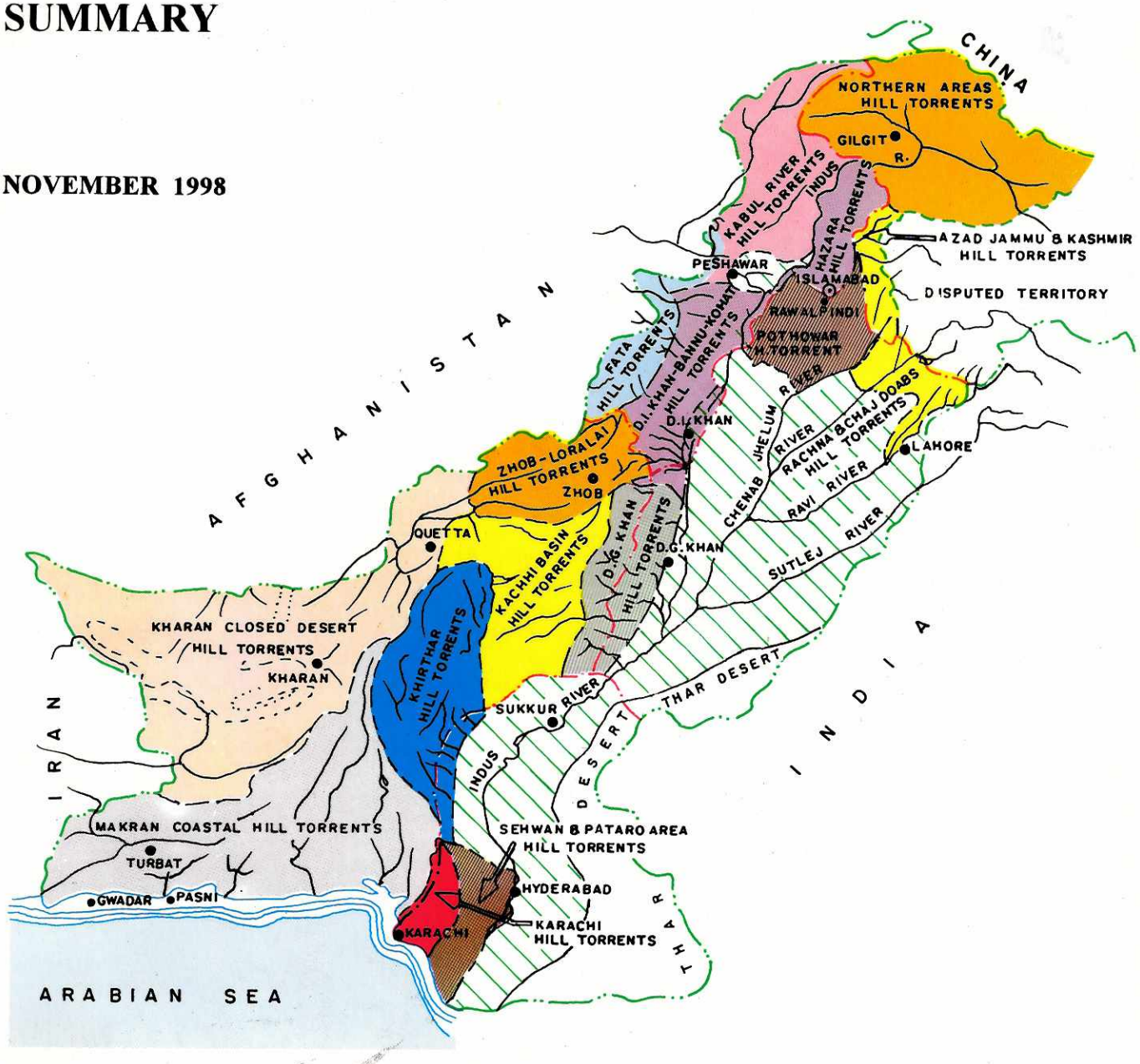
ISLAMIC REPUBLIC OF PAKISTAN
FEDERAL FLOOD COMMISSION
MINISTRY OF WATER AND POWER

MASTER FEASIBILITY STUDIES FOR FLOOD MANAGEMENT OF HILL TORRENTS OF PAKISTAN

SUMMARY

NOVEMBER 1998



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MASTER FEASIBILITY STUDIES FOR FLOOD MANAGEMENT OF HILL TORRENTS OF PAKISTAN

SUMMARY

1. INTRODUCTION

Heavy demographic and socio-economic pressures in Pakistan have resulted in shortage of food. The gap between food production and requirement is increasing with time. Economic conditions of the country and heavy import bill for agricultural products dictate that we should redirect and channelize all our resources, skill and potential to translate the promises envisioned for the economic self reliance of Pakistan into reality. This necessitates that all unutilized potential resources of land and water be used to increase agricultural production in addition to development of other socio-economic sectors.

Pakistan's total potential of fresh water is sufficient to meet the agriculture and food requirements for the growing population for the next 50-year. However, so for there has not been a concerted effort to begin thinking between the Provinces about the conservation/utilization of water for attaining self sufficiency in food for socio-economic amelioration, alleviating poverty, combatting environmental degradation and securing sustainable development. Very soon, the stark reality of food shortage will make it absolutely necessary to reach a provincial consensus on how to deal with these differences and thereby remove the threat of famine in the country. Achieving sustainable development will be a major challenge in the twenty-first century and conservation and utilization of available water resources will undoubtedly be one of the most critical tools for realising this objective.

The major exploitable water resources of Pakistan are:

(A) Surface Water
- (i) Surplus River flows
- (ii) Floodflows of Hill Torrents

(B) Groundwater
- (i) Useable Groundwater Reservoirs (Aquifers)
- (ii) Sweetwater layers overlying saline water.

