Water usage and sustainability

Stephen Fietta KC

Hearing for the First Phase on the Merits

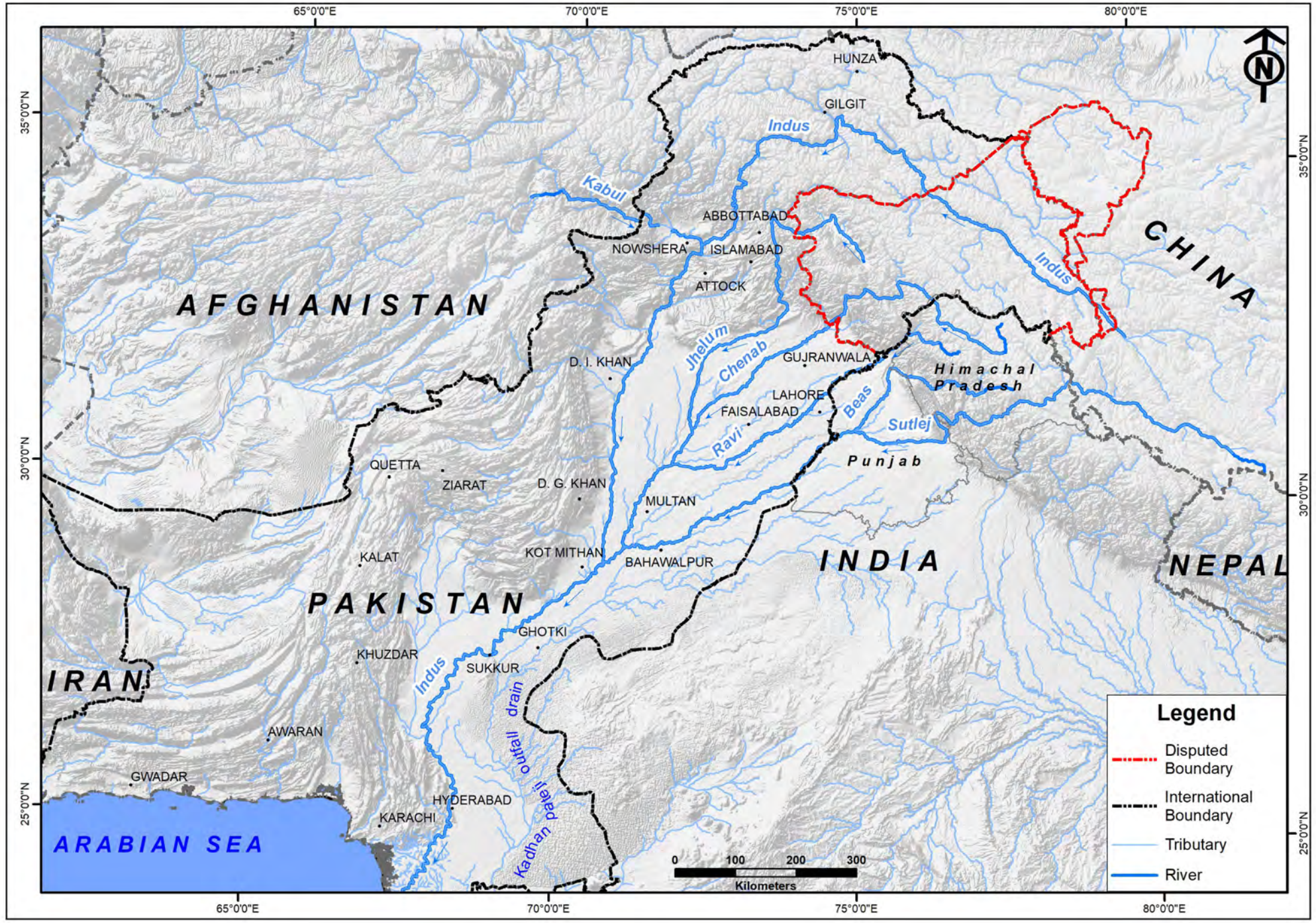
Indus Waters Treaty Arbitration (Pakistan v. India)

PCA Case No. 2023-01

9 July 2024, The Hague

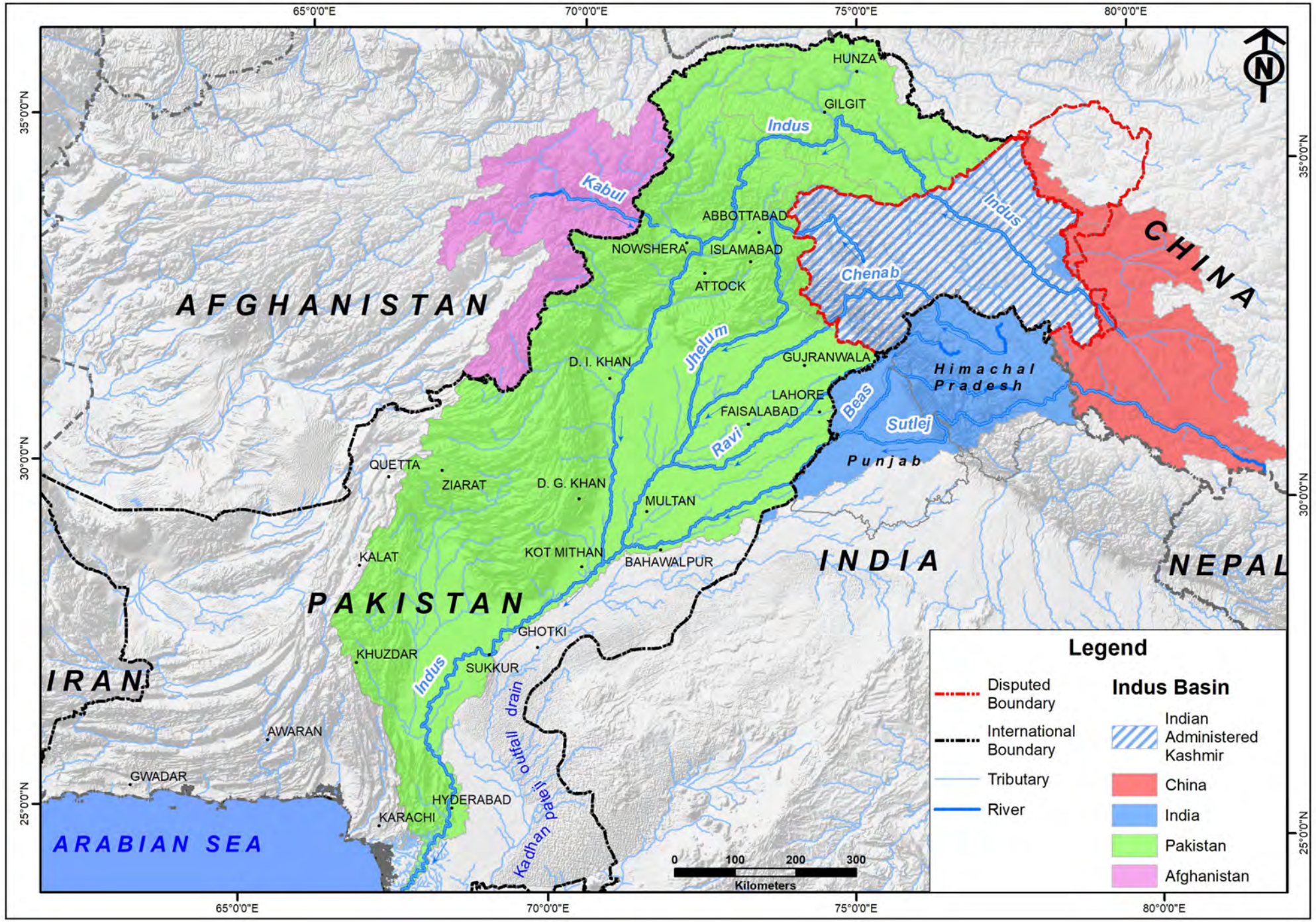
STRUCTURE OF THE PRESENTATION

1. Overview of the Indus Basin and the Western and Eastern Rivers
2. India has worked to maximise its hydroelectric and irrigation development of the Eastern Rivers so that they no longer flow into Pakistan
3. Seasonal flows, agricultural usage and irrigation on the Western Rivers, including in large areas previously supplied by the Eastern Rivers
4. Pakistani and Indian power-generation usage on the Western Rivers
5. The rapidly increasing demand for water from the Western Rivers
6. The reduction in flows on the Western Rivers and potential impacts of climate change
7. Concluding remarks



