WATER AND WATERSHED MANAGEMENT OF NORTHERN PAKISTAN

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"The road map of peace and development, flood control, mitigation of energy crises, Job opportunities for the world largest youth force of the country"

ABSTRACT

Pakistan is situated in the watershed of Indus river having 154 million acre feet annual run off. The Indus river not only serves as the lifeline of the country's agriculture but also capable as power machine of Pakistan. Indus has provided the world's oldest and largest canal Irrigation system to the country coupled with production potential of more than 50,000MW cheap electricity.

Pakistan is water scarce country i.e. less than 1000m^3 per capita water resources and contrarily has suffered from the world's worst flood disaster in 2010. This situation warrants management of water resources of the country, specially the watershed of river Indus. The territory of almost entire area of Pakistan constitute watershed of river Indus. The flow of Indus is trans-country and runs throughout its length of more than 1700km from northern high peaks to Arabian Sea in the south. This provides maximum opportunity for irrigating the plains situated in Khyber Pakhtunkhwa, Punjab, Balochistan and Sindh while flowing from north to south. The precipitation received in the catchments of Indus is in the form of snowfall during December to March and the monsoon rain during the summer. The precipitation received both in the form of winter snowfall and monsoon rains is almost of equal quantity. The snowfall occurs at the extreme north in Mansehra, Swat, Upper Dir, Chitral, Indus Kohistan districts and the province of Gilgit Baltistan. The monsoon precipitation is observed in south to the snowfall areas, overlapping some of the snowfall areas in the catchment of river Indus. When the snow accumulated during the winter in the extreme north of the country melts during the summer, about half million cusecs water is produced in Indus river. The water resulted from the snow melting on its way flowing towards south, joins the runoff water of the same quantity received through monsoon rains in the low lying areas during these months and thus the quantity of water is doubled in the Indus Basin. The result is thus floods of more than a million cusecs as experienced in 2010. This unfortunate phenomenon is a matter of routine in our country with slight fluctuation in the intensity of floods every year.

In the months of June and July, we witness floods and its resultant devastations and the havoc played with our crops and economy. Likewise, from October till February of the next year we face acute water shortage for our crops irrigation. The floods during the summer months not only destroy life and property but also result in loss of valuable water that could be stored for crops during water shortage periods.

Pakistan is an agricultural country having 70% population dependent upon agriculture with non-significant water storage capacity to meet its agricultural needs. During the year 2003, the water storage capacity was 13.64 MAF of its three reservoirs (Tarbela, Mangla and

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Chashma) which is around 9 % of total (154MAF) runoff water. Contrary to this India has 245 MAF storage capacities through 4636 reservoirs which is 33% of its total 750 MAF runoff water. Total water storage capacity throughout the world is 8000 MAF which is 40% of 20,000 MAF, world total runoff. Keeping in view the statistics, construction of dams at Naran on river Kunhar, Basha on main Indus and Jaglot and Kadzghara on Skardu river is warranted. Similarly Utror and Ushu on river Swat, Munda and Sharmai on river Panjkora and Seen Lasht, Kari and Kesu on River Chitral along with multipurpose dam and a diversion tunnel to Dir Upper on Chitral river at Mirkani. The existing water flow in river Indus is fluctuating between 50,000 Cusec and 1,200,000 Cusec. The ideal management will be constant flow of 2,92,987 Cusecs water round the year in the river system which is easily practicable given the watershed dynamics of Pakistan.

Construction of the dams will perform like safety valve during floods season and will enable us to keep uniform flow of water in the Indus basin. Water storage capacity will be increased which can be utilized during dry months for agriculture purpose. The dams will help in resolving the severe energy crisis which Pakistan is facing these days. At present, thermal power houses run by furnace oil and natural gas, contribute 70% of the total power generated in the country contrary to 1980, when the generation ratio was 80% hydel and 20% thermal. Thermal power, drains foreign exchange for purchase of fuel as at present the consumption of furnace oil alone is 35,000 Matric Tons per day in addition to natural Gas and other hydrocarbons. The result is reflected in shape of Gas and electricity load shedding apart from environmental hazards. Combustion of hydrocarbons in thermal power plants is reducing the oxygen four times the weight of hydrocarbon used in the power plants and is therefore detrimental to the very existence of life on this planet.

The arrangements proposed in this study will not only regulate the flow of water for agriculture but power generation on cheaper rates will be ensured. The additional water storage of 40 million Acre feet will be sufficient for irrigation of additional 20 million Acre agriculture land. The estimated hydel power generation from these dams is 26,515MW cheap electricity. The hydro electric power generation from construction of these dams will generate annual revenue of Rs.2312.7 billion @ Rs.10 per unit apart from providing relief in consistency and cost of power to the citizens of the country. The new 20 million acre land brought under irrigation on utilization of the additional water stored in these reservoir will add Rs.5,000 billion per year to the GDP @ Rs.25,000 per acre average crop price. Also the annual losses sustained by the country to the tune of Rs.100 billion will be prevented and the miseries faced by the nation will be brought to an end. This tremendous revenue is capable of setting off the whole debt of the country in less than 6 months. Harnessing the hydel power potential will open new era of development, employment opportunity to the world No.1 largest youth force of the country, this will close the option for the unemployed youths to join militants.

