night and with high intensity. As a result some residents cannot displace some materials.

g) FLOOD WATER DRAINAGE

Some respondents have reported that their living conditions have in reality been made worse by the drainage improvements in that area they experience inundation in their houses more due to the flux and flood the area more during heavy rains, several respondents felt their children are not safe any more because of the open collecting station, some other respondent saying when ever this sewage is discharging an oxidious smell is raising specially during lunch and dinner and is no more a nice place to live.

For some residents negative perceptions appear to be linked with health since this collecting station is open then mosquitoes are breeding. One lady commented, "our kids are having temperature most of time and the small one is not growing normally a five years girl shows three".

h) RESPONSES TO FLOODING: PUBLIC AND PRIVATE SPACES

When asked about the reasons why the problems were not solved yet, many answers were given which are presented in Fig. 4&5. Despite the sharp criticism towards local authorites, most of the people had done nothing to help solving the problem. The exception are some residents and shop owners that had experienced flood and had tried something afterwards, namely complaining and discussing with responsible people.

As has already been outlined, residents in areas susceptible to inundation made modifications to their home environment (private space) to minimize possible flood damage interestingly, in most areas there is a clear differentiation made by residents between public and private spaces, residents generally took responsibility only for their yards ('private' space) and felt that the cleaning and maintenance of 'public' spaces, that is the streets and verges, is the responsibility of the municipal authorities.

It is also important to note that the differentiation between public and private space differs between individual in this section, individual and group responses to flooding have been outlined. A number of points emerge:

1. Residents reported public services are not fulfilling their jobs and most of lower employees leave their duty to work somewhere else.
2. Some respondents noted the nullah so far has been cleaned twice once before partition and other during General Ayub Khan and now needs to be cleaned again.
3. Community responses that the drainage system should be improved. This will effect on social and cultural belief of the community
4. Flooding and its effects do not only impact on the communities directly affected. Networks exist in the city for flood relief and compensation. In turn, the responses of the wider city, including Municipal and religious institutions will affect the lives of individuals and groups in flood prone areas [Stephens, 1994].
5. Individuals are prepared to invest substantial amounts of resources in protecting their 'private' environment and their businesses from the effects of flooding.
6. In living with a natural hazard individuals have developed sophisticated prediction and protection systems and contingency plans for flood evacuation. These systems, developed over time, can be adversely affected by man-made or unexpected changes to normal seasonal patterns of flooding and drainage.