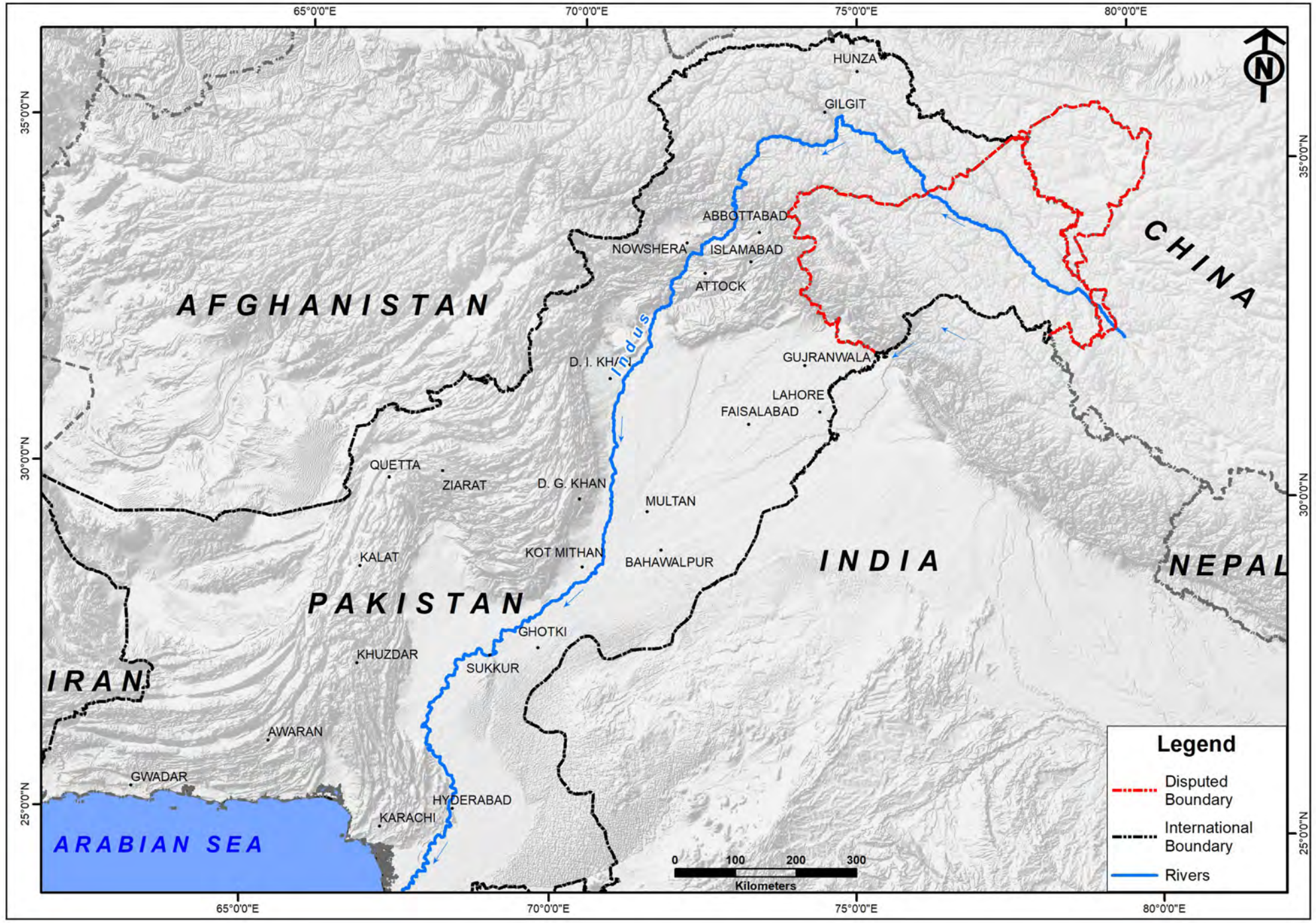
THE INDUS RIVERS

Modified version of Map 3.2, Pakistan's Memorial

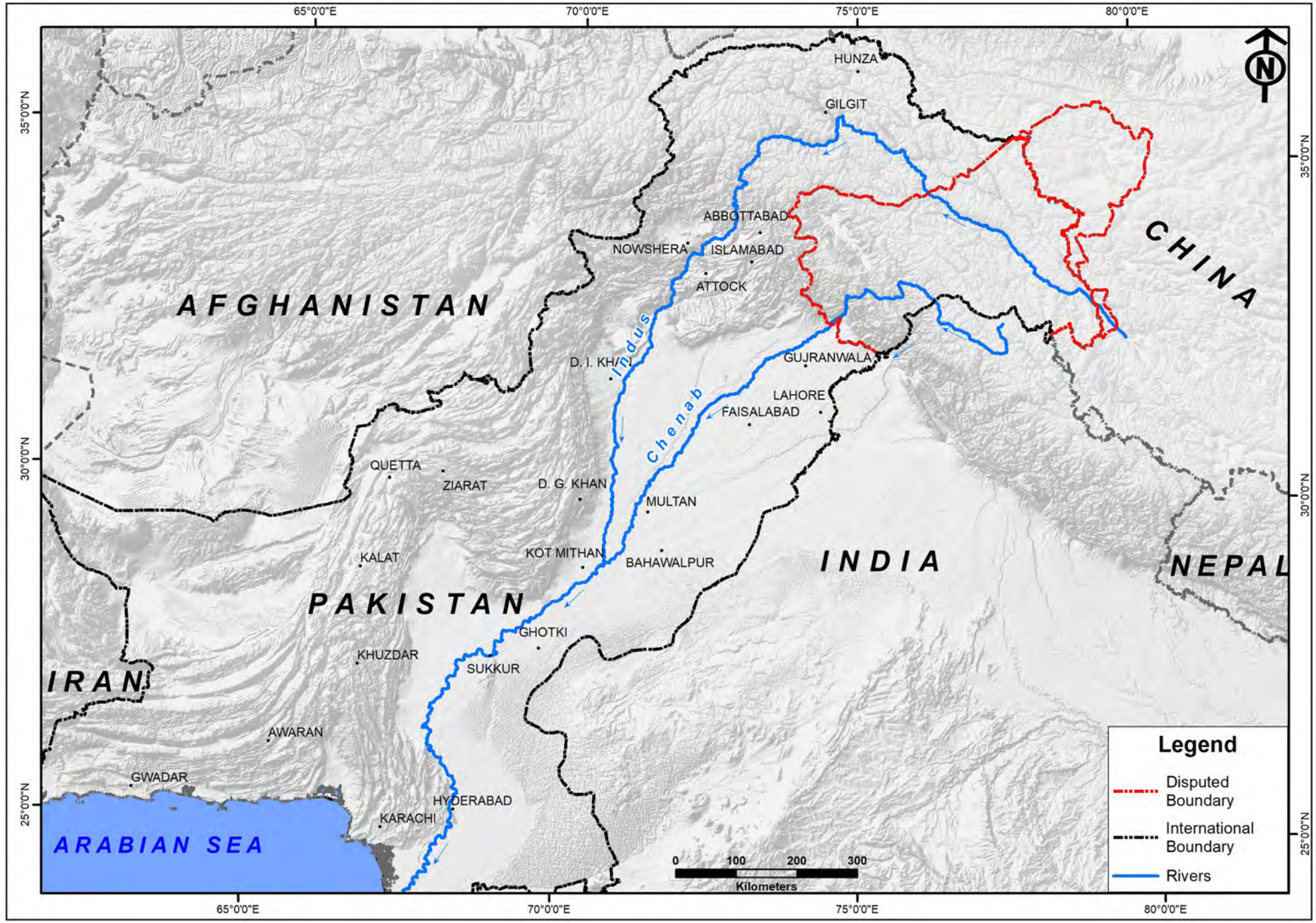


FOUR RIPARIAN STATES, ONE RIVER BASIN

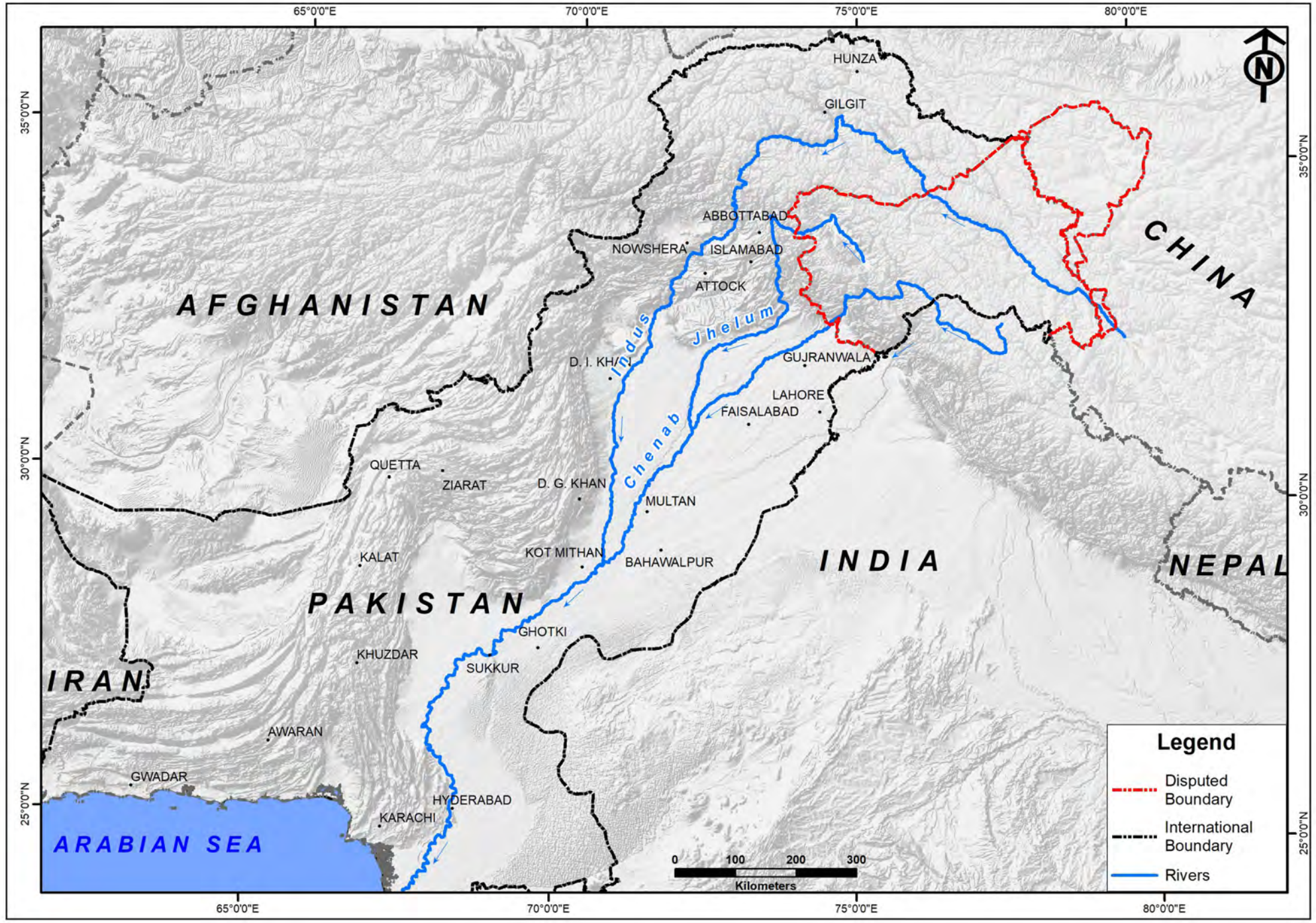
Modified version of Map 3.2, Pakistan's Memorial