Pakistan has already utilized major part of its conventional water resources while concerted efforts are required to conserve and develop unexplored resources. Flood flows of hill torrents offer great prospects for development to meet growing demand of water for agriculture. Harnessing of flood flows of hill torrents is, however, a complex enterprize due to large variation in peak to normal flows, high sediment load and spatial and temporal mismatch with crop water requirements. Generally the hill torrent areas are backward and more than fifty percent population live below poverty line. The optimum combination of land and water resources is the key for improving the quality of human environment and development of fauna and flora in the area.

Conservation of hill torrent flow would transform the concept of uncertain crop yields to secure crop production. For the beneficiaries of hill torrent areas, it would be a change from subsistence way of life and farming to market oriented agriculture which offers for more possibilities for development. For the hill torrent areas, water conservation would be 'sine qua non' for socio-economic change.

The Government of Pakistan has taken a keen interest in the development of these resources in poverty stricken areas of Pakistan for socio-economic amelioration. In view of keen interest and guidance of the Government of Pakistan, a Comprehensive Master Feasibility Study, including detailed study of one potential hill torrent area of each Province has been prepared and presented in six volumes. A brief summary of the country wide study is presented herewith, which constitutes the seventh volume of the report. The report is not a static description, but an attempt to show the problems involved in the process of transition from dry land farming to irrigated farming.

2. MAJOR HILL TORRENT AREAS

There are 14 major hill torrent areas of Pakistan of which 13 have considerable potential for conservation and development. Hill torrent areas are listed below and shown on **Exhibit S-1**.

I. **Federal Areas & Azad Kashmir**
- Northern Areas
- Federally Administrated Tribal Areas (FATA)
- Azad Jammu and Kashmir

II. **North Western Frontier Province (NWFP)**
- D.I Khan
- Hazara, Kabul and Bannu (HKB) Basins
- * FATA

III. **Punjab Province**
- D.G Khan
- Pothowar Area
- Rachna & Chaj Doabs

IV. **Balochistan Province**
- Indus Basin Component (including Quetta Region)
- Kharan Closed Desert (KCD) Basin
- Makran Coastal (MC) Area

V. **Sindh Province**
- Khirthar Range
- Karachi Area
- Sehwan & Petaro Area

The hill torrents bring in flashy floods of shorter durations and higher magnitudes. Because of steep gradients, flood flows move with high velocity, which result in the erosion of banks and bed of channels. Flood flows debouching onto the plain areas, are generally charged with high silt contents, which generally preclude their management by dams or reservoirs. As the floodflows traverse the flatter areas, they deposit their silt load as a result of reduction in velocity. The silting and scouring phenomena are largely responsible for frequent changes in flow regime and shifting of flow paths of hill torrents. Unpredictable and erratic nature of floods and high silt contents pose a serious challenge to the ingenuity of flood planners for their economic management.

The principal objective of this study is to establish a basic framework for the orderly and integrated planning and development of water resources of hill torrents of Pakistan. Presently, major part of flows not only goes waste but also causes untold miseries further aggravating conditions in the areas which are already most wretched and underdeveloped in the country. A rational planning of the existing water resources can ensure a systematic development of agriculture to lay the foundation for socio-economic uplift of these areas.

The behaviour and development potential of a hill torrent depend upon a number of interacting factors like, hydrometeorology, catchment characteristics, physiographic features of piedmont area, existing water uses and agricultural potential of available land resources.

The conservation of flows of various hill torrent areas conforms with the overall national planning for bringing additional areas under cultivation so as to provide more food and to improve socio-economic conditions of the local population. For project planning and decision making, technical, economical, environmental, social and host of other factors have been kept in view. In order to achieve planned objectives, the review and analysis of a number of parameters were undertaken, which are considered as basic tools for planning the water resources of hill torrent areas.

Large number of identified water conservation sites were visited in all the sub-project areas. Interviews of the beneficiaries were held and their response/interest in the project was evaluated. Special field investigations were carried out to study:

- Mode of water conservation;
- Identification of land areas;
- Type of conveyance system;
- Existing cropping pattern and production;
- Specific site problem(s) etc.

Special attention was given to determine the land and water resources which are considered as the key elements for development of irrigation system of hill torrent areas. Generally all available area cannot be economically commanded or may not be fit for irrigation. Due to erratic and unpredictable nature of rainfall in most of the areas, available water resources do not match with crop water requirements. In some areas, land resources are a constraint while in others water resources are short. In some areas both the resources are limited or in abundance. All the four scenarios have been observed in various hill torrent areas.

During the currency of project studies, the Consultants were asked to identify Core Projects one in each Province of Pakistan with high development potential. The following four areas were selected in consultation with the Client to prepare Bankable Documents:

- DI Khan Hill Torrents (NWFP)
- DG Khan Hill Torrents (Punjab)
- Khirther Range Hill Torrents (Sindh)
- Indus Basin Component Hill Torrents (Balochistan)

Studies for land and water development potential were carried out in greater detail for Core Projects and the matching of the two basic parameters i.e land and water resources for different cropping patterns and intensities were studied using various computer packages. For other areas, these studies have been carried out in lesser detail but potential has been determined for development of both the resources. Report layout is given in **Fig.S.1**.

In all hill torrent areas, a number of water conservation and/or utilization structures have been constructed. Land parcels have been developed for irrigated agriculture in the close vicinity of water conservation structures. Generally, the following type of structures have been constructed:

- Dispersion Structures;
- Diversion Embankments (Salais);
- Delay Action Dams;
- Storage Dam;
- Floodwalls;
- Flood Diversion Channels; etc.

Flows from these structures are being used through the following modes:

- Diversion Channels;
- Karez;
- Tubewells;
- Open/Dug wells etc.