INTRODUCTION

Pakistan is lucky of being gifted with mighty, perennial river system, flowing through its full length, connecting sky high mountain peaks in the north, the world's second highest peak 28,200 feet K-2 (highest peak of Karakorum Range), the world's No.6th highest peak27500feet high Nanga Parbat of Himalayan Range and, 25600feet high Terichmir the highest of Hindukosh Range, and at the south the Arabian Sea. Thus Pakistan is world No.1 on the bases of difference between the highest and lowest point of its watershed. The highest point of its watershed is 28200feet K-2 in the north and 0(zero) at the south Karachi.(Arabian Sea).This

provide the capability to river system of the country for hydel power generation potential of 50,000MW (Economic survey of Pakistan 2010-11 Govt: of Pakistan Finance Division). The annual market value of this tremendous power potential is Rs.5000 billion @ (Rs.10/- per unit).

The River Indus that provides single drainage system to the entire country is flowing over full length of the country from north to south ie more than 1700km long. This longitudinal flow of the River Indus system of Pakistan coupled with world No.1 altitudinal range (28,200 feet) provides opportunity for maximum utilization of the water of River Indus for agriculture development of the country and its exploration for hydel power generation. The runoff water received in the north of Indus watershed takes almost a month to reach the Arabian Sea, this phenomenon provides for maximum utilization of runoff water for agriculture development of the country. This longitudinal flow of the River Indus across the country also provides maximum opportunity for preventive measures against the flood damages.

This study is an effort to highlight the need of development of watershed and water resources of the country in the right direction. The focus is to identify the multipurpose efficient and economically feasible potential sites for water storage and chipper hydel power generation coupled with effectively minimizing the chances of devastating floods and soil erosion. The implementation of this study will produce employment opportunities for the world largest youth population of the country in the field of agriculture, industry and services sectors of the country and will lead the nation to achieve the goal of peace and development.

MATERIAL AND METHOD

General Topographic sheets (GT sheets) of the northern parts of Pakistan were arranged and studied for identification of suitable sites for construction of dam. Elevation difference was calculated though GT sheets contour lines and verified in the field through altimeter. Relevant positions of suitable sites were plotted on map through GIS data and verified on ground through GPS coordinates. Hydrological data was analyzed for hydro electric power generation potential and possible water storage of the respective sites. Seismic and geological data of the areas was also observed for considering suitability of the sites for construction of the dams. To calculate the cost benefit ratio, Dargai Hydropower Station # 3 (82 MW) completed in 2007 was taken as standard and the prevailing rates of WAPDA taken as unit cost of power.

REVIEW OF LITERATURE

Al-Quran. "*This is He who sends down Rains from the sky; from it ye drink, And out of it (grows) The vegetation on which ye feed your cattle"*. (Al-Nahal. Verse #10)

Field Marshal Muhammad Ayub Khan N.Pk.H.J President of Islamic Republic of Pakistan, abstract form his address to the First West Pakistan Watershed

Management Conference 1968,"Scientific management of watersheds has made great advances in western countries, particularly in the United States. Knowing this, I approached the President of the United States in 1967 to send a team of experts to evaluate watershed problems in Pakistan. He was kind to take personal interest in the matter and send out a team to Pakistan. After preliminary study, a larger team came about three months ago and is now engaged on the task of survey and assessment of the problems. I hope the recommendations of this team will furnish the necessary foundation, on which a realistic plan of action can be based.

First West Pakistan Watershed management conference 1968 Resolution No.1. The important watersheds in west Pakistan have suffered from unregulated and excessive use and whereas the production of water and its regulated use have assumed increasing importance with the development of multipurpose water storage projects, it is resolved that a clear and comprehensive policy for scientific management of the watersheds may be enunciated, inter alia (Planning Commission Government of Pakistan 2005-10) defining the criteria for determining watershed improvement needs and opportunities; and (Planning Commission, Government of Pakistan, Vision 2030) providing for enabling legislation in the form of new and comprehensive Soil and Water Conservation Act on the pattern of the enabling laws of Australia.

First West Pakistan Watershed management conference 1968 Resolution No.2.The urgency and magnitude of watershed development has been duly recognized, and whereas various agencies are working in this field discernible duplication of effort, waste of funds and facilities, and whereas there is no competent technical service for this task, it is hereby resolved that a special watershed Management Service be created, having within its fold technicians of various disciplines such as, Agronomists, Foresters, Hydro-meteorologists, Engineers, Economists and Sociologists and be charged with the functions of problem appraisal, planning and execution of watershed projects. It is further resolved that the Service shall enlist the participation of the land owners in programming and implementation.