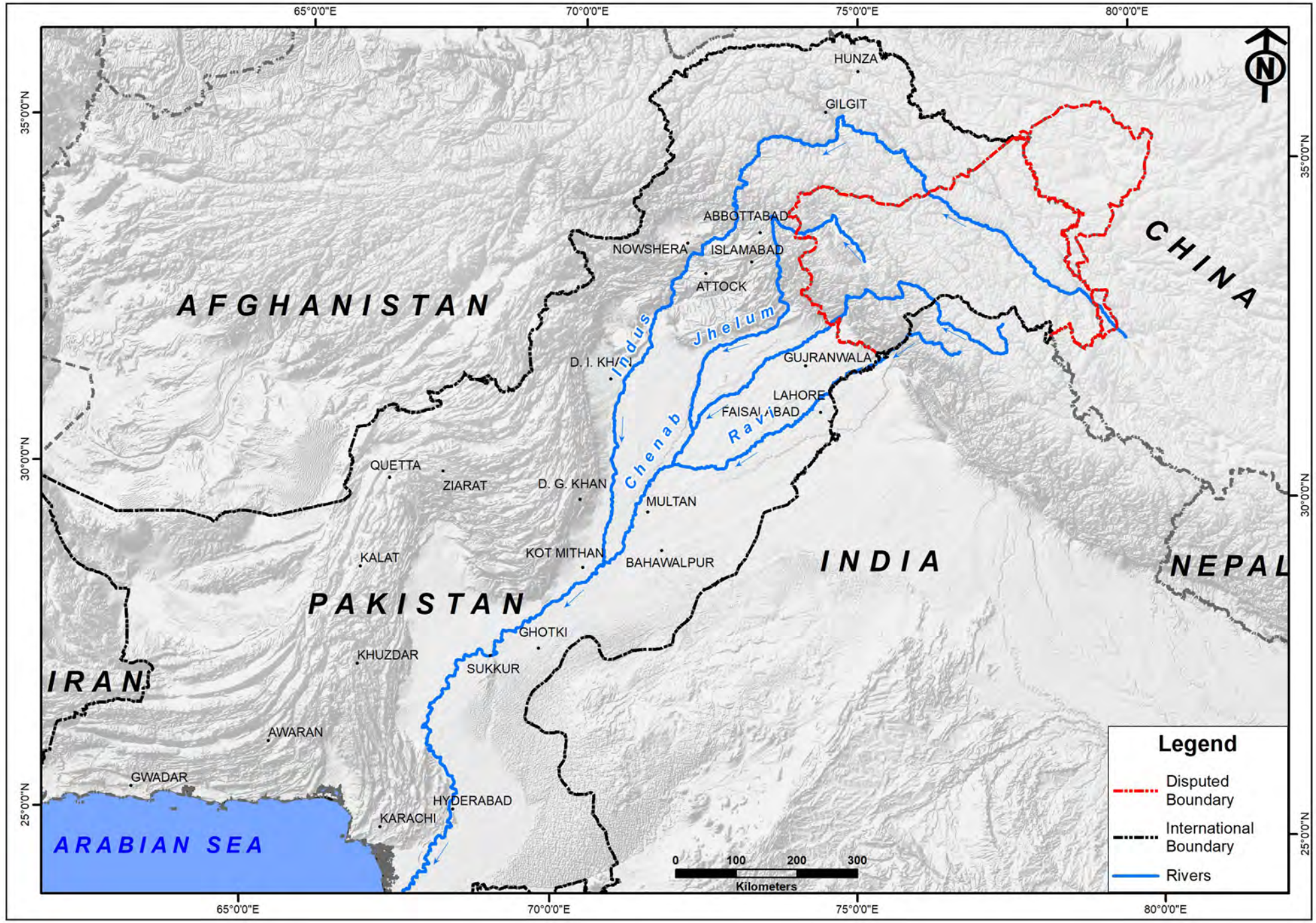
THE INDUS RIVER



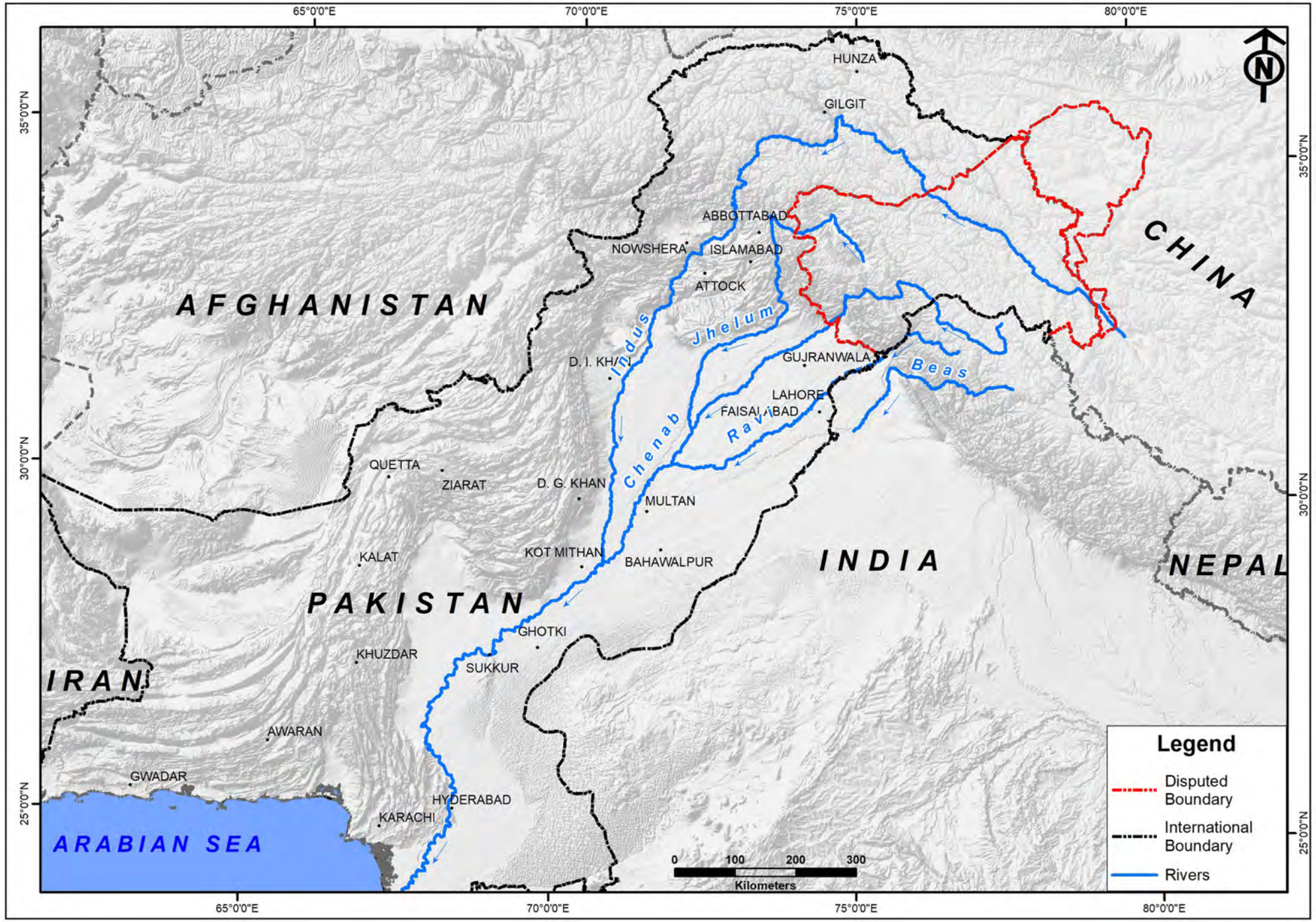
THE CHENAB RIVER



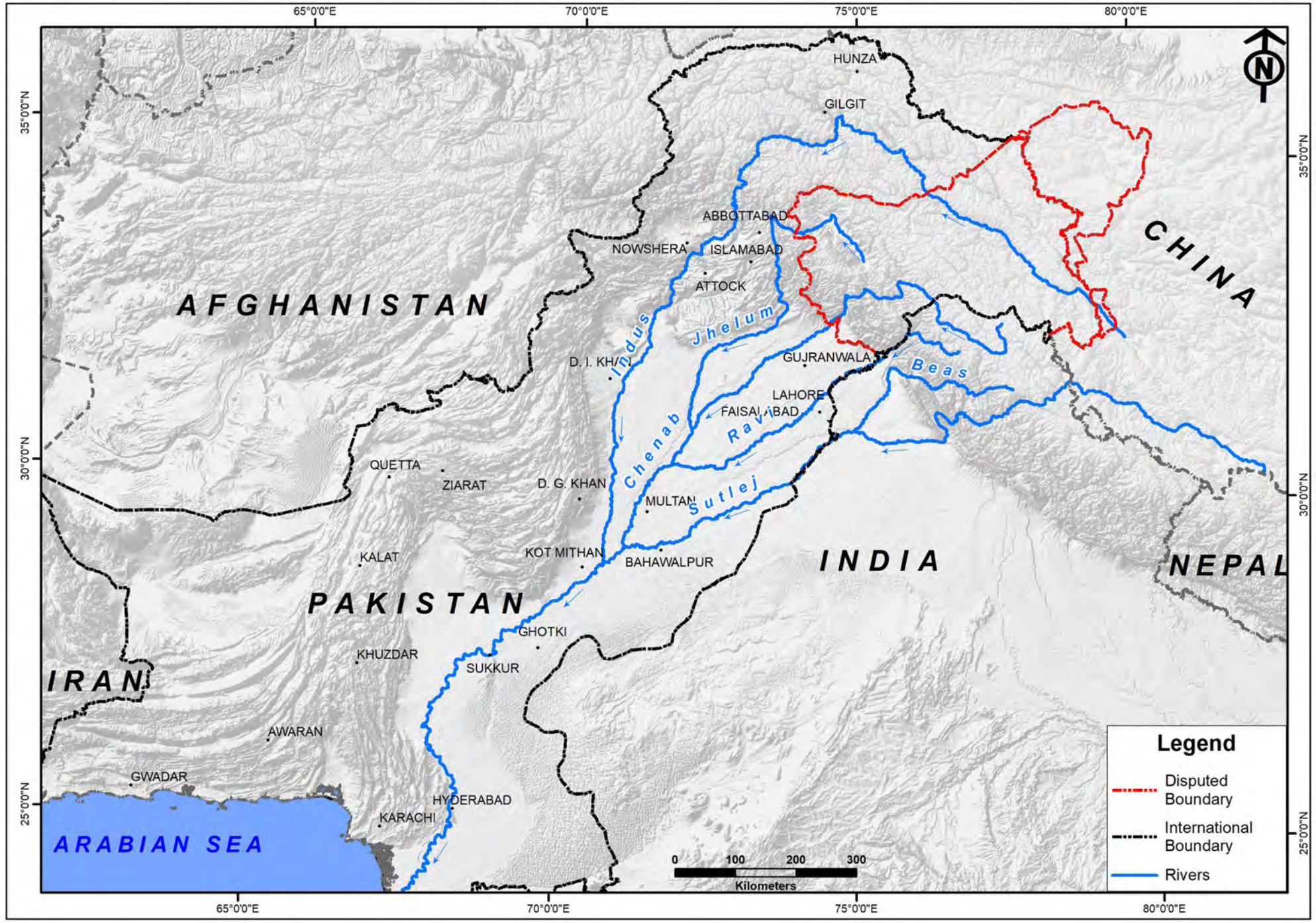
THE JHELUM RIVER



