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FLOODS AND ROADS IN INDUS BASIN

BY

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ABSTRACT

Floods are recurring tragedy in Pakistan. We faced severe flood conditions six times in the last forty years. There was lot of damage to roads, irrigation system, crops, houses, livestock and human life.

Road network is severly affected by floods. Presently we have 130,000 Km of roads which works out to be 0.16 Km/Sq. Km. So it is important to have safer roads. Usually our roads are not located on the highest contours of the area and this should have free flow conditions of course embankment would be high and lot of cross drainage work will have to be provided. It would be able to pass floods safely as well as provide refuge to men and livestock during floods.

1. FLOODS

Floods are becoming a recurring tragedy for the people of Pakistan. There were six occasions when we had to face most disastrous floods. Those were in 1955, 1959, 1973, 1976, 1988, and 1992. Earlier before 1947, there was very severe flood in 1929.

In 1959, floods inundated 1.4 millions acres of land, 110 million people were dislocated and about 12 thousand houses collapsed.

In 1973, floods rendered 8 million people houseless, 10 millions acres of land was inundated and one million people were dislocated only in Punjab.

In 1988, flooding affected 1.6 million acres of land & 1.3 millions people lost their shelters.

The 1992 flood is regarded as worst in the recent history of Pakistan. In this catastrophy 13185 villages were affected 7.6 millions persons were up-rooted and area of 9.7 millions acres was flooded, 6.1 millions acres of crop and 422480 houses were damaged, 1332 persons died and 168040 cattle head and sheep etc. were lost. Total damage to works had been estimated to be Rs. 10,567,566,000. The rainfall and inundation damages are shown on the attached maps.

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It would be observed that this colossal loss is to be suffered by people of Pakistan at regular interval due to floods. It severally affect our growth rates which leads to poor economic performance.

Let us examine the behaviour of roads during floods. It has been observed over the years that lot of roads are damaged by various floods in the past years. To illustrate the point, damages to various roads in 1992 floods were estimated to be Rs. 4,970,124,000.

It is colossal loss to government exchequer. There is tremendous loss of human life and livestock. In addition there is damage to crops, houses & canal system etc.

2. ROADS IN PAKISTAN

Sufficient roads are not available in Pakistan for transportation of men & materials. Therefore this is a scarce Capital and once any investment is made on roads it should be preserved by proper maintenance. It is only possible if roads are properly designed. Data regarding roads in Pakistan in given below for information.

Total Length of Road	=	130,000	Km
a. National Highways	=	6,587	Km
b. Provincial Highways	=	48,263	Km
c. Farm to Market Roads	=	65,957	Km
d. Urban Roads	=	9,200	Km
Total Area of Pakistan	=	796,095	Sq. Km
Road Density	=	0.16	Km/Sq. Km
Developing Country's Average Density	=	0.62	Km/Sq. Km

It will be seen from above that we have much less roads than the requirement. Moreover our maintenance is not upto the standard. Additionally roads are effected by rains and floods and these are damaged extensively during severe floods. Solutions are available to have safer roads.

3. HYDROLOGY

Hydrology is that branch of Physical geography dealing with the waters of the earth. The branch of hydrology concerned with roads and highways deals with the frequency and intensity of precipitation and the frequency with which this precipitation brings peaks of runoff that equal or exceed certain critical values

The prediction regarding future rainfall or runoff from accumulated records, rest on the law of probability in other words, the chance that a given event will or will not take place.

The rain that falls, some is returned to the atmosphere by evaporation from land and water surface and by transpiration through plants. Another portion percolates through the ground. The remaining precipitation flows overland in a thin sheet until it reaches streams or channels/rivers, which in turn would deliver the water to an ocean. Lakes, Reservoirs and other man made works (which are diversions for human use) often intervene in this progression. Therefore for various reasons, the determination of peak runoff from rainfall records in difficult.

The road/highway system generally disrupts established/natural drainage pattern for various reasons. A road would be located on the highest contours of the area to have proper drainage but generally it did not happen. Therefore it would have sufficient cross-drainage works to be safe in flooding conditions.

4. DRAINAGE

Let us examine the means for collecting, transporting, and disposing of surface water originating on near the right of way or flowing in streams crossing or bordering that right of way. On an average, on highway construction one rupee in four is spent for culvert, bridge, and other drainage structures. Substantial added expenditures are demanded on rural roads for ditches, dikes, channels, and erosion-control installations. In urban and suburban locations, major capital investment goes into storm drains and their appurte-

nances. In addition, routine cleaning and repair of drainage facilities coupled with the expense of rebuilding after heavy storms takes a substantial share of maintenance funds.

The attack on surface-drainage and erosion-control problems must begin in the location survey. Ideal locations from a drainage standpoint would lie along the divides between large drainage areas. Then all streams flow away from the right of way and the drainage problem is reduced to caring for the water that falls on roadway and back slopes. In contrast, locations paralleling large streams are far less desirable as they cross every tributory where it is largest. Again, ideal locations avoid steep grades and heavy cuts and fills, both of which raise difficult problems in erosion control. Admittedly, surface drainage is only one among many considerations in location, but it warrants careful attention.

Once the location is established, analysis of surface-drainage problems follows three basic steps: (a) hydrology-estimating the peak rates of runoff to be handled, (b) hydraulic design-selecting the kinds and sizes of drainage facilities to most economically accommodate the estimated flows, and (c) making certain the design does not create erosion or other environmentally unacceptable conditions.

4.1 Economy in Drainage

True economy in drainage means finding the solution that is cheapest in the long run. The first step to estimate the first cost, maintenance outlay, and anticipated loss and damage for each reasonable solution. These are then compared.