M. I. R Khan, 1968, First West Pakistan Watershed management conference. Watershed management assumed far greater importance with our signing of the Indus Waters Treaty with India in 1960. According to this treaty, our share of water from the three eastern rivers, viz, the Sutlej, the Beas and the Ravi is being gradually reduced and by 1970 we will have to depend entirely on our water resources derived from the Chenab, the Jhelum and the Indus. The various projects under the Indus Basin Settlement Plan are costing us billions of rupees. As such, scientific management of our existing and new water storage reservoirs, barrages, canals, and hydro-electric installations.

Luna and Thomas, 1954 Flood damage may be reduced by moving the damageable property out of reach of flood waters. Flood damage may also be reduced by passing flood flows downstream in a ways and places in which they will be least harmful. This is accomplished by increasing the capacity of the river to carry flood flows. A third approach is to decrease the discharge rate in the reach of

potential damage by holding water temporarily at some up stream place and releasing it later at no damaging rates. This can be accomplished through storage behind dams or in the soil. Increase retention of water in the soil on watershed area reduces the total volume of flood water as well as the peak discharge downstream.

Raeder, 1968 First West Pakistan Watershed Management Conference. In the USA forest hydrologic experimentations lies in the hands of the US Forest Service since 1930, and there are today approximately 250 experimental catchments in this country alone in which stream flow behaviour under different land use and vegetation is being accurately observed.

Muhammad, 1968 First West Pakistan Watershed Management Conference Report. West Pakistan has one of the largest canal system in the world. These are fed by the perennial rivers of Indus basin. The Indus water treaty 1960 provides that India might divert completely by 1970 the waters of the three eastern rivers the Sutlej, the Beas and the Ravi. Pakistan has to make permanent arrangements by this date to compensate for the withdrawal of water by India.

Awan, 1980; Surface Water Hydrology; Water is one of the most valuable resource essential for human and Animal life, industry and agriculture. In fact, there is hardly any human activity which is not one way or another way affected by water .Shortage of water may lead to droughts and as consequence to failure of agriculture. Man in the past has been exposed through out the ages to the vagaries of rainfall and river flow and was forced to adopt his life and habits to them.

Highly seasonal flow is another problem for arid and semi-arid regions in the world, where agriculture is a major source of sustenance. Here eighty percent of the annual flow occurs during the summer and 20 percent during the winter season.

Incase of a large dam, when failure of the structure would lead to catastrophic loss of life and damage to property a high degree of safety is essential in the design. This requires several hundred or thousands of years of stream flow record at the dam site. Since, at present, it is not possible to get such a lengthy record, estimate of design flood is based upon metrological estimation of the probable Maximum precipitation.

ANALYSIS OF THE SECONDARY DATA

Water Resources of Pakistan

Pakistan has total Area of 88430442 hectares and population about 180 million. Pakistan is facing water scarcity situation since commencement of year 2012 as by then per person water availability is reduced to less than 1000 cubic meter (Medium Term Development Framework 2005-10 planning Commission Govt: of Pakistan).

The following table represents the true picture of the situation.

Table 1. Per capita Water availability of Pakistan

S.No	Year	Population (Million)	Per person water availability	Remarks
1	1951	34	5650 Cubic meter	Water in abundance
2	2003	146	1200 Cubic meter	Water stressed
3	2010	168	1000 Cubic meter	Water scarcity

(Medium Term Development Framework 2005-10 planning Commission Govt: of Pakistan)

Pakistan is currently facing the problem of water scarcity, coupled with mismanagement of the meager water sources. Following is the status and utilization of water also the balance available in million acre feet (MAF) for storage and utilization for bringing additional land under Agriculture.

Table 2. Water resources of Pakistan

S.No	Source	Available (MAF)	Utilization (MAF)	Balance (MAF)
1	Surface water	154	106	48
2	Ground water	55	41.6	13.4
3	Hill torrent	17	5	12
4	Glaciers	640	-	640

(WAPDA reports published in Economic Survey of Pakistan 2009-10)

Table 3. Discharge of river system of Pakistan (000, cusecs) during various months of the year

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
90	90	100	120	180	750	800	900	170	110	100	90

(Watershed Management Conference 1968 Pakistan Forest Institute Peshawar and WAPDA report 1967)

Table 4. Present water storage capacity available in Pakistan

S.No	Storage/ Reservoir	Original Gross Storage(MAF)	Storage Loss till year2003(MAF)	Storage loss 2010 (projected)(MAF)
1	Tarbela	11.62 (1974)	3.14(27%)	3.95(34%)
2	Chashma	0.87(1971)	0.37(43%)	0.48(55%)
3	Mangla	5.88(1967)	1.18(20%)	1.60(27%)
	Total	18.37	4.69(26)	6.03(33%)

(Medium Term Development Framework 2005-10 planning Commission Govt: of Pakistan)

Table 5. Comparison of average annual flow and storage capacity of dams of Pakistan, India and in the world

S. No.	River Basin/ Country	Catchment Area (1000 sq km)	Length km	Average Annual flow(MAF)	No of Dams	Storage capacity (MAF)	% storage
1	Indus/Pakistan	1166	2880	154	3	13.64	9
2	Basin India(total)	---	---	750	4636	245	33
3	World	---	---	20,000	---	8000	40

(Medium Term Development Framework 2005-10 planning Commission Govt: of Pakistan)

Various provinces are utilizing their share of water from the existing water storage as per detail given in the following ratio as per water utilization accord 1991.