THE RAVI RIVER



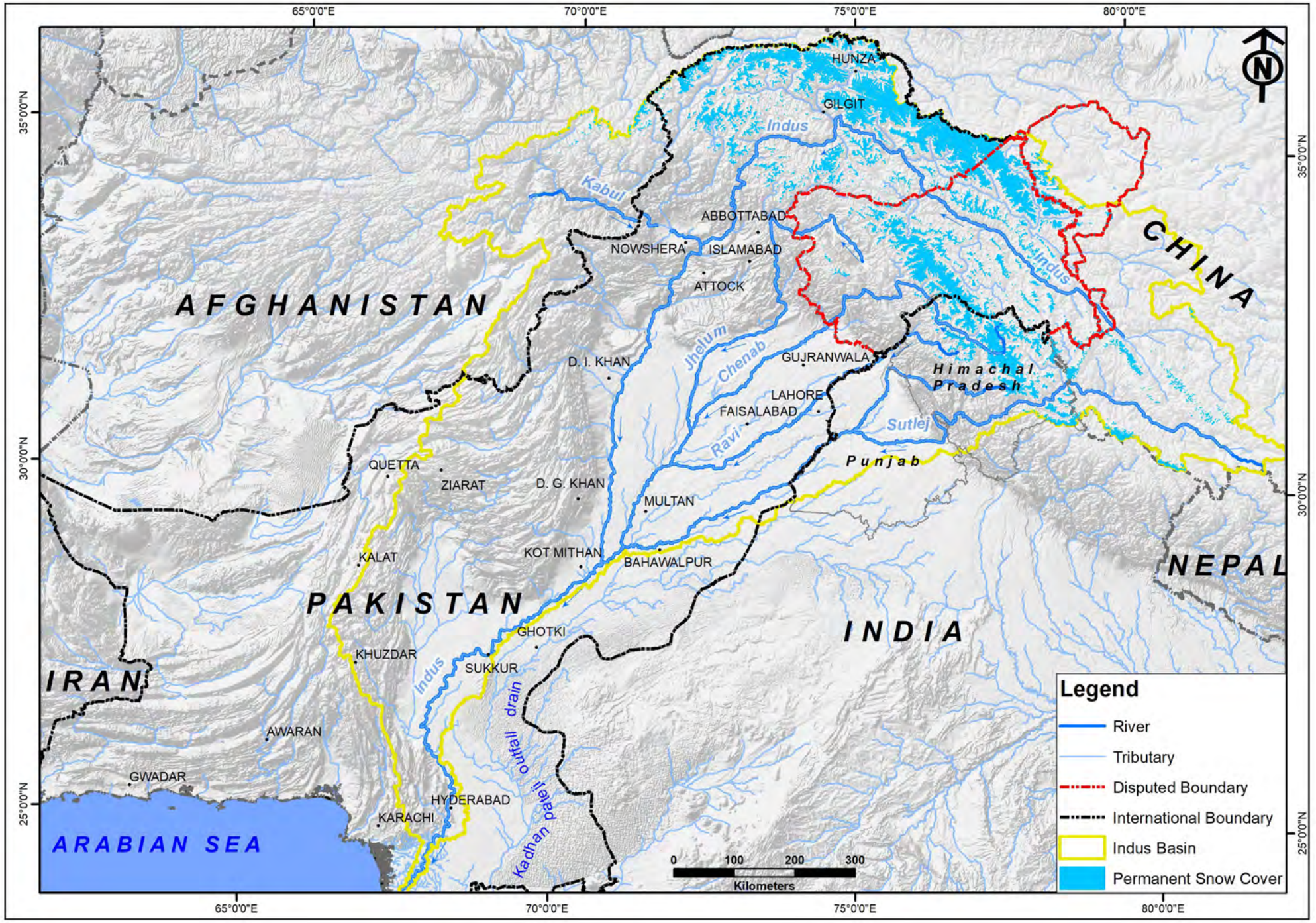
THE BEAS RIVER



THE SUTLEJ RIVER

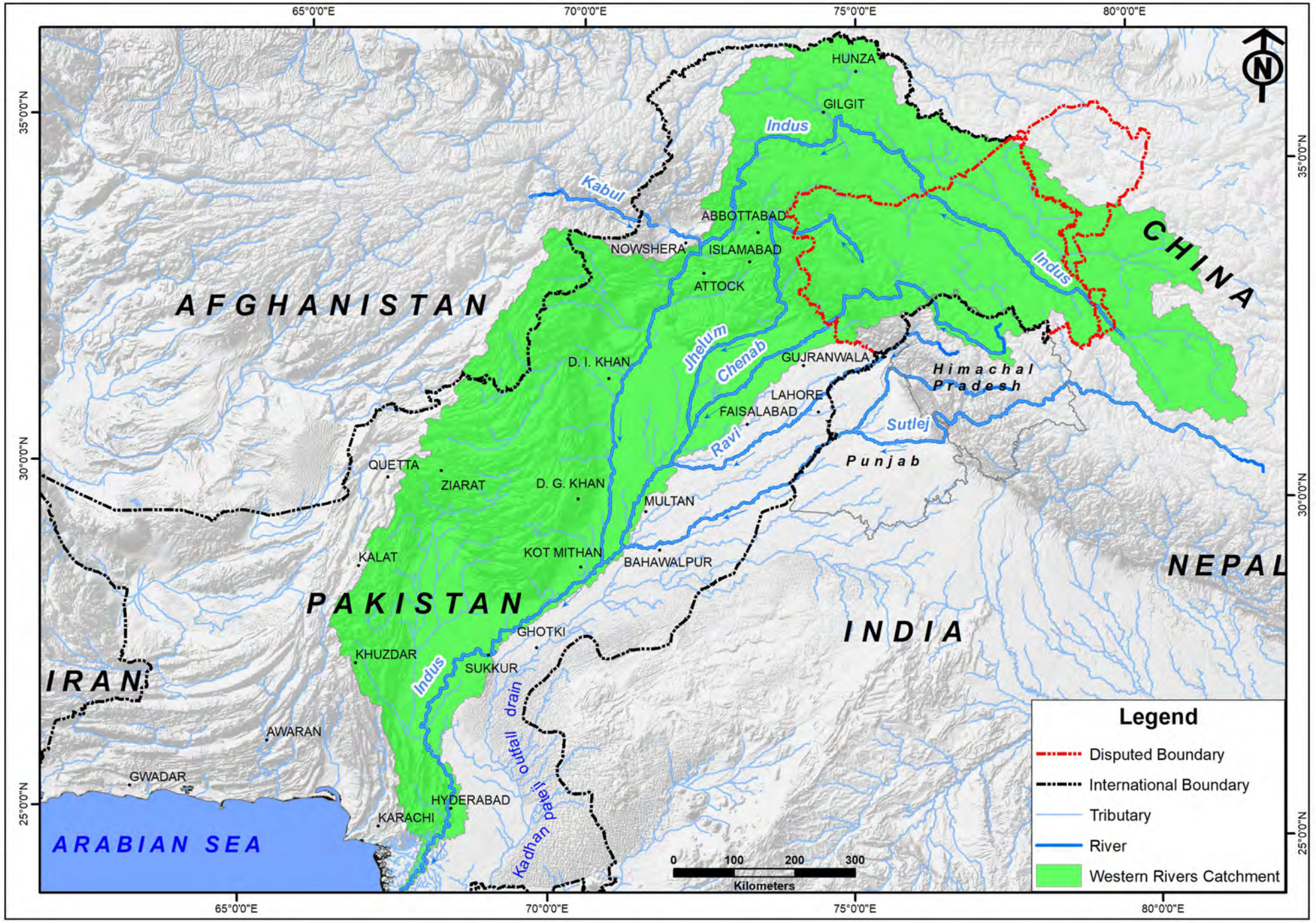
AREAS OF GLACIER AND PERMANENT SNOW COVER