In these computations, the annual charges for possible flood damage or economic loss equals the estimated losses from floods of various magnitudes, multiplied by the probability that these floods will occur in any one year. For example, if losses from any flood exceeding the design flow total Rupees One Million and hydrologic studies indicate that such a flood will occur once in 25 years, the annual charge for possible flood damage equals Rs. 1,000,000 x 1/25, or Rs. 40,000. This approach can be extended to recognize different cost of damage for floods of various magnitudes.

Economy problems in drainage are diverse, and do not lend themselves to any single set of assumptions or rules. Commonly, the answer sought is the flood frequency on which the design should be based. For a major highway carrying large volumes of heavy traffic, losses to motorists and to the economy in general may be tremendous if the road is

closed frequently by floods and wash-outs. On the other hand, on a lightly traveled rural road, economic losses will not justify large capital expenditures to prevent occasional interruptions to traffic. For the major highway, studies might prove that drainage facilities should accommodate a 50-yr flood, whereas designs based on a 5-yr flood would be more reasonable for the low-volume rural road. In another instance, capacity to accommodate infrequent floods would be appropriate if smaller waterways resulted in flooding of valuable property. However, it might be cheaper in the long run to inundate bottom lands every few years rather than to provide channels and structures large enough to protect them. As a third example, damage to embankments overtopped by flood water will generally be much more severe in arid regions where the slopes are unprotected than in humid regions where they are covered with grass or other growth. Thus, other things being equal, more generous designs to prevent overtopping would be appropriate in arid regions than in humid ones.

Where drainage problems of any magnitude have alternative solutions, economy studies based on reasonable estimates of costs and possible future damage represent the best approach. It is true that flood frequencies and some of the costs must be roughly approximated, and that catastrophic occurrences warp our perspective.

4.2 Legal Aspects of Drainage

Agencies have legal responsibility for damage to private property resulting from changes they make in natural drainage patterns within the limits that "water must flow." Thus, damage claims against an agency could be established if erosion, silting, or flooding of private property resulted when the flow of several small streams was concentrated into a single structure or channel. Again, a cause of action might be created if water backed up against a highway structure or embankment and inundated lands or property or resulted in injury or death because of poor design or inadequate maintenance. However, liability supposedly is restricted to those damages that are a direct consequence of the improvement. It follows that the agency normally would not be liable if an unprecedented storm caused a stream to overflow a newly constructed channel, provided this channel had a capacity equal to the natural one. This follows the rule that engineering decisions, if based on accepted practice, do not provide a cause for action. In each case, responsibility of the highway agency would be determined by negotiation or court proceedings. The important point is that improper or inadequate drainage designs may bring not only criticism and charges of incompetence, but damage suits as well.

Design for drainage also must satisfy a variety of environmental laws and regulations.

5. ROAD LOCATION AND DESIGN

Ideally a road should be built on the highest contour of the area. Thus it would be safer and reduces damage and is economical in cross drainage works. But usually roads are not built on the highest contours of the area. Roads are built to serve the population and carry men and materials. Therefore, these are located nearest to human settlements and join various trading centres. Therefore in flood prone areas roads should be build/designed that free flow conditions exist in the area.

Our rivers have many works on which is based our irrigation system. To save a headwork usually when flood level reaches a pre-determined level, the protection bunds are breached and thus flood water is spread over areas where floods are not ordinarily expected and in turn roads are affected in these areas as well. Design capacities and maximum floods at various works/barrages is shown in the table below.

DESIGN CAPACITIES AND MAX FLOODS AT VARIOUS WORKS/BARRAGES

River	Barrage H. Work	Designed Cap. Lakhs Cs	Highest Flood Lakhs Cs	Flood Dates
INDUS	Kalabagh	9.5	9.2	4-7-1942
	Chashma	11.00		
	Taunsa	10.0	7.89	7-3-1976
	Gudu	12.0	10.83	1973
	Sukkar	15.0	11.17	21-8-1973
	Kotri	8.75	8.11	1973
JHELUM	Mangla		11.0	29-8-1929
	Rasul	8.5	8.8	4-7-1959

CHENAB	Marala	11.0	11.0	26-8-1957
	Khanki	8.0	10.9	27-8-1957
	Qadirabad	9.0	8.5	10-8-1973
	Trimmu	6.45	9.4	14-7-1959
	Panjnad	7.0	8.0	18-7-1973
RAVI	Jassar	2.75	6.8	5-10-1955
	Ravi Syphan	4.0	6.6	6-10-1955
	Shahdara	2.5	5.4	6-10-1955
	Balloki	2.25	2.75	1950
	Sidhnai	1.5	2.1	18-8-1973
SUTLEJ	Suleimanki	3.25	6.1	8-10-1955
	Islam	2.75	4.93	11-10-1955
	Mailsi Syphan	4.29	4.27	

It would be observed that discharges exceeded the capacity of different barrages and headworks on many a occasion. Generally the management of flood water had been to breach the dykes and bunds to save these civil works and installations, inundating nearby areas and abadies. Floods are also caused by overflows and sudden breaches developed in banks and protective bunds.

Keeping above conditions in view, it is recommended that road embankments should be high enough so as not to be overtopped by flood water i.e. enough freeboard should be provided. Further there should be enough cross drainage structures (culverts and bridges) to safely pass the floods as and when those come. It will have an additional benefit of providing refuge during floods to men and livestock.

Low lying areas are also flooded due to rain and overflow of rivers. Our road network is severely effected by the flood waters. Generally our roads do not have adequate drainage in flood prone regions. So it would be economical and safe to design our roads keeping the man made flooding conditions in view.

If the above conditions persist, the roads should be designed and built which cater for the flooding conditions created due to various existing irrigation headworks on our rivers.