Table 6. Utilization of water and share of provinces in the present water storage

S.No	Province	Kharif (MAF)	Rabi (MAF)	Total (MAF)	% share
1	Punjab	37.07	18.78	55.94	47.7%
2	Sindh	37.94	4.82	48.76	41.5%
3	Khyber Pakhtunkhwa	5.28	3.5	8.78	7.5%
4	Balochistan				3.3%

(Abstract from Water Accord 1991)

Share of various provinces in the future storage of water

Water apportionment accord 1991 also guarantees the share in the future water storages of different provinces. Therefore, the interest of all the federating units of the country is properly protected. There is no disagreement between the provinces. All the provinces are in win and win situation.

Table 7. Share of various provinces in future water storage reservoirs

S.No.	Province	%age
1	Punjab	37
2	Sindh	37
3	Khyber Pakhtunkhwa	14
4	Balochistan	12

(Abstract from Water Accord 1991)

Hydel Power Potential

Table 8. Hydel power potential of Pakistan

S.No.	Particular	Capacity (MW)
1	Pakistan hydel power potential	50000
2	Khyber Pakhtunkhwa 70%	32000
3	Malakand Division 39% of country total	18000

(Economic survey of Pakistan 2010-11 Govt: of Pakistan Finance Division)

Hydel Power Installed Generation Capacity in 2009-10

Khyber Pakhtunkhwa	3767 MW
Punjab	1698 MW
AJK	1036 MW
Gilgit- Baltistan	0054 MW
Total	6555 MW

(Economic survey of Pakistan 2009-10 Govt: of Pakistan Finance Division)

Table 7. Trend of Hydel Power Generation of the Country since 1990

Year	Generation	Year	Generation	Remarks
1990	2898 MW	1999	4826 MW	
1991	3330 MW	2000	4857 MW	
1992	4626 MW	2001	5041 MW	
1993	4726 MW	2002	5041 MW	
1994	4826 MW	2003	6491 MW	
1995	4826 MW	2004	6494 MW	
1996	4826 MW	2005	6499 MW	
1997	4826 MW	2006	6479 MW	
1998	4826 MW	2007	6480 MW	

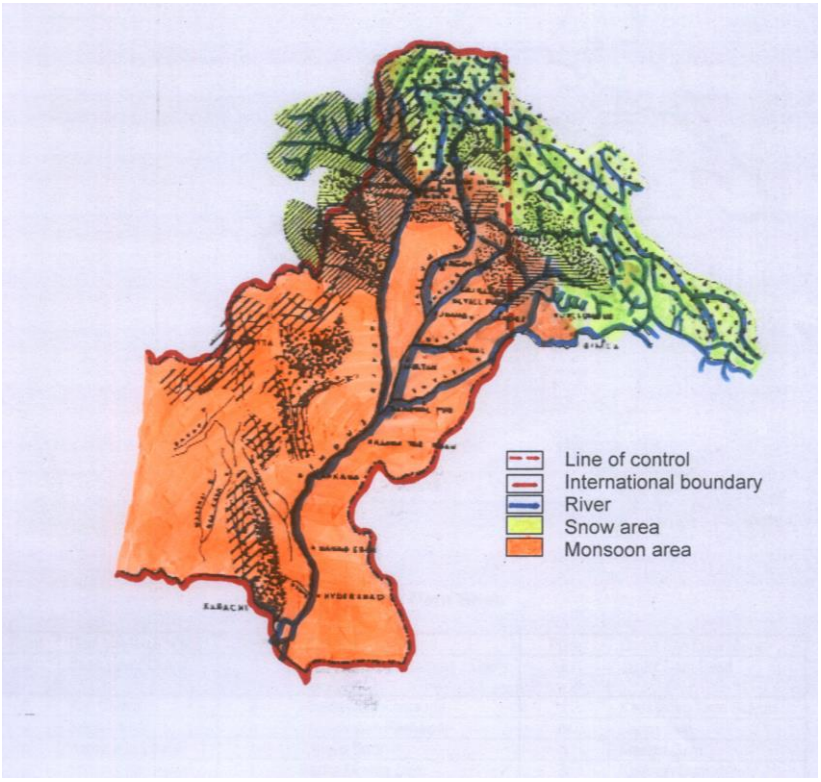
(WAPDA reports published in Economic Survey of Pakistan 2009-10)

Table 8. Production cost and sales rate of power generation (rupees per unit) through different sources