Modified version of Map 3.6, Pakistan's Memorial



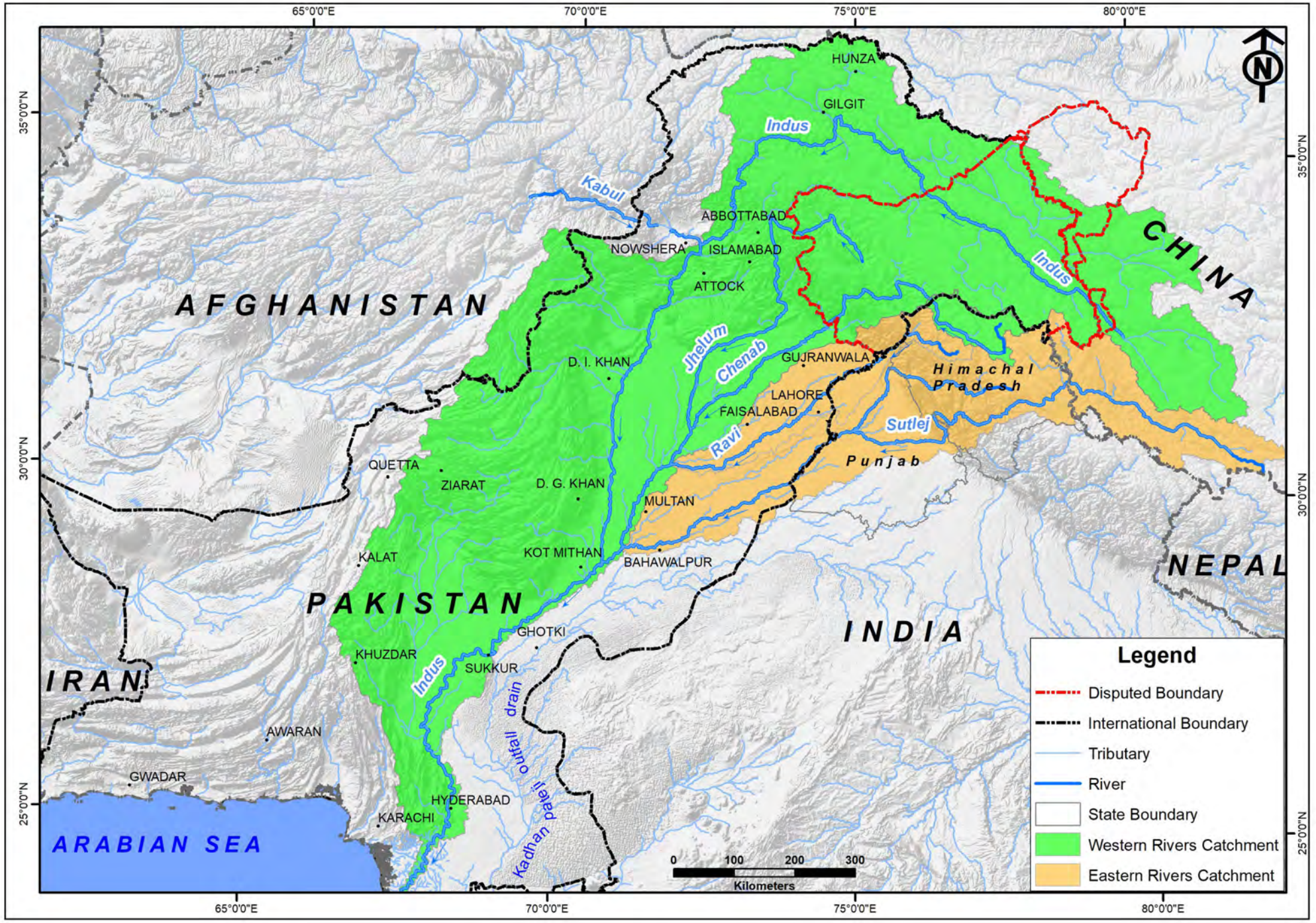
WESTERN RIVERS CATCHMENT

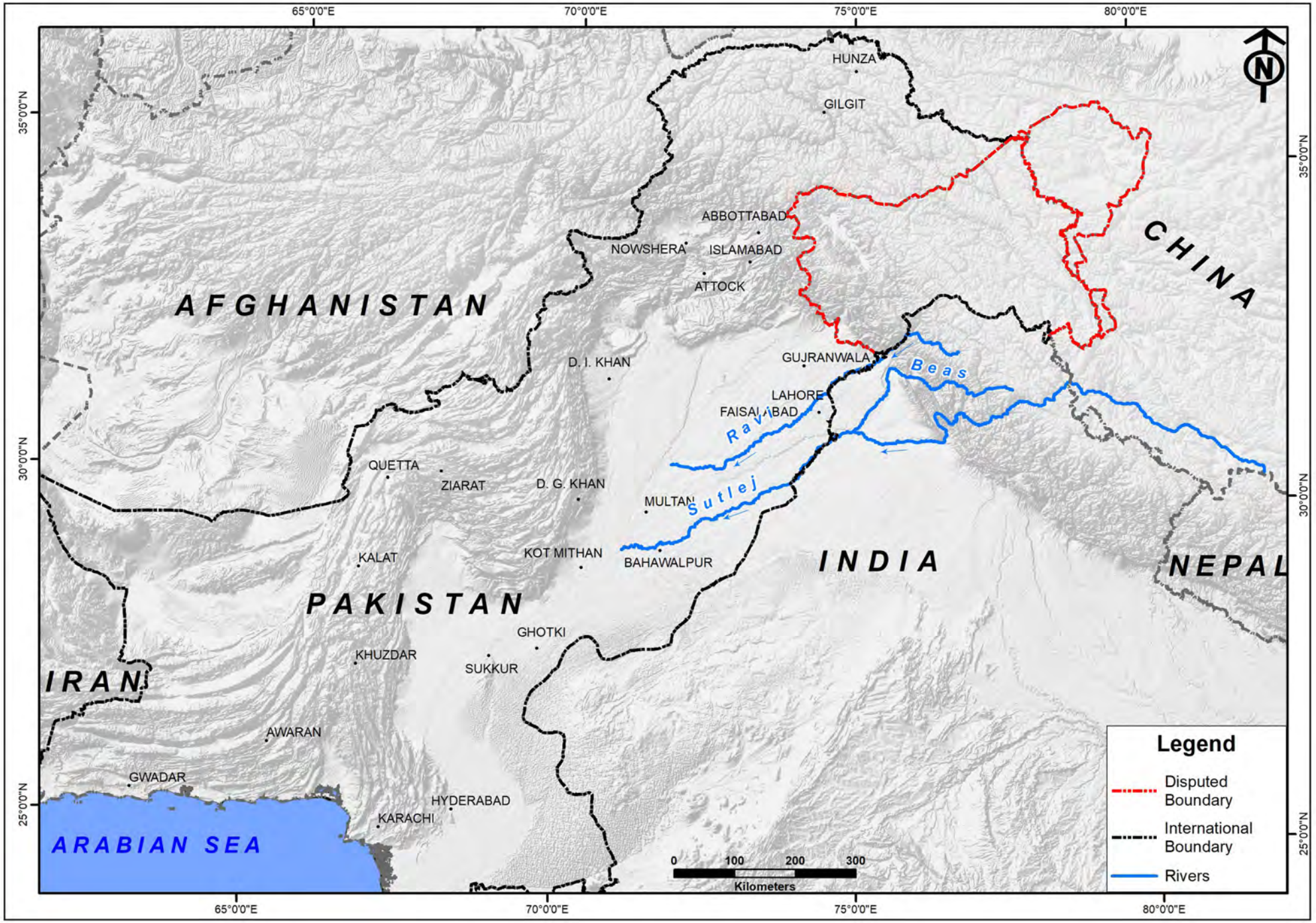
Modified version of Map 3.1, Pakistan's Memorial



WESTERN AND EASTERN RIVERS CATCHMENT

Modified version of Map 3.1, Pakistan's Memorial





EASTERN RIVERS

FLOWS OF THE EASTERN RIVERS INTO PAKISTAN DECLINED SIGNIFICANTLY AFTER THE TREATY

8.4.2 Reduced or Fluctuating Surface Flows

The average annual flows of major rivers in the basin show decreasing trends for both west- and east-flowing rivers (Table 8.3). These flows represent the pre-IWT (1922–61) and post-IWT (1985–2002 and 2007–10) situations. The average flow of eastern rivers into Pakistan

TABLE 8.3 Average Flows in Major Rivers of the Indus Basin Before and After IWT

	River	Rim Station	Average Annual Flow (1922–61) (km^3)	Average Annual Flow (1985–2002) (km^3)	Average Annual Flow (2007–10) (km^3)
West flowing rivers	Indus	Kalabagh	114.4	94.1	101.9
	Jhelum	Mangla	28.3	23.7	19.3
	Chenab	Marala	31.9	24.5	23.9
East flowing rivers	Ravi	Below Madhopur	8.6	4.0	1.1
	Sutlej	Below Ferozepur	17.2	2.2	0.8
	Total		200.4	148.5	147.0

Source: Khan, A.R., 1999. An Analysis of the Surface Water Resources and Water Delivery Systems in the Indus Basin. Research Report 93. IWMI, Lahore, Pakistan, p. 66; Government of Pakistan, 2011. Pakistan Statistical Year Book 2011, Agricultural Data Set. Federal Bureau of Statistics, Statistics Division, Islamabad, Pakistan; IUCN, 2011. Water Resources of Pakistan: The Government's Main Objectives, in Pakistan Water Gateway. Available from: http://waterinfo.net.pk/?q=node/19.

was reduced by 75% and 92% during the years 1985–2002 and 2007–10, respectively. About 17% reduction in the average flow of the west-flowing rivers is also observed (Cheema, 2012).

M. J. M. Cheema and M. U. Qamar, "Transboundary Indus River Basin: Potential Threats to Its Integrity", ***Exhibit P-0263,*** *pp. 190-191*

Ministry of Water Resources, River Development and Ganga Rejuvenation

Indus Waters Treaty 1960 : Present Status of Development in India

Posted On: 22 FEB 2019 10:46AM by PIB Delhi

PRESENT STATUS OF DEVELOPMENT IN INDIA

To utilize the waters of the Eastern rivers which have been allocated to India for exclusive use, India has constructed Bhakra Dam on Satluj, Pong and Pandoh Dam on Beas and Thein (Ranjitsagar) on Ravi. These storage works, together with other works like Beas-Sutlej Link, Madhopur-Beas Link, Indira Gandhi Nahar Project etc has helped India utilize nearly entire share (95 %) of waters of Eastern rivers.However, about 2 MAF of water annually from Ravi is reported to be still flowing unutilized to Pakistan below Madhopur. To stop the flow of these waters that belong to India for its utilization in India, following steps have been taken:

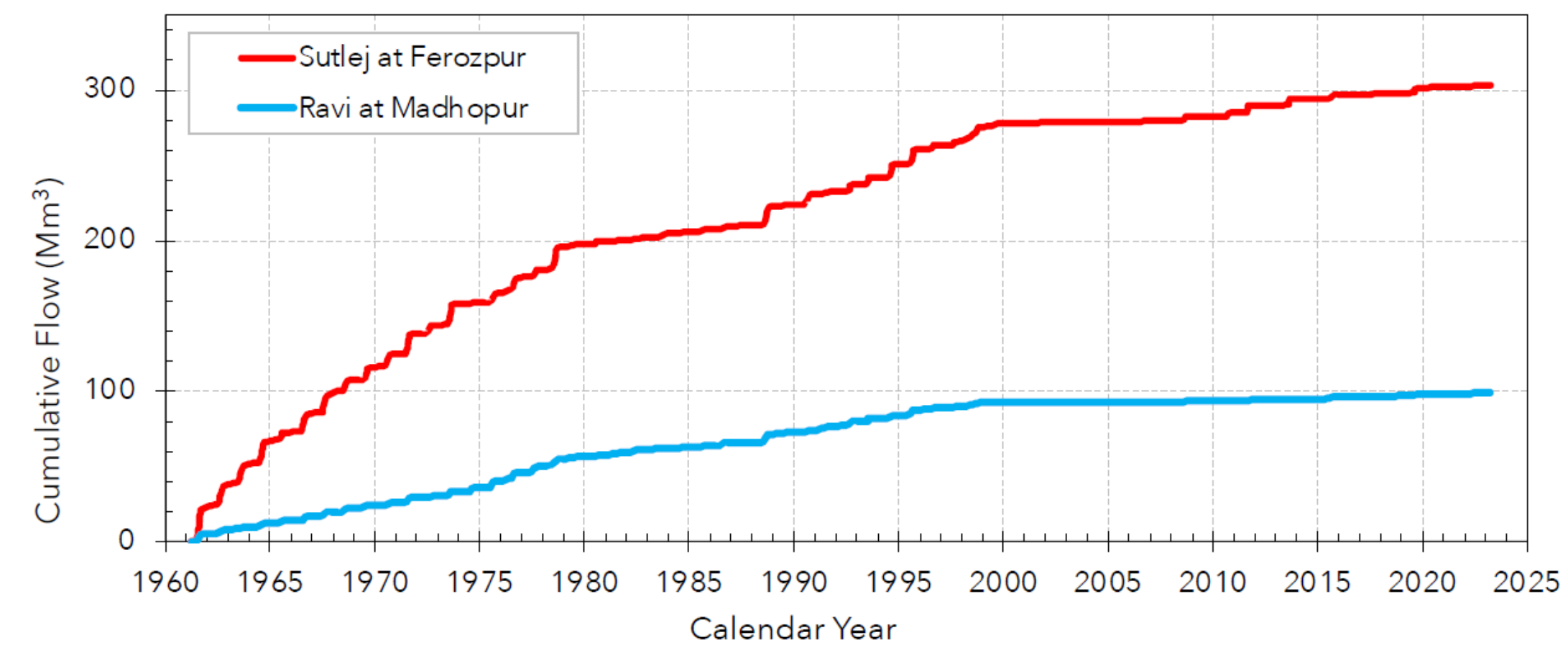
1. **Resumption of Construction of Shahpurkandi project:** This project will help in utilizing the waters coming out from powerhouse of Thein dam to irrigate 37000 hectares of land in J&K and Punjab and generate 206 MW of power. The project was scheduled to be completed by September 2016. However, following a dispute between the state of J&K and Punjab, the work on the project had been suspended since 30.08.2014. Consequent upon agreement reached on 8 September 2018 between J&K and Punjab . The cost of the project is . 2715.70 Crore. Government of India vide order dated 19 December 2018 has approved the Central Assistance of Rs. 485.38 crore towards balance cost of works of irrigated component of the project. The construction work has now resumed by Govt of Punjab under monitoring of Govt of India.