FLOOD MANAGEMENT OF HILL TORRENTS OF PAKISTAN
REPORT LAYOUT

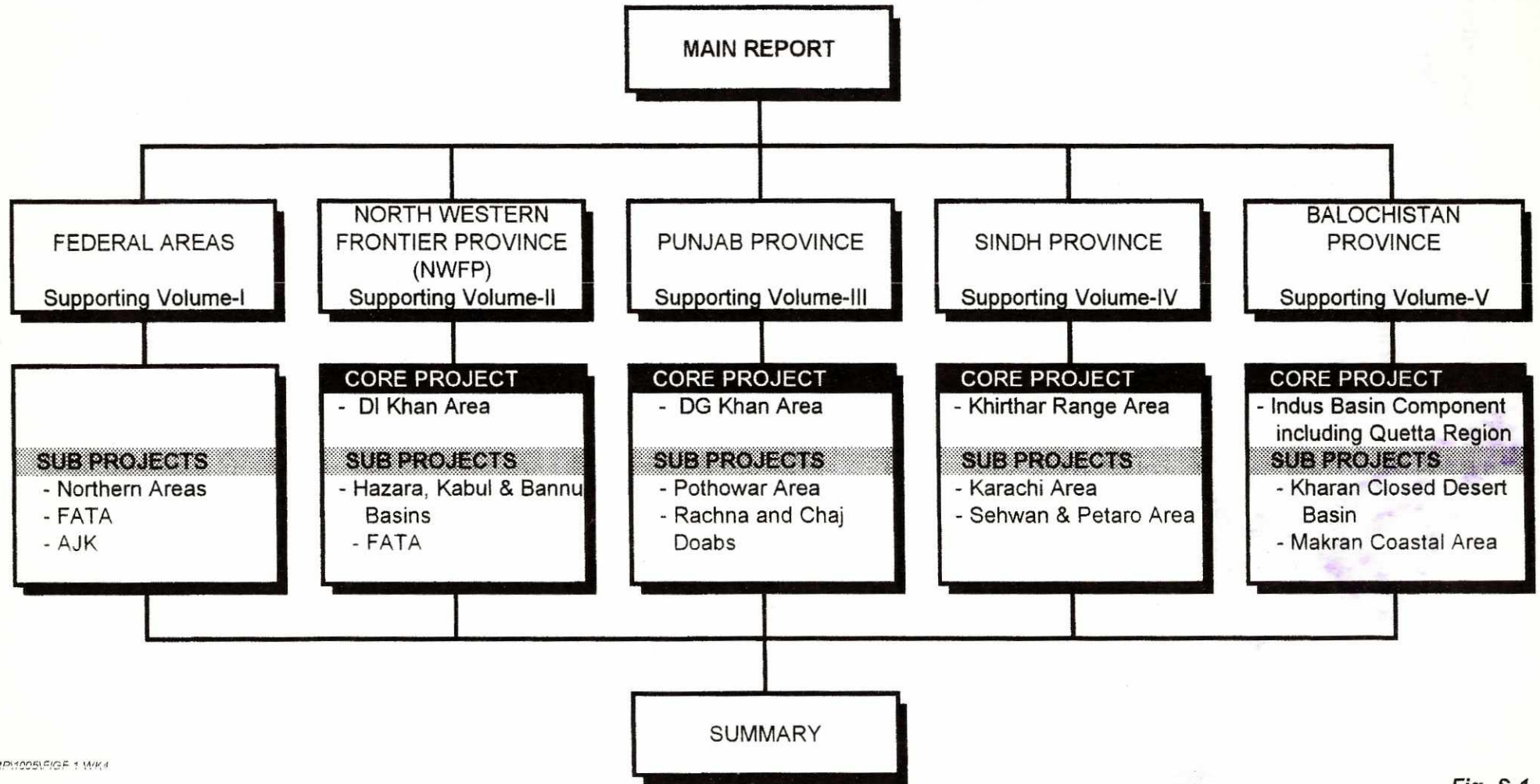

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Fig. S-1

During field visits, various irrigation practices in different hill torrent basins were inspected and their merits and demerits were studied in detail. Irrigation practices vary largely from one area to another depending upon a number of factors. Study of existing irrigation practices greatly helped in evolving and recommending optimal use of water resources likely to be available after the construction of conservation structures. The most frequently used method is to impound the embanked fields to a depth of 1.0-1.2m (3-4ft) and use the soaked fields for sowing and raising the crops with the help of additional freshets.

3. PHYSIOGRAPHIC FEATURES, PROBLEMS & MANAGEMENT STRATEGIES.

From the point of view of physiographic characteristics of catchment areas and drainage pattern, the hill torrents of Pakistan can be divided into the following three regions:

- Indus River Basin (IRB) Hill Torrents.
- Kharan Closed Basin (KCB) Hill Torrents, and
- Makran Coastal Basin (MCB) Hill Torrents.

Indus River Basin Hill Torrents can be further divided into a number of areas from the stand point of their physical characteristics, problems involved and management strategies required to conserve and utilize water resources. The hill torrents of KCB & MCB have typical physiographic features and problems. The overall division of hill torrents areas is given in **Fig. S.2.**

3.1 INDUS RIVER BASIN HILL TORRENTS

All hill torrents of Indus Basin finally outfall into the Indus Basin rivers. However, before joining the rivers, these inflict serious damages enroute. These hill torrents can be broadly divided into three main regions,

- North & North Western Mountain Hill Torrents.
- Suleiman, Kachhi and Khirthar Basin Hill Torrents.
- Low Mountain Hill Torrents.