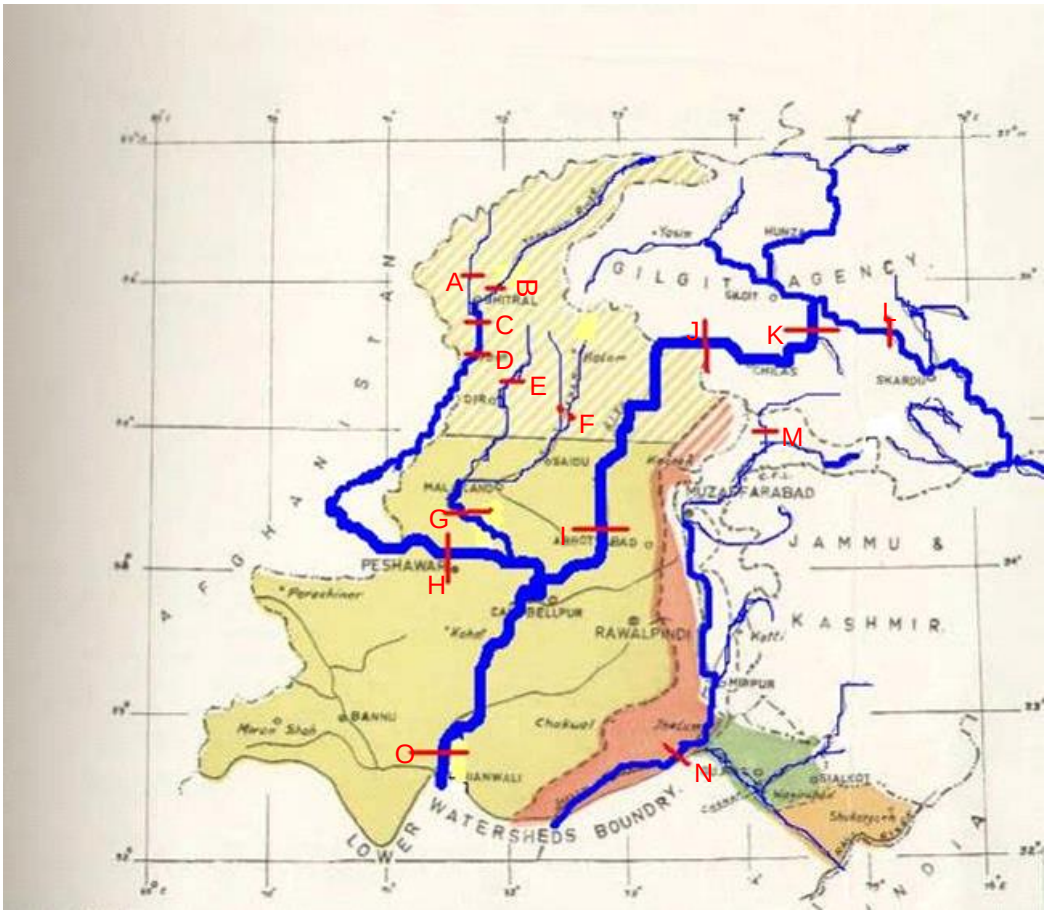
Mode of production	Cost of Production	Average Sales Rate	Profit
Furnace oil	18.00	13.50	(-) 4.50
Nuclear	12.00	13.50	1.50
Natural Gas	7.00	13.50	6.50
Hydel power	1.65	13.50	11.85

(WAPDA record 2012)

Watershed Map of Indus River



Drainage Map of the water shed of Northern Pakistan.



Red lines drawn perpendicular on the river show the proposed dams sites denoted by alphabet starts from A to O

Index of the dam sites

Dam point	Dam site local Name	Dam Point	Dam Site local Name	Dam Point	Dame Site local Name
A	Seen Lasht Chitral	F	Utror and Matalthan Dams Kalam	K	Jaglot Dam Gilgit
B	Kari Chitral	G	Munda Dam Charsada	L	Kadsghara Dam Skardu
C	Kesu Chitral	H	Warsak dam Peshawar	M	Naran dam
D	Nagar port Chitral	I	Tarbela Dam	N	Mangla Dam
E	Sharmai Dir Upper	J	Basha Diamar Dam	O	KalBagh Dam

River system of Pakistan

The Indus River system has its origin in the northern mountain ranges of Himalaya, Karakuram and Hindukosh. From its origin to the terminal point, this system forms shape of an oak tree structure where small ravines join together forming a network of rivers that combine to form the main Indus River. River Hunza and River Gilgit joining together at Jaglot, have their origin spreading over Karakuram. The watershed of river Skardu spreads over a vast area in the Himalaya range that reaches up to China and is the main artery of the system. Rivers Kunhar, Nilum and Jehlum joining together at Muzaffar Abad, too have their origin in Himalaya and then join main river Indus near DG khan. Rivers Kabul, Panjkora and Swat originates from Hindukosh Range join together at Charsadda and then join the main Indus at Attock. Detail of these rivers is given below.