We assume that :

i) Capacity of barrages, dams and headworks is not being increased in near future.

ii) Raising and strengthening of protective bunds are not envisaged in future.

iii) Construction of large and small dams on our rivers is not envisaged in the near future.

Accordingly it is recommended that :

a) The road embankment should be half a meter above the observed highest flood level of the area.

b) Roads should have sufficient cross-drainage works to pass flood waters without any hindrance.

c) Embankment slopes should be properly maintained.

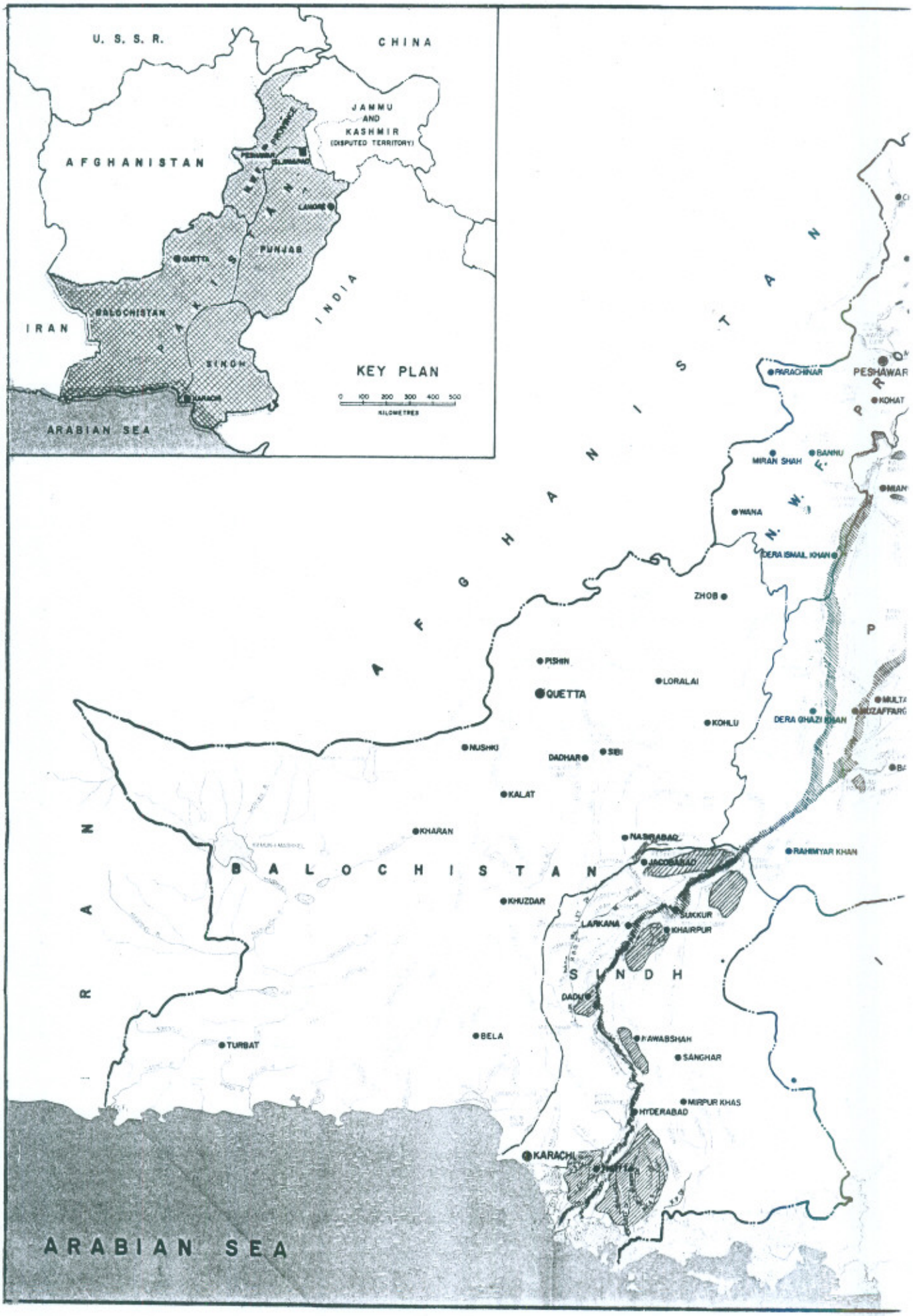
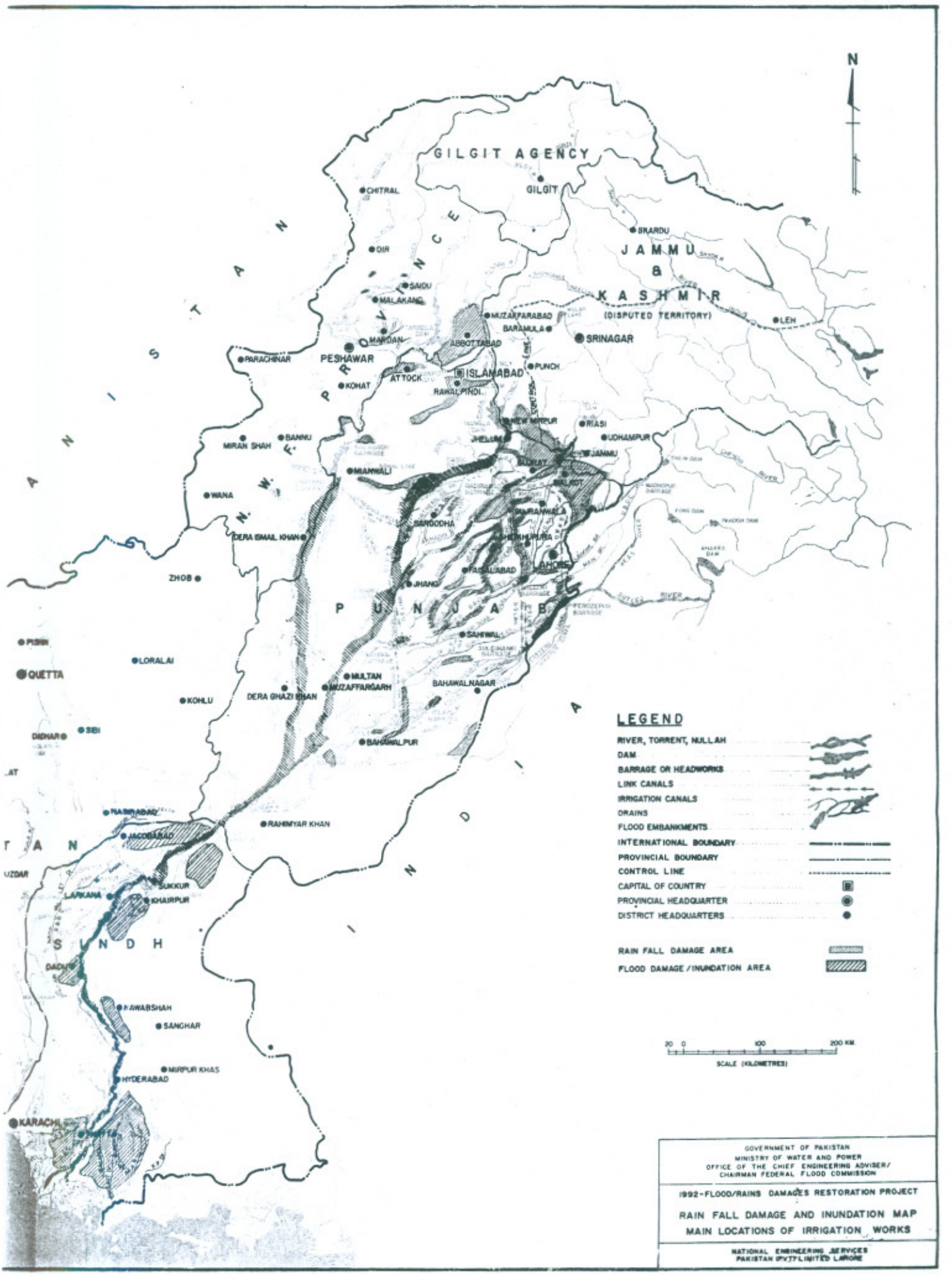