"Press Release – Indus Waters Treaty 1960: Present Status of Development in India", ***Exhibit P-0563***

THE COMPLETION OF THE SHAHPUR-KANDI BARRAGE HAS STOPPED REMAINING FLOWS OF THE RAVI

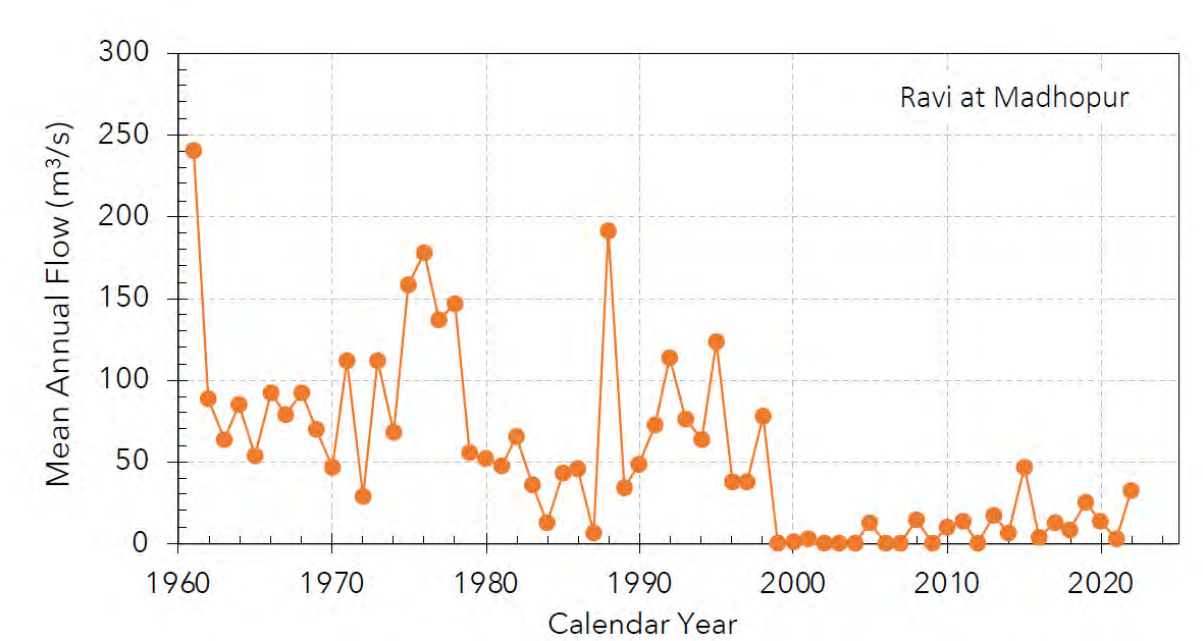
"India Stops Ravi Water Flow to Pakistan With A Dam in Punjab: Explained", NDTV, ***Exhibit P-0559***

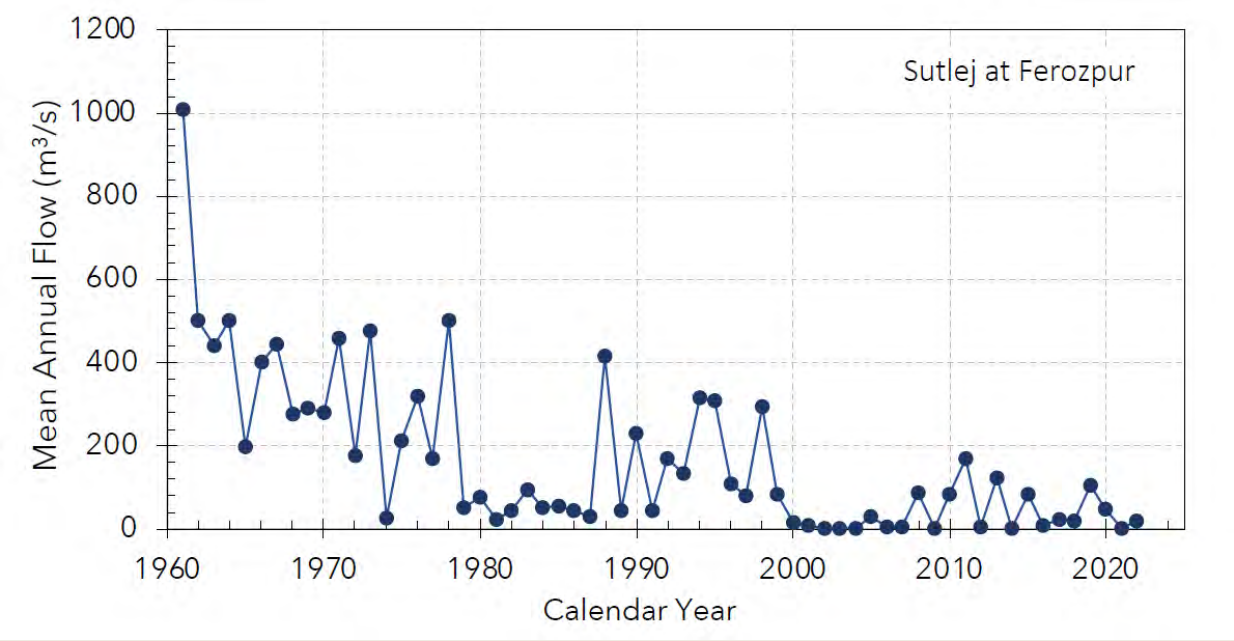
FLOWS OF THE EASTERN RIVERS INTO PAKISTAN DECLINED SIGNIFICANTLY AFTER THE TREATY



*Graph prepared by Dr Gregory Morris, based on 10-day flow data for the Eastern Rivers from 1961-2023 (**Exhibit P-0402**)*

FLOWS OF THE EASTERN RIVERS INTO PAKISTAN DECLINED SIGNIFICANTLY AFTER THE TREATY





*Graphs prepared by Dr Gregory Morris, based on 10-day flow data for the Eastern Rivers from 1961-2023 (**Exhibit P-0402**)*

THE WESTERN RIVERS ARE THE LIFEBLOOD OF PAKISTAN'S WATER RESOURCE

Basin	Surface Runoff, BCM[209]	Groundwater Recharge by Rainfall, BCM	Total, BCM	Percent of Total
Indus – external inflows				
Western Rivers			151.1	66.0
Eastern Rivers			3.3	1.5
Kabul River[210]			19.4	8.5
Indus – internal	32.6	12.7	45.3	19.8
Kharan Desert	5.5	0.7	6.2	2.7
Makran Coast	2.9	0.6	3.5	1.5
Grand Total			**228.8**	**100%**

Figure 3.1 - Contributions to Pakistan's average annual renewable water resource[211]

Figure 3.1, Pakistan's Memorial – based on "Pakistan: Getting More from Water", (2019) Water Security Diagnostic, World Bank Group, ***Exhibit P-0249****, p. 5*

THE FLOWS OF THE WESTERN RIVERS INTO PAKISTAN ARE HIGHLY SEASONAL

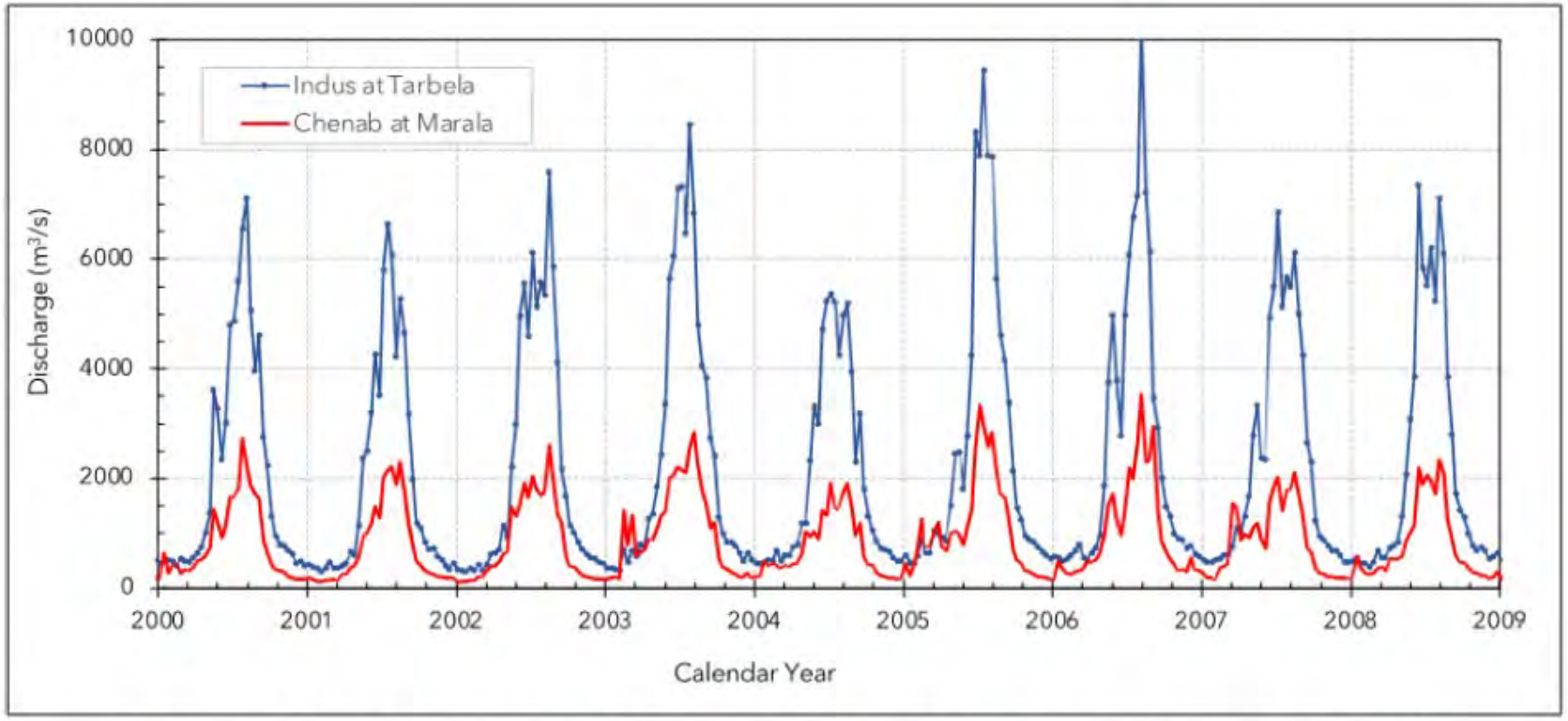


Figure 3.4 - 10-year 10-day discharges of the Indus and Chenab Rivers[251]

Figure 3.4, Pakistan's Memorial – graph prepared by Dr Gregory Morris, based on daily discharge data for the Indus River at Tarbela dam and the Chenab River at the Marala monitoring station, collected by WAPDA

THE TREATY ENVISIONED MASSIVE IRRIGATION WORKS IN PAKISTAN TO REPLACE WATER SUPPLIES PREVIOUSLY RECEIVED FROM THE EASTERN RIVERS WITH WATERS FROM THE WESTERN RIVERS

ARTICLE IV(1)

Pakistan shall use its best endeavours to construct and bring into operation, with due regard to expedition and economy, that part of a system of works which will accomplish the replacement, from the Western Rivers and other sources, of water supplies for irrigation canals in Pakistan which, on 15th August 1947, were dependent on water supplies from the Eastern Rivers.