a. Chitral River

The average month wise flow of the river Chitral is 60,000 cusecs in the month of July and August reduce to 5,000 cusecs in the month of December and January. The difference of the originating point, Terichmir peak (26000ft altitude) and Arandu (3500ft altitude) makes the river capable of generating more than 80 Megawatt on each kilometer. The river can be diverted to River Panjkora by constructing a tunnel of 41.6 Km between Nagar port of Chitral District and Chowkiatan Scout Posts of Dir upper District. This arrangement will not only secure the water of river Chitral but will also add to the hydel potential capacity of river Panjkora by 5000 Megawatt from Chowkiatan 4000 feet (from sea level) up to Munda of Charsada District 1150 feet (from sea level). Few prominent sites are below:

1 Proposed site of multi purpose dam at Seen Lasht 5Km North of Chitral on Garam Chashma river *71 48 34.7 E and 35 56 05.5 N.* The construction of reservoir at this particular place will help control floods by storing runoff water received due to snow melting during the month of June to August. This dam will work as water shed divide between monsoon rains run off water received in the south and the water received from melting of snow during June to August in the north. The combined impact of snow received during winter melting during summer and monsoon rains run off water, resulting in generation of devastating floods in the country during the months of July and August will be efficiently addressed and will result in the control of floodsin the country. Apart from flood control and precious water storage capacity the site is capable for generation more than 700 MW electricity.

2 Proposed site of multi purpose dam site at Kari 4 Km north of Chitral on Booni rive *71 49 35.6 E and 35 54 31.5 N*. Construction of dam at this site is of the same importance as that of Seen Lasht Dam with more hydel power generation potential of 1000MW and water storage capacity.

3 Proposed multi purpose dam site at Kesu 5Km North from Drosh on Chitral River *71 47 37.3 E and 35 38 28.3 N*. The construction of reservoir at this site is of

the same importance as that of Seen Lasht Dam and Kari dams with more hydel power potential 2000MW and water storage capacity.

4 Proposed 41.6 Km diversion tunnel, from Old Nagar Port Chital 71 53 41.3 E and 35 08 45.5 N, to Chowkithan Scouts Post Dir upper. The construction of this tunnel will not only secure the water of River Chitral . Also the addition of this water from river Chitral to river Panjkora of Dir, will boost the hydel power generation potential of river Panjkora by five time in the down stream from Chowkitan to Munda of District Charsada. The estimated increase in the hydel power generation potential of river Panjkora is about 5,000 MW.

b. Panjkora River Dir

River Panjkora starting from Jazdanda at the north enter Peshawar valley at Munda of Charsada District is capable of producing 20 Megawatt of electricity on each Kilometer by harvesting gradient of the river. The hydel power generation potential of river Panjkora can be increased many time by connecting river Chitral to this river through a tunnel of 41.6 Km long between Nagar Port Chitral and Chowkitan Scout Post of Dir Upper.

1 Proposed site of Sharmai dam Dir upper *71 57 00 E and 35 10 25.8 N* and a tunnel to proposed site of Gandegar power house *71 57 23.8 E and 35 10 48.4 N.*. This project is in the pipe line for implementation with SHYDO for hydel power Generation of 115 MW. The site can be developed as multi purpose dame i.e. water storage. This site is suitable water shed divide between water received from melting of snow in its north and runoff water received from monsoon rains in its south during the month of June to August. The hydel power generation capacity of the site will shoot up by conversion into multipurpose Dam.

2 Proposed site of multi purpose Munda dam on the negotiation point of river Panjkora and river Swat at Munda of District Charsadda *71 33 26.4 E and 34 20 49.1 N*. The site was identified before creation of Pakistan. The lower Swat Canal head works are situated at this point. Construction of Munda dam is capable of producing about 25000 MW hydro electric power, also capable of eliminating risk of floods in Peshawar valley in particular and in the country in general. The project is also capable of precious water storage necessary for agriculture development in the country. The delay in construction of Munda multi purpose dam is grave crime against the nation.

c. River Swat

River swat originates from heaven on earth the Mahodand, sky touching peaks of Falakseer, Mankial and Desan at the North join river Panjkora of Dir near Munda of Charsada Distract. The river is irrigating the north eastern part of Peshawar valley through upper Swat canal and lower Swat canal the upper swat canal apart from irrigation also generate electricity at Dargai 19 MW Malakand I(this

was the largest power house before partition of subcontinent), 20 MW Malakand II and 82 MW Malakand III. This river has the potential of producing more than 8 Megawatt of electricity per km by harvesting gradient of the river.

Proposed site of multi purpose dam on Utror Kalam river 6km North of Kalam city *72 32 42.1 E and 35 31 03 N*. The construction of reservoir at this particular place will help control floods by storing runoff water received due to snow melting during the month of May to August as water divide between monsoon rains run off water. The combined impact of snow received during winter and melting during summer and the monsoon rains runoff water received during June to August, resulting in generation of devastating floods in the country during the months of July and August will be efficiently addressed resulting in flood control in the country. Apart from flood control and precious water storage capability the site is capable of more than 500 MW power generation.