U. S. S. R.
CHINA
JAMMU AND KASHMIR (DISPUTED TERRITORY)
AFGHANISTAN
N.W.F. PROVINCE
PESHAWAR
ISLAMABAD
LAHORE
PUNJAB
QUETTA
BALOCHISTAN
IRAN
SINDH
KARACHI
INDIA
ARABIAN SEA
KEY PLAN
0 100 200 300 400 500
KILOMETRES
AFGHANISTAN
N.W.F.P.
PARACHINAR
PESHAWAR
KOHAT
MIRAN SHAH
BANNU
WANA
DERA ISMAIL KHAN
ZHOB
PISHIN
LORALAI
QUETTA
KOHLU
DERA GHAZI KHAN
MUZAFFARG
NUSHKI
DADHAR
SIBI
KALAT
KHARAN
NASIRABAD
JACOBABAD
RAHIMYAR KHAN
BALOCHISTAN
KHUZDAR
SUKKUR
LARKANA
KHAIRPUR
SINDH
DADU
TURBAT
BELA
NAWABSHAH
SANGHAR
MIRPUR KHAS
HYDERABAD
KARACHI
ARABIAN SEA

Figure - I



GOVERNMENT OF PAKISTAN
MINISTRY OF WATER AND POWER
OFFICE OF THE CHIEF ENGINEERING ADVISER/
CHAIRMAN FEDERAL FLOOD COMMISSION