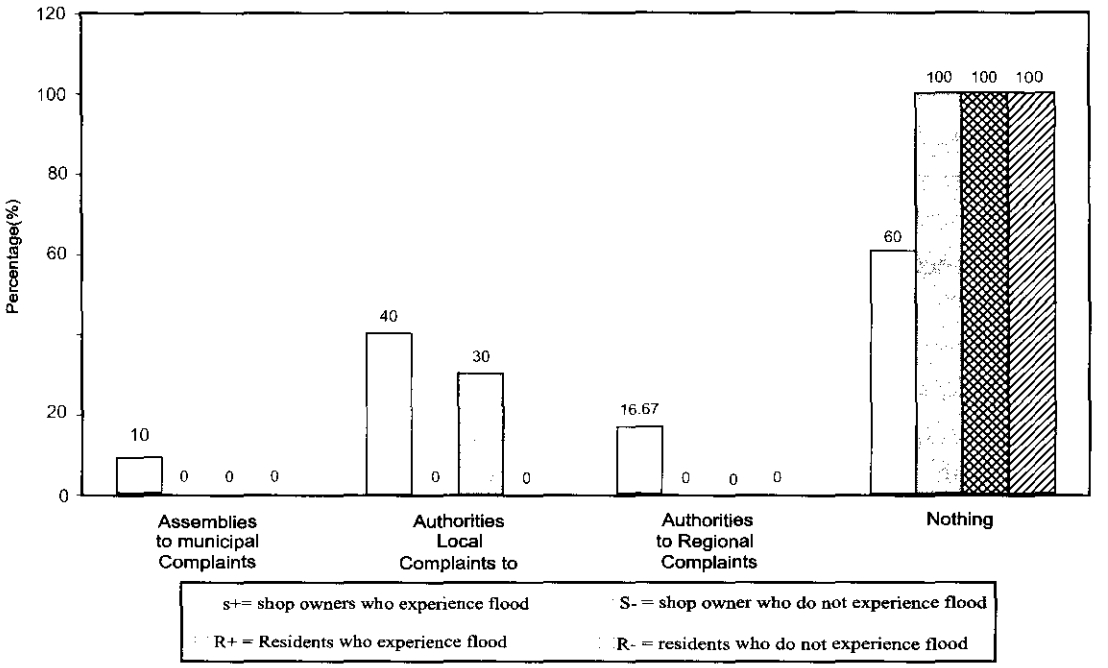

Figure 4: Public participation to solve the flood problems.

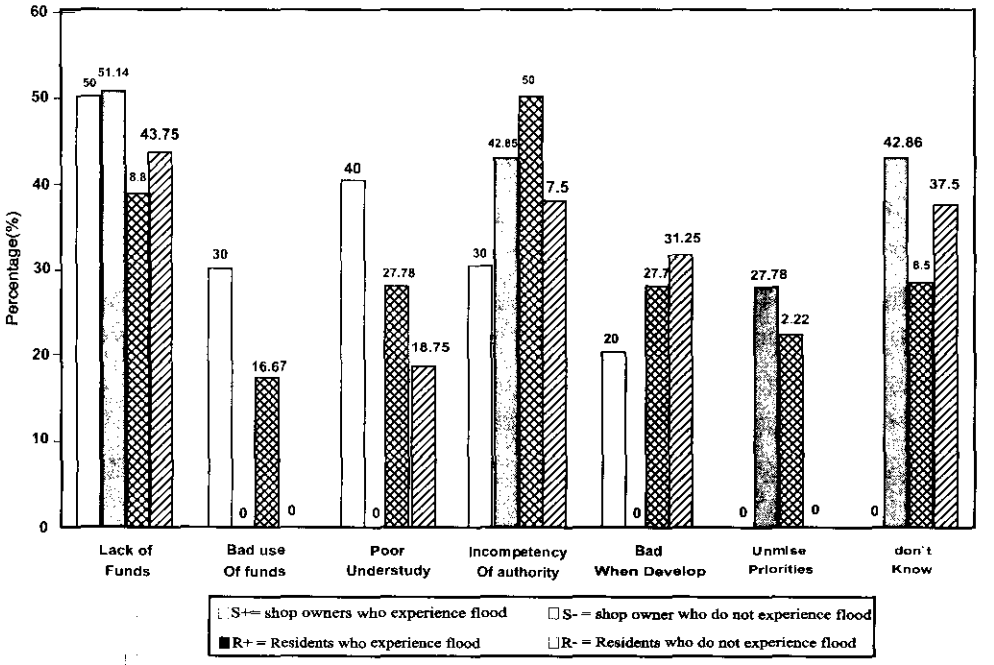

Figure 5: Perceived reasons for having not solved the flood problems.

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BRINGING DRAINAGE TOWARDS INTEGRATED WATER RESOURCE MANAGEMENT IN THE INDUS BASIN

By

Muhammad Nawaz Bhutta[1]

ABSTRACT

Irrigated agriculture is the largest contributor to Pakistan's economy. Before the introduction of canal irrigation the groundwater table was more than 100 ft (30 m) deep in the Indus Basin. As a result of the expansion of irrigation and inadequate provision of drainage, waterlogging and salinization emerged as major constraints to the productivity of agriculture. It is estimated that about 25% of the reduction in the production of major crops (which may be 40 - 60% in Sindh Province) is attributed to salinity. Municipal and industrial effluents are being disposed into drainage network without treatment. This has resulted in loss of human and animal lives. Drainage institutional issues are mainly: inadequate funding; poor governance, stakeholders conflicts, over emphasis on infrastructure and low priority to watermanagement, weakening knowledge base centres and lack of monitoring. Competition between different water uses is expected to increase. All these uses generate drainage effluent but at present only agriculture sector is held responsible for drainage development and water management.

Drainage is an indispensable element of land and water management. It has multiple functions and diverse impacts. Drainage can buffer the peaks of rainfall runoff. It also helps to quickly dispose off floods water. Drainage has important functions of protecting water quality of the rivers and canals and safeguard for build up property.