Proposed site of multi purpose dam at Usho on Matalthan Kalam river 7 km north east of Kalam city at Palogah and power House at Usho *72 40 09.5 E and 35 33 37.5 N*. The construction of reservoir at this particular place will help in floods control by storing runoff water received due to snow melting during the month of June to August. Apart from flood control and precious water storage capability the site is capable of more than 600 MW hydro electric power generation.

d. River Indus

River Indus is one of the world famous river being the world 15th largest river and world 5th longest river it has world No.1 Hydel power potential due to its world highest gradient in single country i.e. Pakistan, maximum is 28,000 feet (K-2) and minimum 0 feet Karachi sea level. The annual discharge of this river is about 110 million acre feet at Attock port. The minimum water discharge per second is 50000 Cubic feet per second (January) and maximum 12,00,000 Cubic feet per second (July). The river is the life line of the country. This river is also known as mighty river Indus the power machine of Pakistan. The world largest dam of its time has been constructed on this river at Tirbela with the water storage capacity of 11.62 million acre feet and hydel power potential of 3500MW the construction of this dam has brought revolution in the economy of the country by boosting the agriculture and industrial sectors. There are also six (6) barrages constructed on this river forming the world largest canal system of Pakistan. Similarly the country second largest hydel power project of 1500MW at Ghazi Brotha is another example of the might of this river.

Kalabagh Dam

There are numerous site for construction of reservoirs for storage of water and power generation these include, Kalabagh dam, having water storage and hydel power capacity more than Tarbela, the construction of dam at this site is technically feasible and of similar importance like any other site on this river but the construction

of dam on this site is suffering of political victimization for the last 50 years due to the short sighted political leadership of the country and is therefore, the causality of politics.

Diamir Basha Dam

Another suitable dam site on river Indus is situated at Bash, this site has tremendous importance due to its location. The site is situated about 50 Km south from Chalas on the boundary of District Kohistan of Khyber Pakhtunkhwa province and District Diamir of Gilgit Baltistan province, *73 45 01.261E and 35 31 6.66 N.* The project is in the process of implementation but suffering from slow or almost no progress since last 30 years. The construction of dam at this site will act as water shed divide between monsoon rains runoff water received during July and August in south and the runoff water received due to melting of snow received during winter in the north and melt during June to August and produces runoff water. The construction of dam at this site will not only work as water reservoir and will control floods and regulate the stream flow but will also produce more than 4000MW electricity. The construction of dam at this site will also increase the life of Tarbela dam.

Pamir Dam

This site is situated some 20 Km south of Gilgit city the site provide for three valley reservoir ie at the junction point of Skardu river, Gilgit river and Hunza river. The site has the same importance as that of Basha. This site has geographical importance being situated on the negotiation point of the world important and famous mountain ranges Hamalia, Karakuram and Hindukosh. The hydel power and storage capacity of the dam at this site is half of Bash Diamir dame site (6 million acre feet water and 2000 MW hydel power potential).

Kadzara

This is another potential site of enormous water storage and power generation some 20Km from Skardu. The water storage potential is more than 15 million Acre feet and power Generation Potential of more than 6000 MW.

e. River Kunhar

River Kunhar is originating from Babosar pass and is funded for water by the world famous, Lake Saiful Malook, Dodi path Sar, Lulupath Sar etc. The river while flowing towards south join river Neelam and Jehlam near Muzarfar Abad of Azad Jammu and Kashmir and is thus the main source of water of the Mangla Dam, the second largest dam and hydel power station of the country.

Naran Dam

The site of this dam is some 5 Km north of Naran PTDC Motel *71 48 34.7 E and 35 56 05.5 N.* This site for the construction of dam has tremendous importance due to its location. The construction of dam at this site will act as water shed divide between monsoon rains runoff water received during July and August in south and the runoff water received due to melting of snow received during winter in the north and melt during June to August. The dam at this site will not only work as water reservoir and will control floods and regulate the stream flow but will also produce more than 600MW chief hydel power this will also increase the life of Mangla dam substantively.

Lake Saiful Malook

The lake Saiful Malook can easily be utilize for water storage and hydel power generation the elevation difference between Naran and Saiful Malook lake is 4500 feet and the distance between Saiful Malook is hardly 4km *73 41 39.543 E 34 52 41.878 N* a power generation unit installed at Narran with Pen Stock head at Saiful Malook on the pattern of Sdpara lake (Skardu Hydel power project) is capable of generating more than 200 MW.