1992-FLOOD/RAINS DAMAGES RESTORATION PROJECT

RAIN FALL DAMAGE AND INUNDATION MAP MAIN LOCATIONS OF IRRIGATION WORKS

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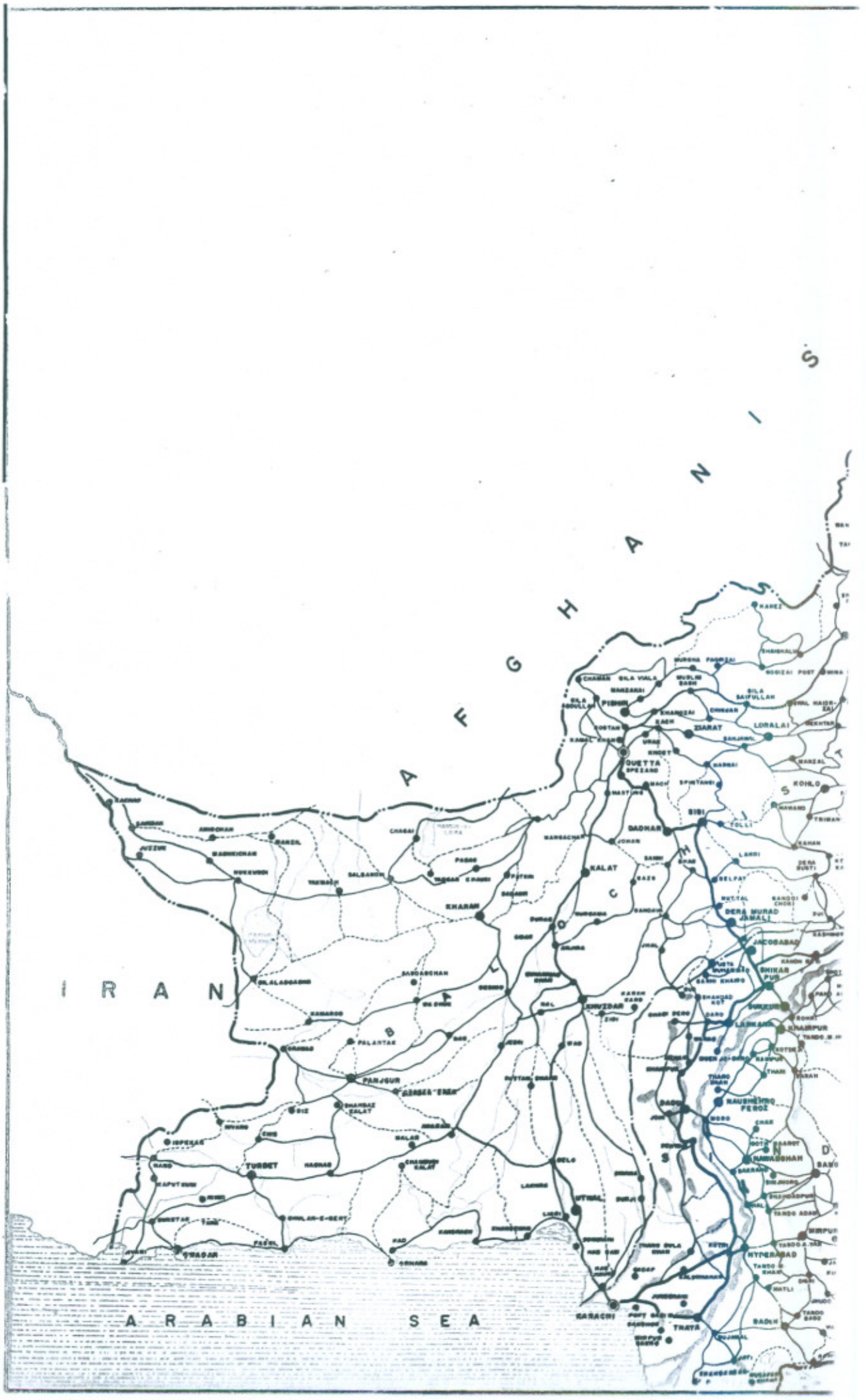
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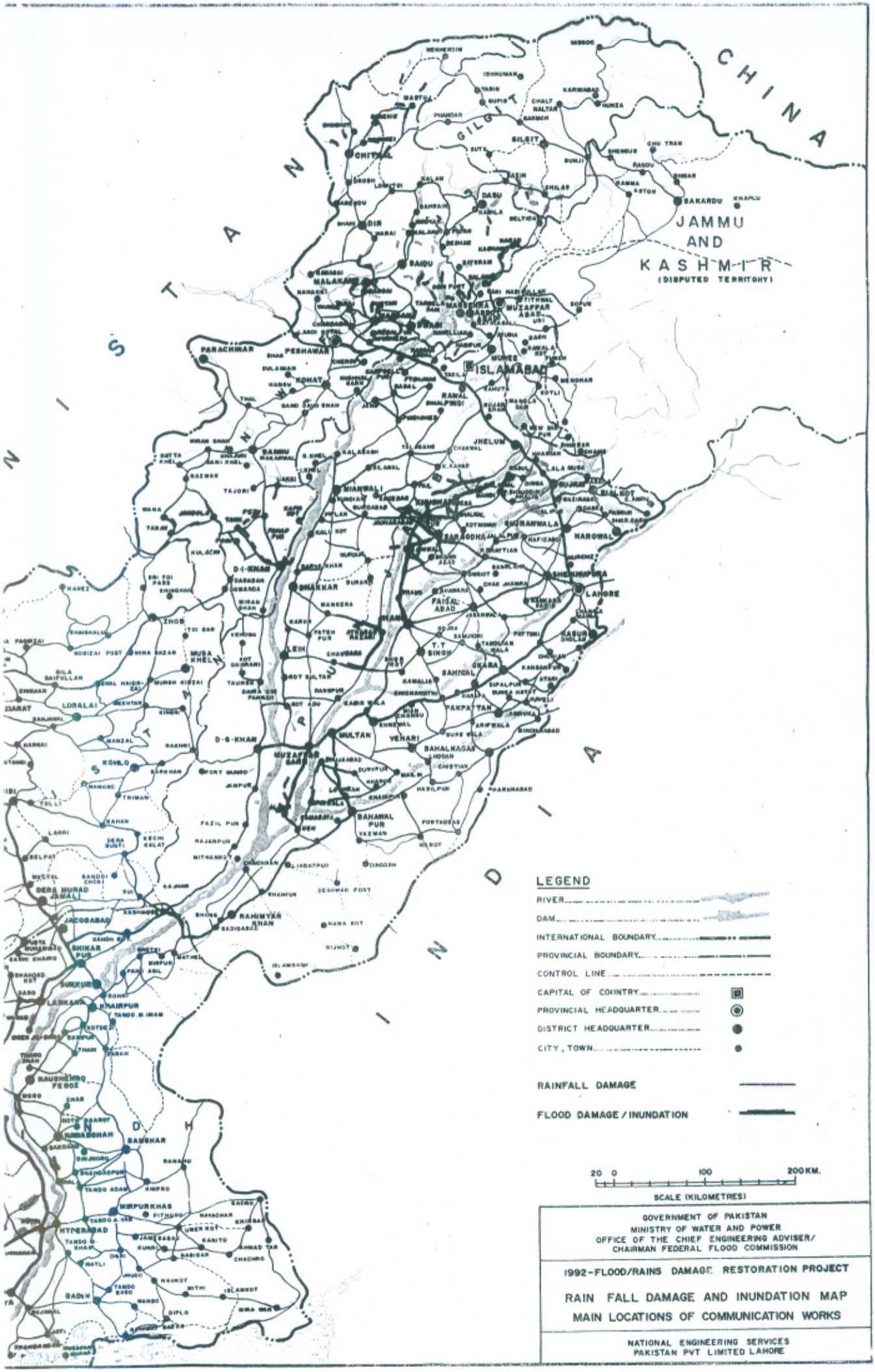
KHARAN
PANJGUR
TURBET
KHUZDAR
UTHAL
KARACHI
THATA
HYDERABAD
NAUSHEHRO FEROZ
LARKANA
SHIKARPUR
JACOBABAD
DERA MURAD JAMALI
KOHLO
GWADAR