ARTICLE V(1)

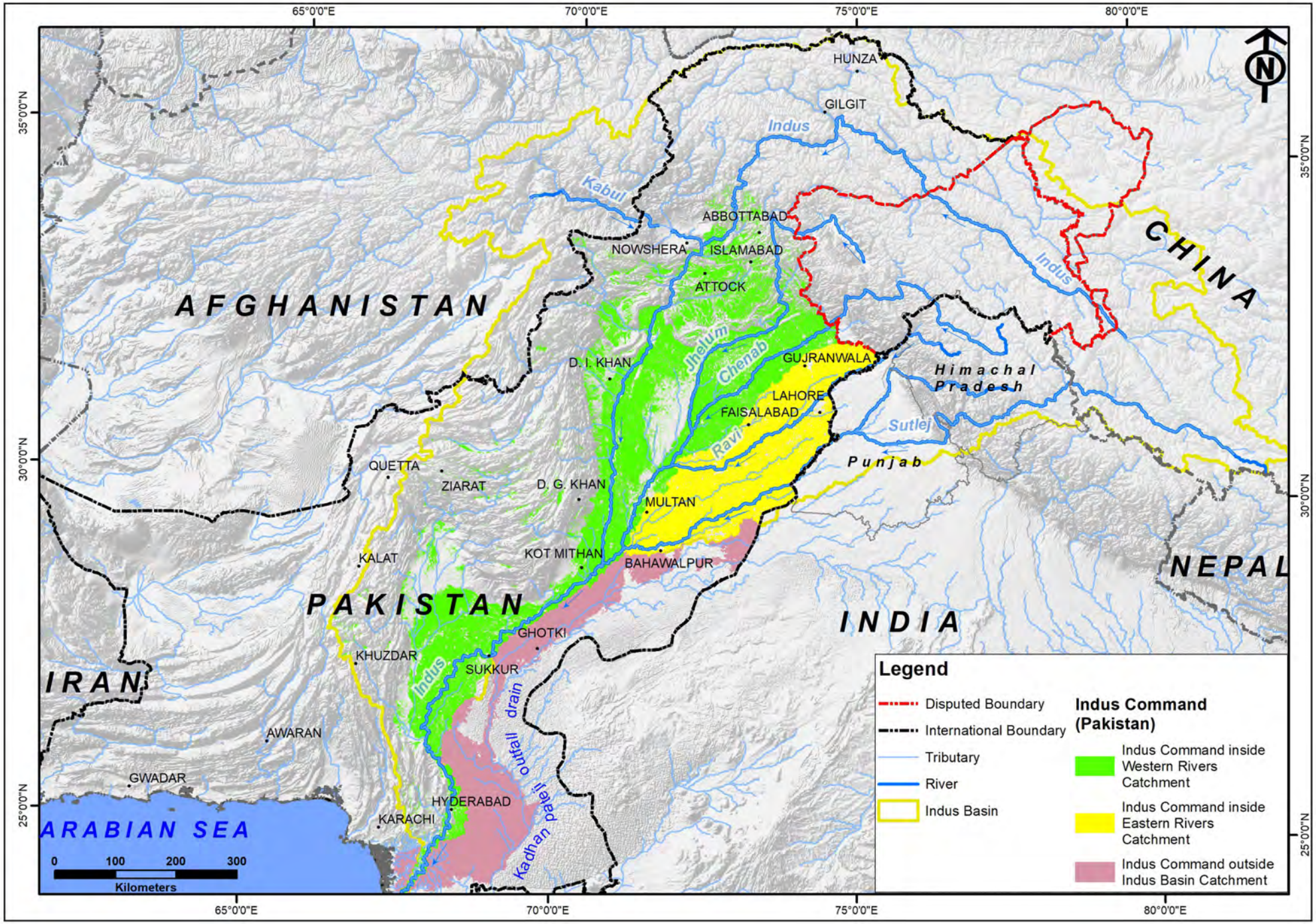
In consideration of the fact that the purpose of part of the system of works referred to in Article IV (1) is the replacement, from the Western Rivers and other sources, of water supplies for irrigation canals in Pakistan which, on 15th August 1947, were dependent on water supplies from the Eastern Rivers, India agrees to make a fixed contribution of Pounds Sterling 62,060,000 towards the costs of these works. The amount in Pounds Sterling of this contribution shall remain unchanged irrespective of any alteration in the par value of any currency.

THE INDUS BASIN IRRIGATION SYSTEM (THE LARGEST IN THE WORLD) PREDOMINANTLY SUPPLIES AGRICULTURAL AREAS IN PAKISTAN

Jurisdiction	Irrigated Area (million hectares)	Percent of Basin Total
Pakistan	21.166	84.2
India	3.592	14.3
Afghanistan	0.365	1.5
China	0	0
Total	**25.123**	**100**

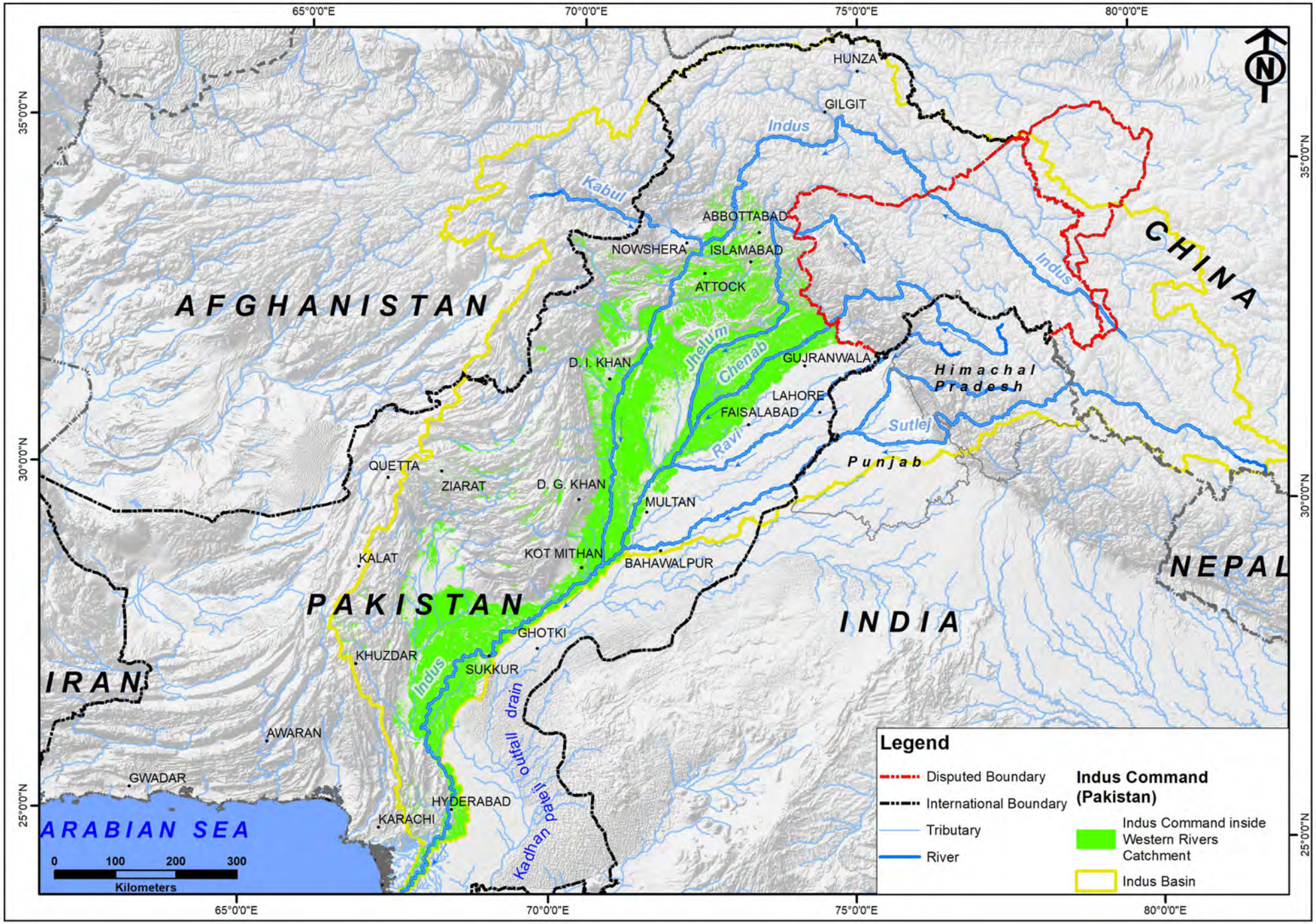
Figure 3.8 - Irrigated area supplied by the Indus Basin across national jurisdictions[300]

Figure 3.8, Pakistan's Memorial – based on Normalized Difference Vegetation Index using remotely sensed data of Sentinel-2 for the years 2017-2022 available on Google Earth