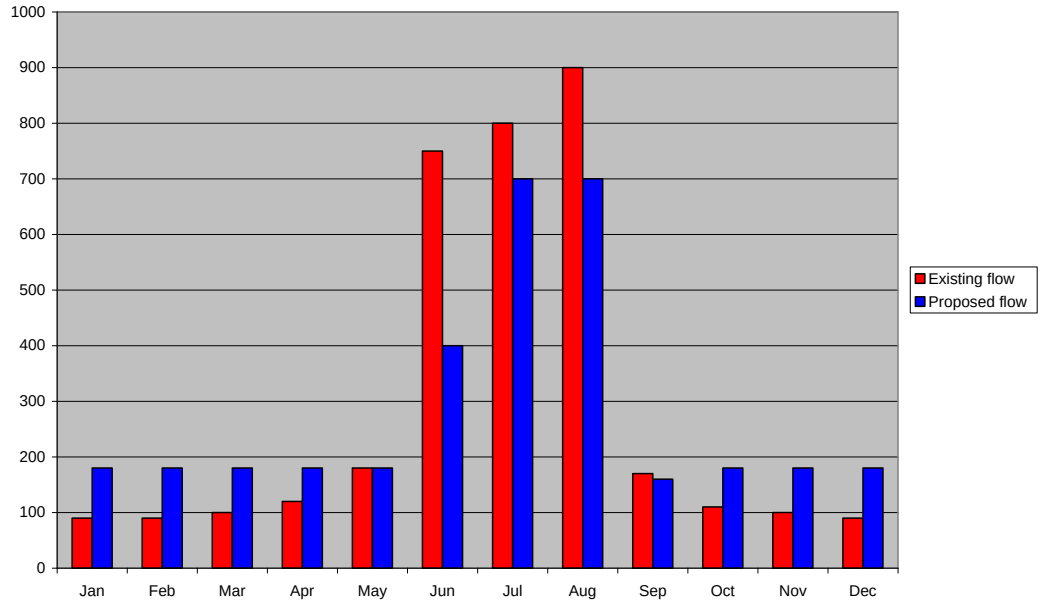
Flood and water availability

Existing and future hydrograph of the Indus basin the discharge rate after flow regulation through construction of proposed storage reservoirs. The following table showing the existing and proposed discharge of River system of Pakistan (000) cusecs after implementation of this study quantity of water is 154 MAF annually.

Table 8. The existing and proposed water flow in the rivers on implementation of this research

Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing flow	90	90	100	120	180	750	800	900	170	110	100	90
Proposed flow	180	180	180	180	180	400	700	700	160	180	180	180

Digram showing the existing and proposed discharge of River system of Pakistan (000) cusecs after implementation of this study quantity of water is 154 MAF annually.



Cost benefit analyses

Estimated annual profit

This is an established fact that all hydel power projects are of numerous positive effects on the economy, sustainable availability of water for drinking/agriculture, flood control, electric power generation leading to industrial, trade and development of fisheries.

The scope of this work is restricted to the evaluation of agriculture sector development of irrigating additional 20 million acres by the stored water of 40 million acre feet. Also the hydel power generation and prevention of the losses inflected by floods each year.

1 Agriculture sector development due to irrigation of additional 20 million acre land by utilizing stored water of 40 million acre feet as result of implementation of this study @ two feet delta per acre irrigation. This will result in the estimated annual return per acre at the minimum rate of Rs.25000.= 2,0000000x25000
= Rs.5000 billion.

2 Hydel Power potential of the projects in the study is 26,515MW.
The estimated annual return @Rs.10 per unit=26515x1000x24x365x10
= Rs.2322.714billion.

3 The annual financial saving as result of flood control. The loss as reported in 2010 floods is Rs.10 billion dollars =Rs.900 billion this much annual loss will be prevented.

Implementation of this research work will lead to annual benefit in these three areas alone = **Rs.8,222.71 billion=91.3634 billion US dollars**.

Estimated expenditures on implementation of this study

a Exploitation expenditures on 26516 MW @ Rs.100000/= per Kilowatt= $.1100/-

=26515 x 1000 x1,00,000= **Rs.2651 billion**

b: Cost of land acquisition and other over head expenditures for the dam sites **= Rs.2651 billion**

Gross total cost of= Rs.5302 billion.= 58.9 billion US

(Major portion of this investment is investment in employment. Thus will bring prosperity to the nation right from 1st day of start of physical work on these projects).

RECOMMENDATIONS

1 The implementation of this study will boost the annual GDP by Rs.8222.71 billion.
2 The energy problem of the country will be solved once for all.
3 Every day strikes and agitation in the country due to load shedding and power shortage will come to an end.
4 The employment problem of unemployed youth population of the country will be solved.
5 The goal of peace and development will be achieved.

Requirements

1. Strong political will. This prime requirement is not presently existing in Pakistan.
2. Man power Professional, technical, skilled and unskilled is abundantly available.
3. The necessary resources can be diverted from curtailment of Developmental funds form the following heads
   a Special Development funds allocated for the members of Parliaments = Rs.100 billions
   b Benazir income support programs funds = Rs.70 billions

c	Prime Minister special funds	= Rs.60 billions
d	Subsidies for thermal power generation sector	= Rs.210 billions
	Total annual resources for the purpose	**= Rs.430 billions**

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