PHYSIOGRAPHIC FEATURES OF HILL TORRENTS OF PAKISTAN

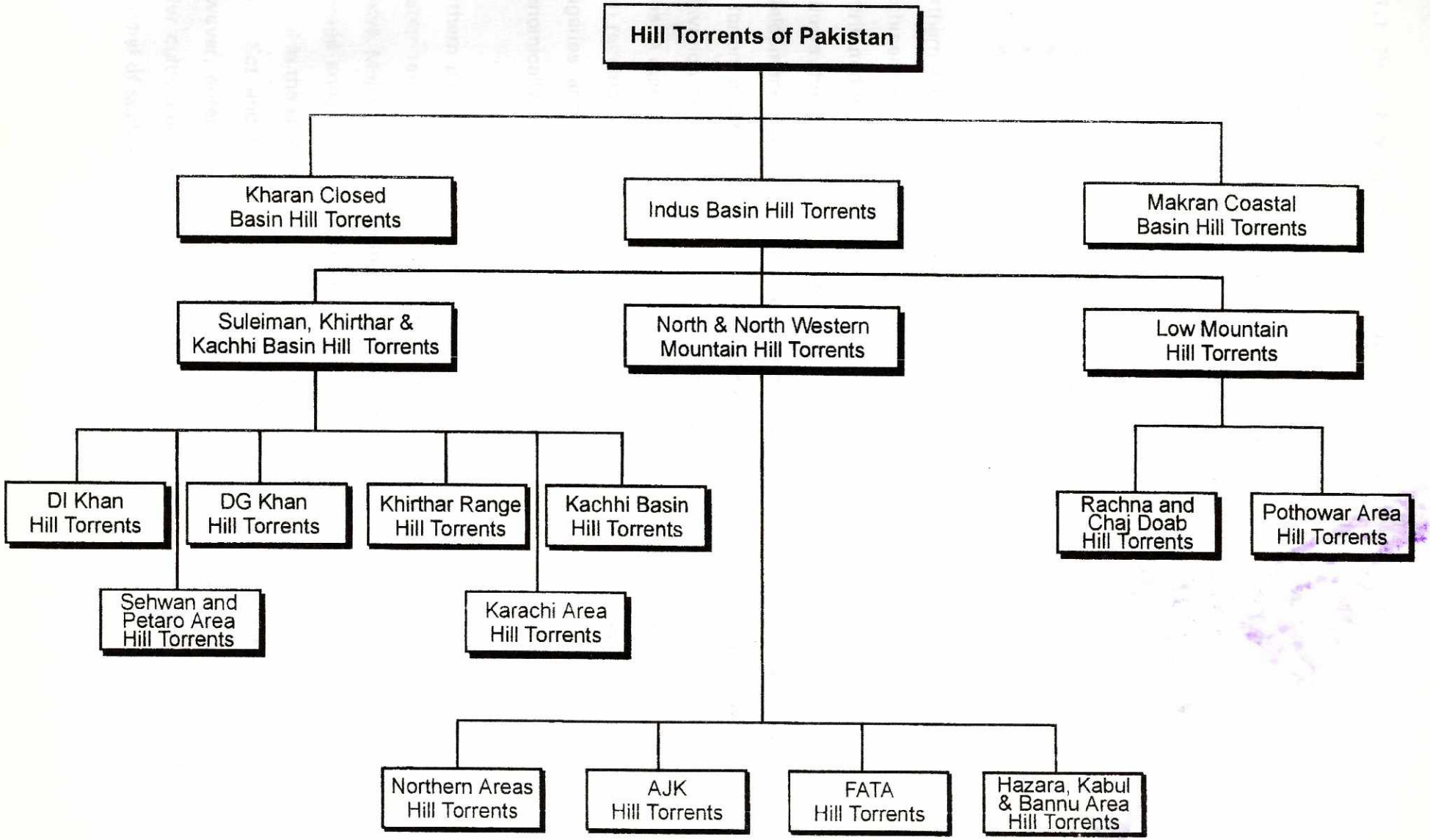

FIG. S-2

3.1.1 North & North Western Mountain Hill Torrents

North & North Western Mountain hill Torrents emerge from high mountains in the north and north western part of Pakistan. The flows of hill torrents in these areas can be generally conserved by constructing low head dams at potential sites. The conserved water could be used by constructing diversion channels to the fields. Major hill torrent areas comprehending this category are:

- Northern Areas Hill Torrents.
- AJK Hill Torrents
- FATA Hill Torrents
- Hazara, Kabul & Bannu Area Hill Torrents.

Northern Areas hill torrents originate from Hindu Kush and adjoining mountain ranges. The catchment areas of these hill torrents are located at high altitudes. Flows are primarily contributed from melting of snow with less sediment load which permits the conservation of flows through reservoirs. Generally these areas do not have large tracts of land for development of agriculture. However, small parcels of land are frequently found in various hill torrent areas which can be used for development of orchards and growing vegetable. Cultivation of potatoes and other vegetables have already been started in some of the areas. A number of potential sites were identified in various hill torrents areas which have been recommended for construction of lowhead reservoirs. However, by using satellite imageries and GPS/GIS, more sites can be identified where water conservation is economically feasible and land areas can be developed for agriculture.

Northern part of AJK comprises foothills of the Himalayas. South of this are the north western reaches of Pir Panjal Range. The hill torrents have cut deeply incised and terraced valleys. Major part of agricultural area is located along the banks of rivers and hill torrents. Average annual rainfall is about 1,140mm (45 inches) and it varies from 500 mm (20 inches) in the south to 1,400 mm (55 inches) in the central part of AJK. In Muzaffarabad, Rawla Kot and Bagh areas very few water conservation sites have been identified. However, potential exists for more sites, with parcels of land which could be brought under cultivation. Use of satellite images, GPS/GIS is required to study development potential of such sites due to difficult approach conditions.

FATA encompasses seven Tribal Agencies and four Frontier Regions spread over an area of 27,220 sq km with about 3.1 million inhabitants (1998 census). It consists of dry and snow covered mountains of heights varying from 610 m to over 2,100m. Presently about six percent of the areas is under cultivation, while potential exists for bringing another seven percent of the area (culturable waste) under irrigation if water resources can be conserved and used for development of irrigated agriculture. FATA has large potential for construction of low head storage dams. Detailed feasibility investigations are required for evaluation of land and water potential of FATA.

Hazara, Kabul & Bannu (HKB) Basins hill torrents cover about 64 percent area of NWFP. Kabul, Swat Kurram. Panjkora and their tributaries traverse through the area. Highest rainfall areas like Abbottabad, Mardan and Malakand are located in HKB Basins. It encompasses an area of 65,516 sq km and covers the entire north eastern region and central part of settled area of NWFP. The area comprises mountain ranges undulating dissected sub-mountain areas and plains surrounded by hills. The area has large development potential for land and water resources which can be developed by constructing low head dams.