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RAIN FALL DAMAGE AND INUNDATION MAP MAIN LOCATIONS OF COMMUNICATION WORKS

NATIONAL ENGINEERING SERVICES
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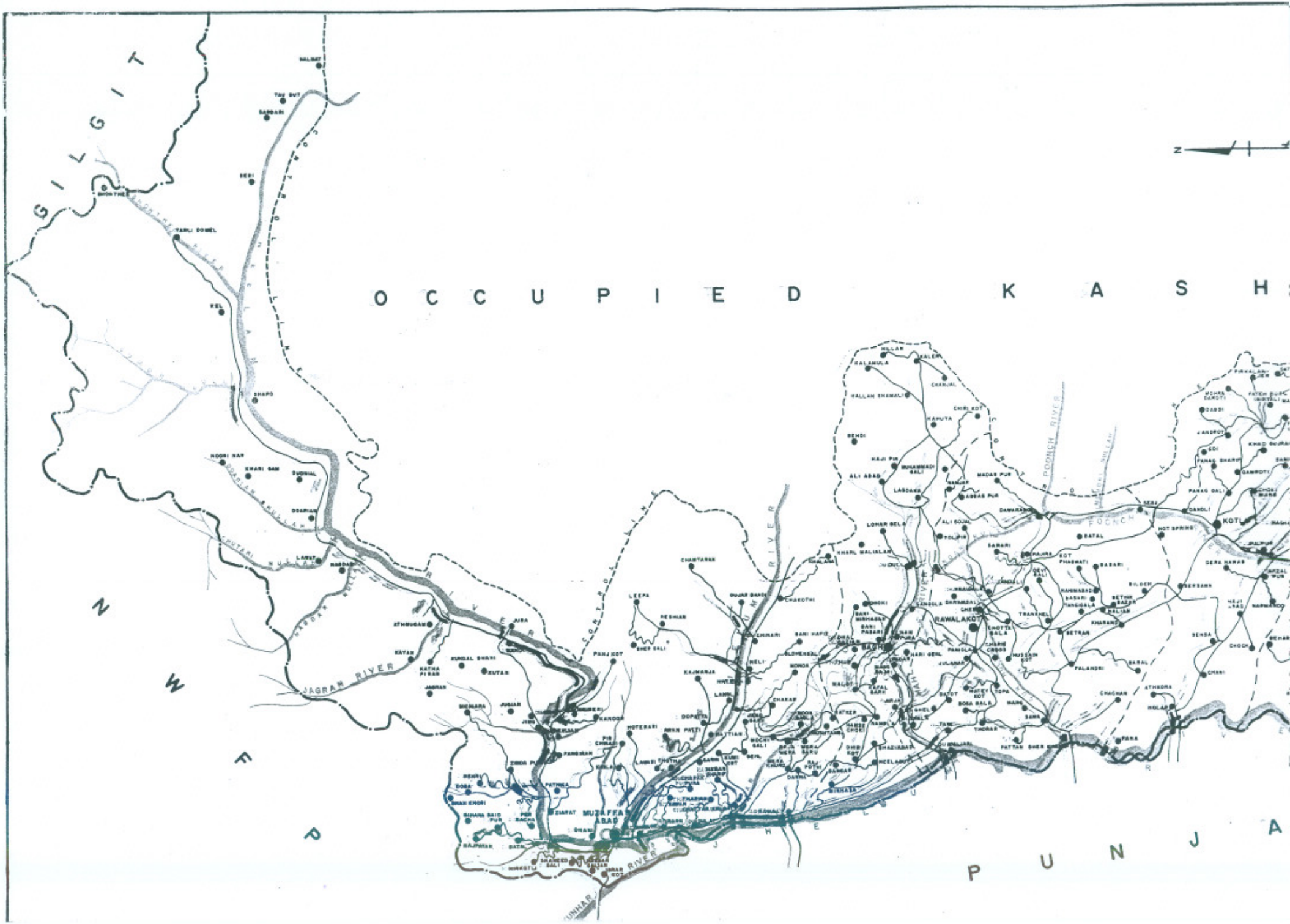
GILGIT
OCCUPIED KASHMIR
NWFP
PUNJAB
CONTROL LINE
JHELUM RIVER
JAGRAN RIVER
KUNHAR RIVER
POONCH RIVER
MUZAFFARABAD
RAWALAKOT
BAGH
KOTLI
HALMAT
TAU BUT
SARDARI
SHAPO
DOGRIAN
LANAT
BARDARI
ATHMUQAM
KAYAL
KATHA PISAR
JAGRAN
PANJ KOT
LEEPA
RESHIAN
CHAMYARA
GUJAR BANDI
CHAKOTHI
KAJMARJA
NELI
CHAKAR
DOPATTA
MATTIAN
HOTEGARI
PANDIRAN
KOHALA
PATHIKA
DOBA
BHAIRAT
SHAHEED PUR
BAGHWAN
BATAL
KALAMULA
HALLAN SHAMALI
KAHUTA
CHIRI KOT
BEHDI
KAJI PIR
ALI ABAD
LASDANA
MADAR PUR
ABBAS PUR
LOHAR BELA
KHARI MALIALAN
TOLIPIR
BARARI
DANGALI
DARMDIAL
CHEHR
BANI HAFIZ
BANI MAHABAT
BANI PASARI
SHAHPUR
HARI GEHL
PANGOLA
WALOT
KAFAL BANI
SEHOT
TOPA
SORA BALA
MAIRE
SAMA
TIMRAR
PATTAN SHER
CHACHAN
ATHKORA
HOLAR
PARA
SERSAWA
CHOCH
PALANDRI
BARAL
BETRAM
KHARANG
BALIAN