Interventions required are good governance, better water management, improve surface drains, ensure stake holders participation and cost sharing. Irrigation, drainage, municipality water supply and sanitation, industrial effluent management and rural water supply need to be integrated. This can only be achieved by bringing drainage towards integrated water resource management. Therefore the way forward will be to analyze values and functions of drainage at basin level. All beneficiaries and affectees should be involved in drainage development and water management.

1. BACKGROUND

The agricultural sector is the largest contributor to Pakistan's Gross Domestic Product (GDP), with a share of about 23% during 2003-2004 (GOP, 2004). Irrigated agriculture accounts for 82% of the total cultivated area, which sustains 68% of the rural population, 46% of the labour force exist, and earns 60% of foreign exchange.

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The rivers supply annually 144 MAF of freshwater to the Indus Basin, of which 104 MAF is diverted through canal systems to the four provinces with a supplement of 42 MAF of groundwater by 710,000, tubewells. Although these wells are generally installed for irrigation purposes, they also have indirectly a drainage function. Of the 104 MAF, about 60 MAF actually reaches the fields. Direct rainfall generates an additional water availability of about 22 MAF for irrigated agriculture. This combined supply of 124 MAF to the total command area of 40.0 Ma - results in an average annual supply of 3.1 af/a to the fields (IPOE, 2004).

By the successive construction of the barrages and reservoirs, increasingly more river water was diverted for irrigation use. The Tarbela storage reservoir, completed in 1976, added some 50% to available river water for the Rabi season. The total annual river diversions vary from year to year, depending on the rainfall in the Himalayan catchment and available storage. River diversions reached the highest value of 112 MAF during the 1900-1991 period while during the last decade these averaged 104 MAF.

The Cultivatable Commanded Area (CCA) has steadily increased form some 3.6 Ma in 1900 to 41.2 Ma in 2004. Before the expansion of irrigation the groundwater table was more than 100 ft deep in the Indus Basin (Figure 1). As a result of the expansion of irrigation system and inadequate provision of drainage, watertable rose close to soil surface.

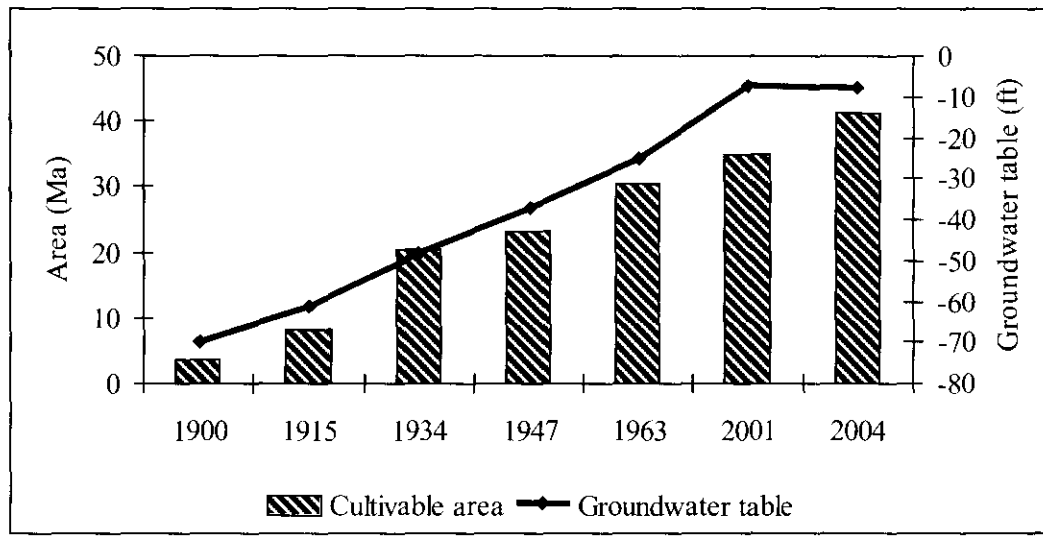

Figure 1: Rise in the average groundwater table and growth of cultivable area since 1900

2. OBJECTIVES

Irrigation, water supply and sanitation, industrial water supply and effluent disposal and agricultural drainage are being executed in isolation. The objectives of this paper are to:

(i) Summarize the causes of waterlogging, salinity and pollution;