3.1.2 **Suleiman, Kachhi & Khirthar Basin Hill Torrents.**

The following six hill torrents areas fall in this category:

- DI Khan Hill Torrents
- DG Khan Hill Torrents
- Kachhi Basin Hill Torrents
- Khirthar Range Hill Torrents
- Karachi Area Hill Torrents.
- Sehwan & Petaro Area Hill Torrents

DI Khan & DG Khan Hill Torrents originate from Suleiman Range, Kachhi Hill Torrents from Marri Bughti Hills and the remaining three from Khirther Range. All these hills, generally pass through narrow gorges and debouch onto the plain areas. DI Khan, DG Khan, Kachhi

Basin and Khirthar Range Hill Torrents strike Chashma Right Bank Canal (CRBC), DG Khan Canal, Pat Feeder Canal and FP Bund respectively and cause serious damage. Malir Nadi of Karachi Area crosses Karachi-Hyderabad Railway Line and National Highway. Baran Nai of Sehwan Petaro Area crosses Karachi-Hyderabad Super Highway & Railway Line, while Kalu and Choherh Nallas outfall into Kinjhar Lake after crossing Karachi Hyderabad Railway Line. Floodflow distributors/dispersion structures can generally be constructed in all these areas to distribute/divert flows to the channels finally leading to the fields. These areas have large piedmont plains with fertile alluvial soils where sustained irrigation systems can be developed. Perennial flows of some of the major hill torrents are presently being used for irrigating the lands. There is already a well developed system of irrigation with specific water rights for use of flood flows. The system generally works well during low flows, but it fails in the event of high flood peaks. The system requires to be improved to cater for flood peaks corresponding to an optimal return period in accordance with the risk analysis studies. Conservation of flows in these areas would not only help in the development of sustained irrigation system in the areas, but would also safeguard the irrigation canals and other infrastructure from frequent flood losses.

Hill Torrents of Pothowar Area & Rachna and Chaj Doabs originate from low mountains. The areas are located in north eastern part of Punjab Province. Headwaters areas of Rachna and Chaj Doabs are located in Indian held Jammu & Kashmir while piedmont areas are located in Pakistan. There are no potential sites in Pakistan, where floodflows could be conserved. Accordingly, detailed studies for water conservation have not been undertaken for Rachna and Chaj Doab Hill Torrents.

Pothowar area also known as Pothowar Plateau is located in the four districts - Attock, Rawalpindi, Chakwal and Jhelum with small component in the northern part of Gujrat District. It encompasses an area of 22,300 sq km. The soils of the area are capable of producing high intensity crops. Pothowar has deeply incised channel beds while major part of the area is extensively gullied with deep ravines. Diversion weirs and low head dams can be constructed to conserve flows of hill torrents. So far 31 small dams have been constructed while 150 additional sites have been identified for construction of dams which require indepth studies for further intervention.

3.2 KHARAN CLOSED DESERT BASIN

Kharan Closed Desert Basin (KCDB) constitutes vast tract of barren lands comprising the north western part of Balochistan. The area is surrounded almost on all sides by overlapping ranges of dry mountains, out of influence of Monsoon and Westerly Disturbances. It encompasses an area of 121,860 sq km (47,050 sq miles). Of the total area, nearly 24,420 sq km has been covered under Indus Basin Component, because of climatic similarity. Remaining 97,440 sq km area is covered under KCD Basin Study. The area is the minimum rainfall region of Pakistan. It is an area of closed drainage whereby streams drain into swamps of Murgha and Mushehel that often dry after low precipitation spells. Nevertheless heavy rainfalls, occasionally produce flash floods which go waste because of lack of conservation structures constructed in the area to conserve flood flows. Fifty six (56) sites have been identified for conservation of flood flows.

3.3 MAKRAN COASTAL BASIN

Makran Coastal (MC) Basin forms the south eastern part of Balochistan and is oriented along a 750 km (466 miles) coastal belt of Arabian Sea. MC Basin encompasses an area of about 123,025 sq km (47,500 sq miles). Physiographically, the area possesses a series of mountain ranges, vast alluvial plains and plateaus. The ranges give rise to a number of rivers and hill torrents of various sizes which do not have a common drainage and individually outfall into the Arabian Sea. The climate is generally humid and hot in summer and cool and dry in winter. Mean annual precipitation in the area varies from 125 mm to 200 mm with an average of about 150 mm. The area is pre-dominentally under the influence of Monsoon which occasionally generate flash floods causing inundation of large areas and damage to village abadies, agricultural areas and infrastructure. Major part of runoff from the precipitation is wasted into the Arabian Sea unused. Recent flood during 1998 caused considerable damage in the area. The flood flows can be managed by constructing diversion weirs and delay action dams. Eighty two sites have been identified which can be used for conservation of floodflows.

4. LAND AND WATER CONSERVATION POTENTIAL OF HILL TORRENTS

In order to study land and water conservation potential of hill torrents of Pakistan, extensive field visits were carried out by the multi-disciplinary team of Consultant to all hill torrent areas. Interviews were held with the beneficiaries to study their response/interest in the project and participation. Discussions were held with the field staff of Provincial Irrigation and Power Departments (PIDAs) and merits & demerits of identified conservation sites were reviewed. Efforts were made to acquire reliable field data of various disciplines to ensure proper linkages among different sectors and to carryout comprehensive analysis for the formulation of sustained agricultural system through optimal use of both the land and water resources of the areas. In order to fill the missing links of data, synthetic techniques, and computer models were used.

4.1 IDENTIFICATION OF SITES & COST ESTIMATE.

In all the areas, large number of potential conservation sites were identified. The number of sites in the Federal Areas and four Provinces of Pakistan are:-

Area/Province	No of Conservation Sites
• Federal Areas (Northern Areas, FATA and AJK)	383
• NWFP (Including FATA)	417
• Punjab	211
• Sindh	33
• Balochistan	423
Total:	1,204

FATA with 263 potential sites included once in the total

A total of 1,204 sites have been identified of which 423 (35.13%) are located in Balochistan Province. NWFP including FATA has 417 sites which is about 34.63 percent of total sites, while excluding FATA is 12.79 percent. Federal Areas including FATA has 383 sites (31.81%). Number of potential sites in Punjab Province is 211 (17.52%). Hill Torrents of Rachna & Chaj Doabs of Punjab have their headwaters areas in Indian occupied part of Jammu & Kashmir, while their fanout areas located in Pakistan have no potential for conservation. Only 33 sites have potential in Sindh Province. Out of total of 1,204 conservation sites, 175 have been conceptually identified from maps and other available data. In order to further certify these sites, the use of satellite images and GPS/GIS is required.