BASARI
HUSSEIN KOT
TRARKHEL
CHOTTA BALA
CHARRI CHOOR
DEVI GALI
RAMNABAD
BANGALA
BILGEN
HOT SPRING
GOT PHAGWATI
BABARI
SERA
PANAG GALI
JANDROT
KHAD GURAN
GAMROTI
CHORI MANG
GERA NAWAB
NAZIL PUR
HAJI NALI
NARMOOD
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SENSA
CHOCH
CHARI
KHAIRA
SAMAHNI
DHANI
SHAHEED MALLAH
SHAHEED GALI
BARAN KOT
BARAN SHARIF
KOTLA
SHAHEED PUR
BHAI KHORI
DOBA
PIR SACHA
ZIARAT
DHANI
KOTLA
ZIKRA PUR
PANDIRAN
LAMBI THATHA
KUTAR
KUTAR SHARI
JAGRAN
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BHIMBER
KHARI SAN
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KOORI NAR
SHAHEED GALI
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KOTLA
SHAHEED PUR
BHAI KHORI
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PIR SACHA
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DHANI
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PANDIRAN
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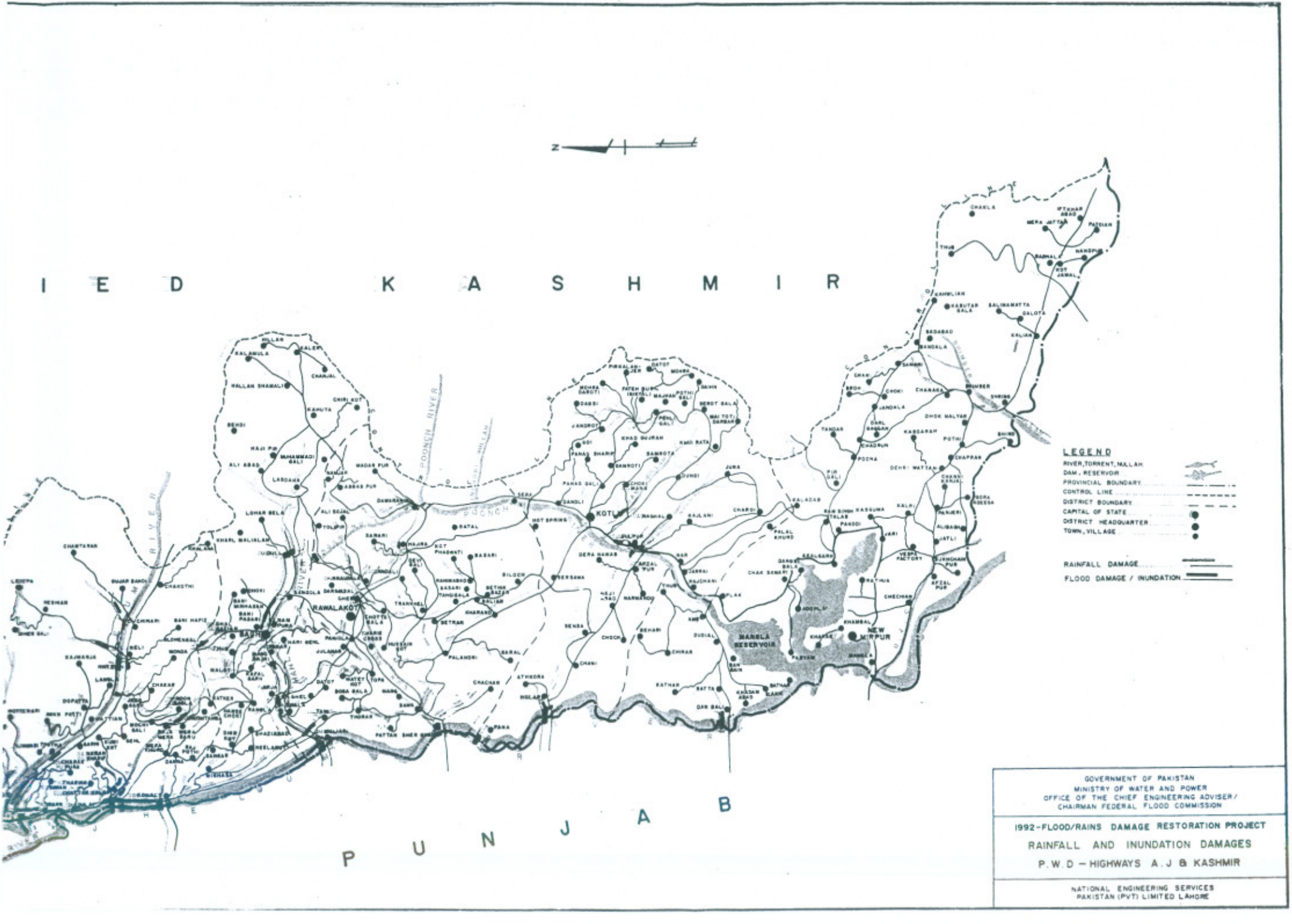
DUDIAL
KOORI NAR