In order to study the potential for horizontal and vertical expansion in agriculture, review of various components like increase in acreage (horizonal expansion), better seeds, fertilizers, pesticides, improved management practices etc to increase yield per hectare (vertical expansion) was undertaken since inception of Pakistan (1947). The review indicates that horizontal expansion has been about 100 percent: irrigated area increased from 8.4 million hectare (Mha) in 1946-47 to 17.6 mha in 1996-97 including about 3 Mha being cultivated through tubewells/wells outside Indus Basin System. Cropped area has increased from 11.63 Mha (1946-47) to 22.61 Mha (1996-97). Canal suplies to these areas are being supplemented by ground water to the tune of about $59.18 \times 10^9 m^3$ (48 MAF). Horizontal expansion in agriculture, which is contributing to the tune of 24% of GNP has been only possible when more water was made available at the formgate. **Table S.1** gives the water & agricultural statistics of Pakistan since its inception.

Groundwater resources have already been developed to an optimal level from useable water quality aquifers while surface water resources can only be enhanced if surplus flows are stored by constructing additional storages. This is because of the fact that nearly 80 percent of the total river water flows during the three Monsoon months, while balance flows move in the river system during the remaining nine months.

Table S-1

Water & Agricultural Statistics of Pakistan

(Area, Million Hectare)

Period	Canal Withdrawals (MAF)	Availability At Farmgate MAF (Canal + Tubewells)	Cultivated Area	Net Sown	Cropped Area	Irrigated Area (Tubewells/Wells only)	Remarks
1946-47	67.36	41.16 (40.12 + 1.04)	14.69	10.68	11.63	8.40 (0.40)	
1959-60	82.22	53.90 (49.85 + 4.05)	16.85	12.85	15.25	10.25 (0.95)	Construction of three link Canals from 1950-60
1960-61	82.38	52.52 (48.35 + 4.17)	18.12	13.27	14.86	10.40 (1.07)	
1971-72	86.05	71.37 (51.24 + 20.13)	19.09	14.34	16.60	11.82 (1.45)	Construction of Mangla Dam in 1967
1976-77	98.07	84.57 (58.40 + 26.17)	19.76	15.07	18.21	13.52 (1.70)	Construction of Tarbela Dam in 1976
1980-81	107.40	94.61 (62.03 + 32.58)	20.30	15.41	19.33	14.84 (1.96)	
1985-86	96.34	104 + 73 (65.63 + 39.10)	20.68	15.77	19.81	15.79 (2.04)	
1987-88	109.10	112.22 (71.24 + 40.38)	20.76	14.72	19.52	15.68 (2.46)	
1990-91	109.60	119.62 (75.64 + 43.98)	20.96	16.11	21.82	16.75 (2.62)	
1994-95	-	129.05 (81.23 + 48.42)	21.55	16.13	22.14	17.20 (2.75)	
1995-96	-	130.85 (82.43 + 48.42)	21.54	16.28	22.59	17.58 (3.00)	
1996-97	-	130.96 (82.65 + 4831)	21.55	16.24	22.61	17.60 (3.07)	

(MAF = 1,233M^3)

Source: 1. Agricultural Statistics of Pakistan 1995-96.
2. Report of the National Commission on Agriculture, March 1988.

4.2 HISTORICAL TREND OF MAJOR CROP PRODUCTION

By studying the historical trend of major crop production and yields, from 1947-48 to 1995-96, it has been observed that Pakistan has achieved reasonable horizontal and vertical expansion in agriculture. Areas under wheat, rice, sugarcane & cotton have increased by 212, 276, 508 and 242 percent during this period respectively. The percent increase in production during the same period for wheat, rice sugarcane and cotton is 504, 573,817, 963 percent respectively, while yield/ha has increased by 238, 209, 161 and 378 percent respectively. However, if land and water resources of hill torrents are optimally developed and used, there is great potential for further expansion of both horizontal and vertical expansion in agriculture. Pakistan can earn foreign exchange to the tune of over $ 10 billion by exporting surplus dairy and agricultural products. **Table S.2** gives the historical data of major crop production and yields.

4.3 DEVELOPMENT POTENTIAL AND ECONOMIC APPRAISAL

Studies carried out for conservation of water and landuse potential of hill torrents indicate that in 13, out of 14 major hill torrent areas, there is large scope for development of both land and water resources. For each major hill torrent area, the land and water potential has been determined. Highest development potential exists in Balochistan Province, where $3.69X10^9m^3$ (3.00MAF) water goes waste to the Arabian Sea and depressional areas in Makran Coastal Basin, while $0.973X10^9m^3$ (0.789 MAF) is being wasted through ponding in Human-e-Mushkel and Human-e-Murgha. The conservation potential for Indus Basin component including Quetta region is about $5X10^9$ m^3 (4 MAF). Unmanaged flow causes extensive damage enroute to Hamal & Manchar Lakes in Sindh where it causes a number of breaches in FP Bund resulting in large monetary losses in canal command area. Provincial Irrigation & Power Department, Government of Sindh has prepared a plan estimated to cost over two billion rupees to strengthen FP. If water resources of Indus Basin Component in Balochsitan Province could be conserved and used through the proposed measures, it will obviate the necessity of restoration of FP Bund in Sindh. Similarly large potential for conservation of water and landuse exists in other Provinces and

Table S-2

Historical Data of Major Crop Production & Yields

Year	Area, (000ha)	Production (000 tons)	Yield/ha (kg)
1. Wheat			
1947-48	3,953.90	3,354	848
1995-96	8,376.50	16,910	2,018
Percent Increase	212	504	238
2. Rice			
1947-48	789.90	692.90	877
1995-96	2,181.80	3,970	1,835
Percent Increase	276	573	209
3. Sugarcane			
1947-48	189.40	5,529.30	29,194
1995-96	963.1	4,520.00	47,000
Percent Increase	508	817	161
4. Cotton		**(Million Bales)***	
1947-48	1,236.80	1.106	159
1995-96	2,997.30	10.650	601
Percent Increase	242	963	378

*** Bale - 375 Lbs**

Source: (a) Pakistan Development Statistics, Statistical Bulletin No.42, P&I Publication No.292.