Figure - III


I E D K A S H M I R
P U N J A B
N
KOTLI
RAWALAKOT
BAGH
MANGLA RESERVOIR
NEW MIRPUR
LEGEND
RIVER, TORRENT, NULLAH
DAM, RESERVOIR
PROVINCIAL BOUNDARY
CONTROL LINE
DISTRICT BOUNDARY
CAPITAL OF STATE
DISTRICT HEADQUARTER
TOWN, VILLAGE
RAINFALL DAMAGE
FLOOD DAMAGE / INUNDATION
GOVERNMENT OF PAKISTAN
MINISTRY OF WATER AND POWER
OFFICE OF THE CHIEF ENGINEERING ADVISER/
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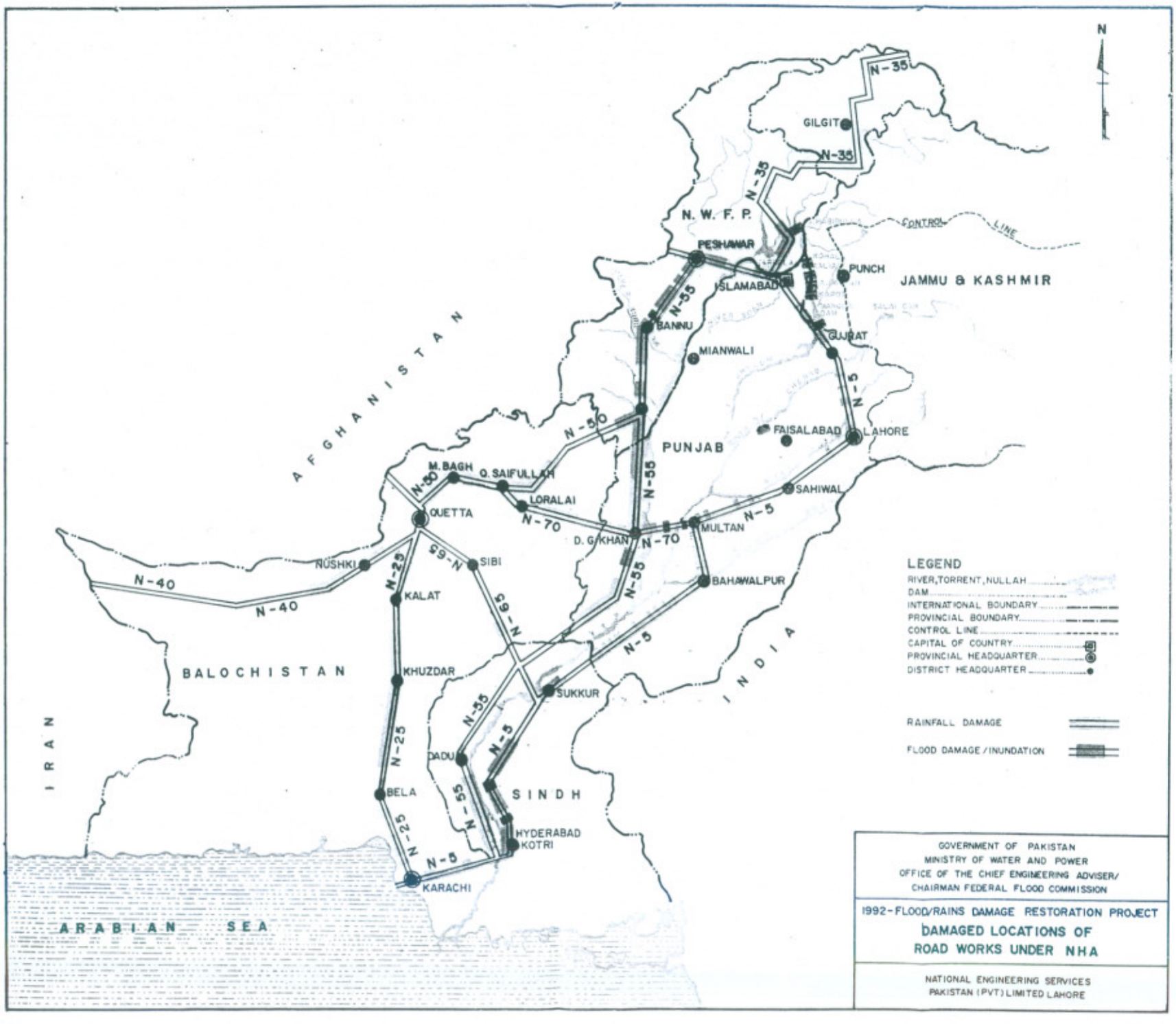
1992-FLOOD/RAINS DAMAGE RESTORATION PROJECT
RAINFALL AND INUNDATION DAMAGES
P.W.D - HIGHWAYS A.J & KASHMIR
NATIONAL ENGINEERING SERVICES
PAKISTAN (PVT) LIMITED LAHORE

FIG.—1


N
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GILGIT
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CONTROL LINE
PESHAWAR
PUNCH
JAMMU & KASHMIR
ISLAMABAD
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BANNU
GUJRAT
MIANWALI
N-5
AFGHANISTAN
N-50
PUNJAB
FAISALABAD
LAHORE
M. BAGH
Q. SAIFULLAH
N-50
N-55
SAHIWAL
LORALAI
QUETTA
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MULTAN
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D. G. KHAN
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NUSHKI
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KALAT
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BAHAWALPUR
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SUKKUR
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1992-FLOOD/RAINS DAMAGE RESTORATION PROJECT
DAMAGED LOCATIONS OF
ROAD WORKS UNDER NHA
NATIONAL ENGINEERING SERVICES
PAKISTAN (PVT) LIMITED LAHORE

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