(b) Agricultural Statistics of Pakistan 1995-96.

Federal Areas. Aggregate potential for the entire country is about $25X10^9m^3$ (18.69 MAF) of which 60 to 70% can be used for development of a part of 6.35 Mha (17.13 M acres) culturable waste in these regions. **Table S.3** indicates the overall land and water conservation potential of hill torrents of Pakistan.

The estimated costs and economic parameters of Core Projects are summarized as:

Core Projects	Estimated Cost (Rs Million)	EIRR (%)
DI Khan (NWFP)	354	17.47
DG Khan (Punjab)	1,055	13.62
Khirthar Hill Torrents, Gaj Nai - (Sindh)	242	16.34
Indus Basin Component (Balochistan)	2,757	18.58
Total	4,408	17.06 (Average)

Economic evaluation of Core Projects indicates that, these are economically viable projects.

4.5 SOCIO - ECONOMIC BENEFITS

Execution of projects in hill torrent areas would not only improve the economic conditions but will also usher in new era of social uplift in these areas.

A few components of hill torrent projects have been executed under Flood Protection Sector Project-I, (FPSP-I). Monitoring of executed projects has indicated some of the following social benefits:

- Development of infrastructure like construction of new roads, installation of telephones, power supply has been started in the villages in the hill torrent areas.
- Migration of people from the area has not only stopped but to the contrary, people have started coming back to the areas.
- The growth of small business centers/cottage industries have started.
- Enrolment in Schools has been greatly increased

TABLE S–3

LAND AND WATER CONSERVATION POTENTIAL OF HILL TORRENTS OF PAKISTAN

Province	Area	Culturable Waste land		Average Annual Water Conservation Potential	
		(Hectares)	(Acres)	(MAF)	(MCM)
Federal	Northern Area	60,700	149,929	0.940	1,159
	A J Kashmir	33,600	82,992	0.400	493
	FATA *	178,700	441,389	1.500	1,850
	Sub–Total Federal	273,000	674,310	2.840	3,502
NWFP	D I Khan	419,000	1,034,930	0.800	986
	FATA *	178,700	441,389	1.500	1,850
	Hazara, Kabul & Banu	442,300	1,092,481	3.760	4,636
	Sub–Total NWFP	1,040,000	2,568,800	6.060	7,472
Punjab	DG Khan	349,700	863,759	0.854	1,053
	Pothowar	220,800	545,376	1.860	2,293
	Rachna & Chaj Doab	–	–	–	–
	Sub–Total Punjab	570,500	1,409,135	2.714	3,346
Sindh	Khirthar Range	279,300	689,871	0.296	365
	Karachi	64,560	159,463	0.094	116
	Sehwan & Petaro	207,000	511,290	0.330	407
	Sub–Total Sindh	550,860	1,360,624	0.720	888
Balochistan	Indus Basin Component	837,900	2,069,613	4.067	5,015
	Kharan	1,060,500	2,619,435	0.789	973
	Makran	2,781,500	6,870,305	3.000	3,690
	Sub–Total Balochistan	4,679,900	11,559,353	7.856	9,678
	Grand Total	6,935,560	17,130,833	18.690	23,036

* FATA is located in NWFP, but is under administrative control of Federal Government. Hence FATA appears both in NWFP and Federal Areas. However, in grand total, it has been counted once.

4.6 RECOMMENDATIONS

Land and water resources have been evaluated for all hill torrent areas of Pakistan. In the light of data analysis, field visits carried out, interviews held with beneficiaries and studies carried out a package of 1,204 water conservation sites estimated to cost Rs 20,785 million has been recommended for execution. Proposed package is given in **Table S.4**. Abject poverty in hill torrent areas warrants that recommended plan be implemented as early as possible to ameliorate the socio-economic conditions of the people. However, in view of financial constraints 20-year implementation schedule has been recommended for studies and execution (**Fig.S.3**). Implementation schedule has been conceived in such a way that at any time, it can adjust to the changing needs of the Project Area, population, emerging new development policies, experience gained from the past activities and critical feedback and new scenarios. Flexible targets have been recommended instead of rigid and fixed goals. It is anticipated that execution of proposed measures would usher in new era of economic prosperity in hill torrent areas.

TABLE S-4

Summary of Recommended Package

Cost: Rs. million

Area/Region	Number of Conservation Sites, Estimated Cost & Present Status				Proposed Execution Period							
					9th 5-Year Plan (1998-2003)		10th 5-Year Plan (2003-2008)		11th 5-Year Plan (2008-2013)		12th 5-Year Plan (2013-2018)	
	Total No.	Cost	Status	No. of Schemes	No.	Estimated Cost	No.	Estimated Cost	No.	Estimated Cost	No.	Estimated Cost
FEDERAL AREAS												
(a) Northern Areas	39	988										
		-	Feasibility	-	9	218	10	300	10	250	10	220
		218	Pre-Feasibility	9								
		-	Reconnaissance	-								
		770	Conceptual	30								
(b) AJK	81	825										
		-	Feasibility	-	31	310	20	205	20	205	10	105
		310	Pre-Feasibility	31								
		-	Reconnaissance	-								
		515	Conceptual	50								
(c) FATA	263	2,806										
		-	Feasibility	-	28	414	65	650	90	910	80	832
		414	Pre-Feasibility	28								
		1,567	Reconnaissance	160								
		825	Conceptual	75								
Total for Federal Area	**383**	**4,619**			68	942	95	1,155	120	1365	100	1,157
N W F P												
(a) DI Khan	36	500										
		354	Feasibility	25	25	354	11	146	-	-	-	-
		146	Pre-Feasibility	11								
		-	Reconnaissance	-								
		-	Conceptual	-								
(b) HKB Basins	118	3,530										
		330	Feasibility	11	11	330	30	900	40	1,200	37	1,100
		3,200	Pre-Feasibility	107								
		-	Reconnaissance									
		-	Conceptual									
(c) FATA *	263	2,806										
		-	Feasibility	-								
		414	Pre-Feasibility	28	28	414	65	650	90	910	80	832
		1,567	Reconnaissance	160								
		825	Conceptual	75								
Total for NWFP	**417**	**6,836**			64	1,098	106	1,696	130	2,110	117	1,932
PUNJAB												
(a) DG Khan	40	1,055										
		1,055	Feasibility	40	40	1,055	-	-	-	-	-	-
		-	Pre-Feasibility									
		-	Reconnaissance									
		-	Conceptual									
(b) Pothowar	171	4,000										
		-	Feasibility	-	25	500	40	940	50	1,200	56	1,360
		840	Pre-Feasibility	21								
		3,160	Reconnaissance	150								
		-	Conceptual									
(c) Rachna and Chaj Doabs	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Total for Punjab	**211**	**5,055**			65	1,555	40	940	50	1,200	56	1,360

TABLE S-4

Summary of Recommended Package

Cost: Rs. million

Area/Region	Number of Conservation Sites, Estimated Cost & Present Status				Proposed Execution Period							
					9th 5-Year Plan (1998-2003)		10th 5-Year Plan (2003-2008)		11th 5-Year Plan (2008-2013)		12th 5-Year Plan (2013-2018)	
	Total No.	Cost	Status	No. of Schemes	No.	Estimated Cost	No.	Estimated Cost	No.	Estimated Cost	No.	Estimated Cost
SINDH												
(a) Khirthar Range	25	842										
		242	Feasibility	10	10	242	15	600	-	-	-	-
		-	Pre-Feasibility									
		-	Reconnaissance									
		600	Conceptual	15								
(b) Karachi	3	170										
		-	Feasibility	3	3	170						
		-	Pre-Feasibility									
		3	Reconnaissance									
		-	Conceptual									
(c) Sehwan and Pataro Area	5	300										
		-	Feasibility	-		-	5	300	-	-	-	-
		-	Pre-Feasibility	-								
		-	Reconnaissance	-								
		300	Conceptual	5								
Total for Sindh	33	1,312			13	412	20	900	-	-	-	-
BALOCHISTAN												
(a) Indus Basin Component	285	3,768										
		2,757	Feasibility	150	150	2,757	135	1,011	-	-	-	-
		1,011	Pre-Feasibility	135								
		-	Reconnaissance									
		-	Conceptual									
(b) Kharan Closed Desert Basin	56	640										
		-	Feasibility	-	20	250	25	300	11	90	-	-
		640	Pre-Feasibility	56								
		-	Reconnaissance	-								
		-	Conceptual	-								
(c) Makran Coastal Basin	82	1,361										
		-	Feasibility	-								
		1,361	Pre-Feasibility	82	20	300	30	450	20	300	12	311
		-	Reconnaissance	-								
		-	Conceptual	-								
Total for Balochistan	423	5,769			190	3,307	190	1,761	31	390	12	311
GRAND TOTAL 1996 Price Level	1,204	20,785			372	6,900	386	5,802	241	4,155	205	3,928

* FATA is located in NWFP, but is under administrative contral of Federal Government. It is included both in NWFP and Federal Areas. However, in the grand total it has been counted once.

Sr. No.		1st 5-Year	2nd 5-Year	3rd 5-Year	4th 5-Year
A.	**CORE PROJECTS**				
1.	Flood Management of DI Khan Hill Torrents (NWFP)				
	i. Detailed Design				
	ii. Recommended Schemes				
	iii. Other Schemes				
2.	Flood Management of DG Khan Hill Torrents (Punjab)				
	i. Detailed Design				
	ii. Recommended Schemes				
	iii. Other Schemes				
3.	Flood Management of Khirthar Range Hill Torrents (Sindh)				
	i. Detailed Design				
	ii. Recommended Schemes				
	iii. Other Schemes				
4.	Flood Management of Indus Basin Component & Quetta Region Hill Torrents (Balochistan)				
	i. Detailed Design				
	ii. Recommended Schemes				
	iii. Other Schemes				
B.	**SUB-PROJECTS**				
I.	**Federal Areas**				
1.	Northern Areas				
	i. Feasibility Studies				
	ii. Detailed Designing & Execution				
2.	FATA				
	i. Feasibility Studies				
	ii. Detailed Designing & Execution				
3.	Azad Jammu & Kashmir				
	i. Feasibility Studies				
	ii. Detailed Designing & Execution				
II.	**NWFP**				
4.	Hazara-Kabul & Bannu Basins				
	i. Feasibility Studies				
	ii. Detailed Designing & Execution				
III.	**Punjab**				
5.	Pothowar Area				
	i. Feasibility Studies				
	ii. Detailed Designing & Execution				
6.	Rechna & Chaj Doab				
	i. Feasibility Studies				
	ii. Detailed Designing & Execution				
IV.	**Sindh**				
7.	Karachi Area				
	i. Feasibility Studies				
	ii. Detailed Designing & Execution				
8.	Sehwan & Petaro Area				
	i. Feasibility Studies				
	ii. Detailed Designing & Execution				
V.	**Balochistan**				
9.	Kharan Closed Desert Basin				
	i. Feasibility Studies				
	ii. Detailed Designing & Execution				
10.	Makran Coastal Basin				
	i. Feasibility Studies				
	ii. Detailed Designing & Execution				

TENTATIVE SCHEDULE FOR PROJECT STUDIES AND EXECUTION

Fig. S-3