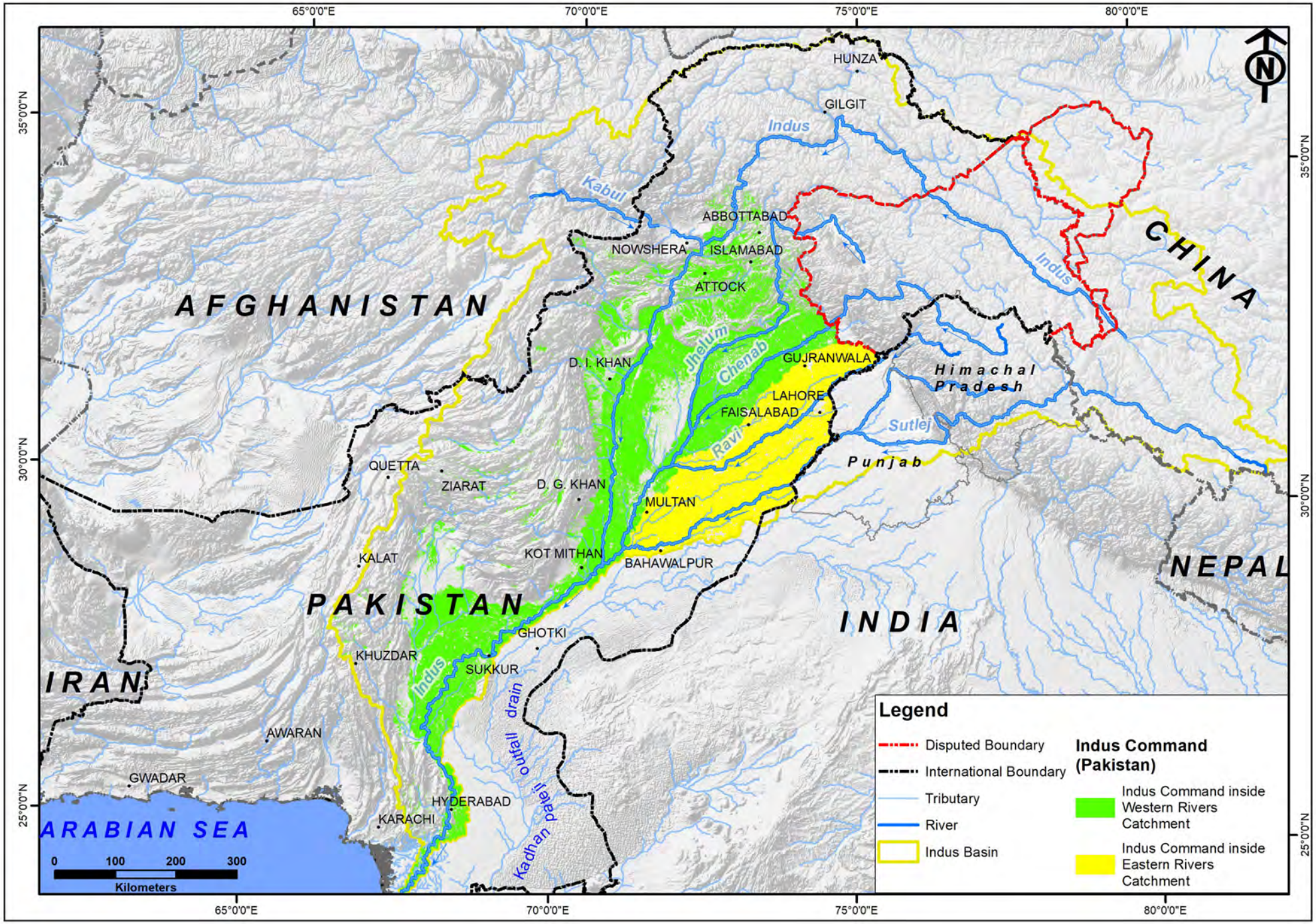
WESTERN RIVERS IRRIGATION NETWORK IN PAKISTAN

Modified version of Map 3.7, Pakistan's Memorial



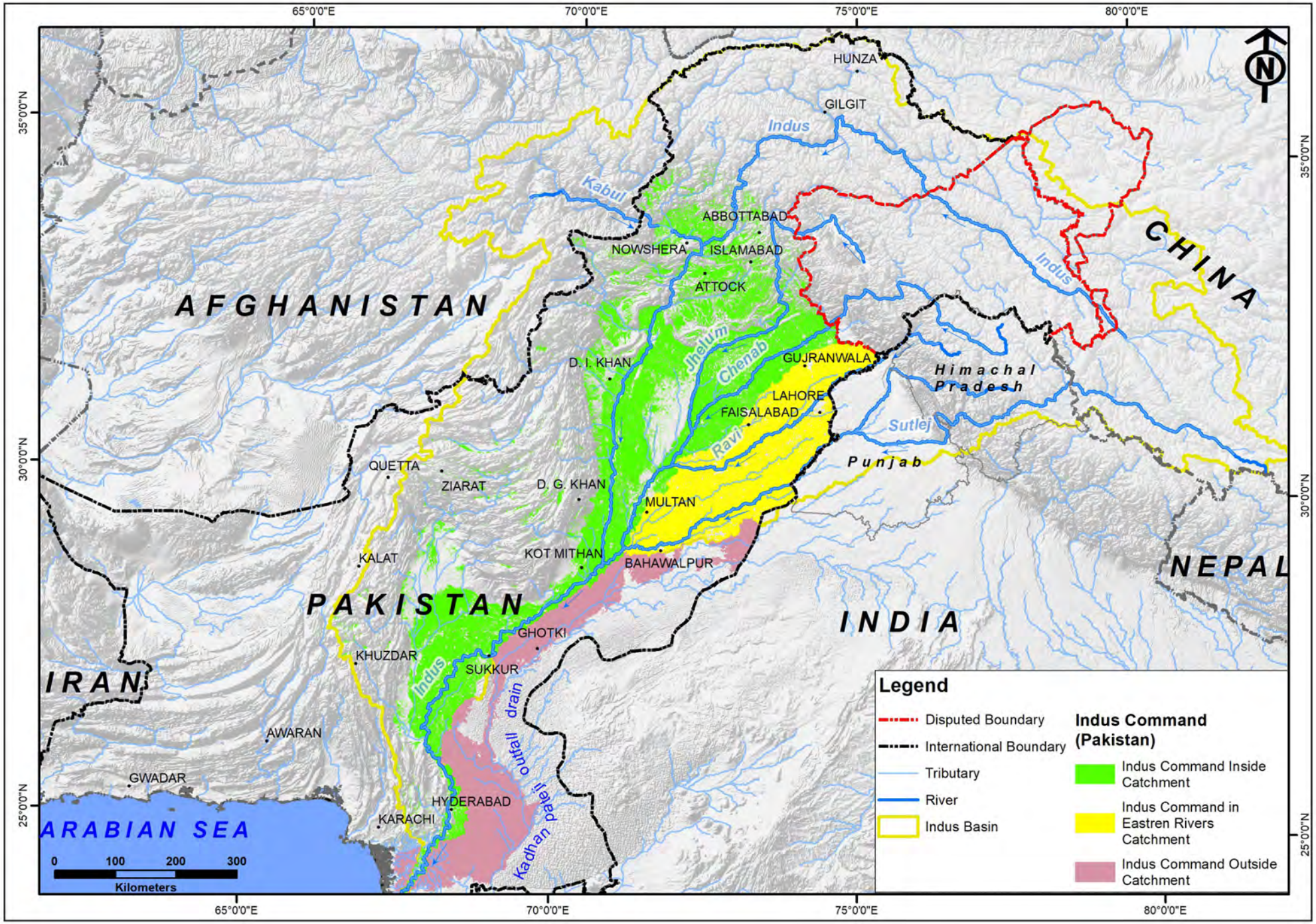
IRRIGATED AREAS FALLING IN WESTERN RIVERS CATCHMENT (green)

Modified version of Map 3.7, Pakistan's Memorial



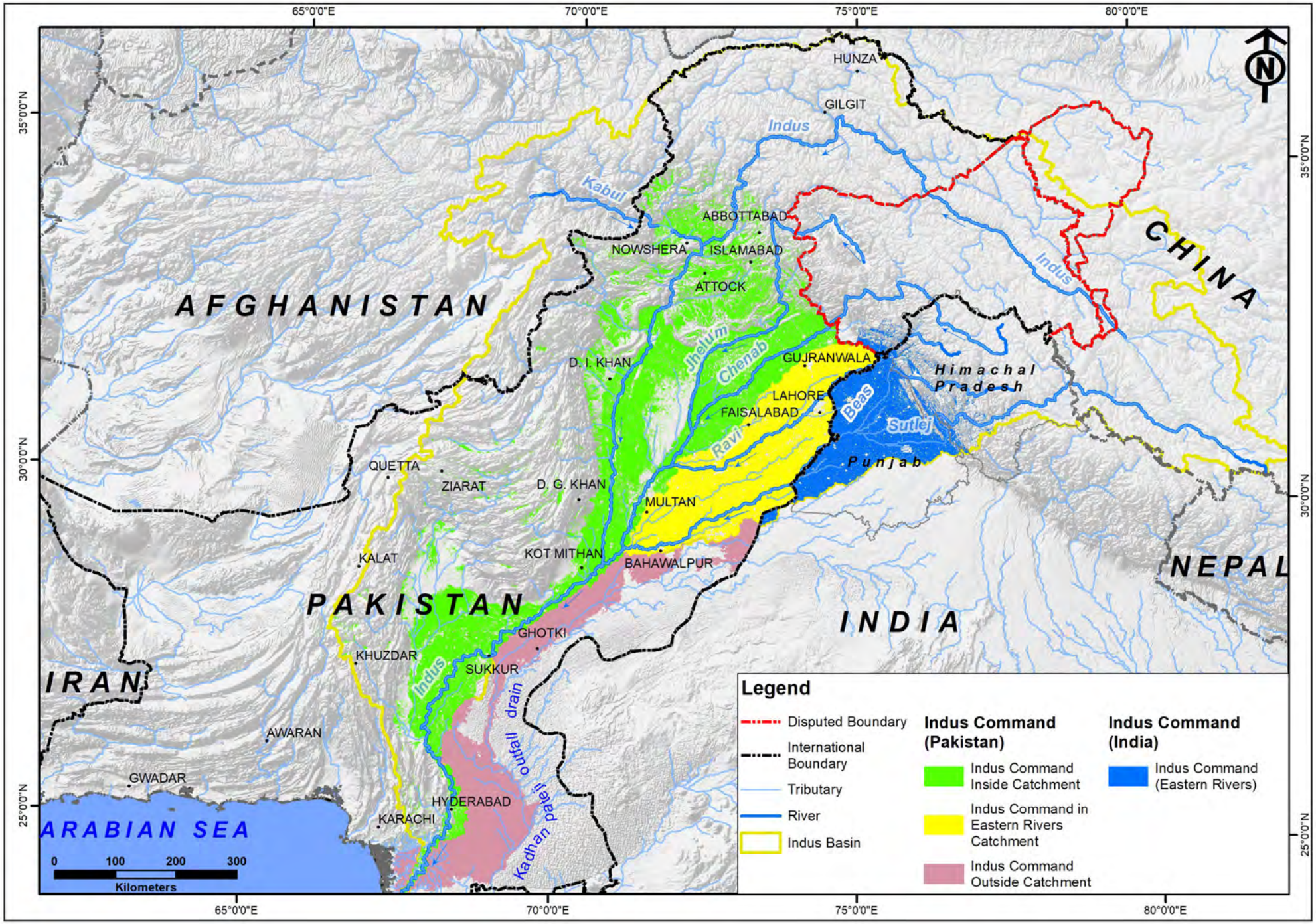
AREAS IRRIGATED BY WESTERN RIVERS FALLING IN EASTERN CATCHMENT (yellow)

Modified version of Map 3.7, Pakistan's Memorial



IRRIGATED AREAS OUTSIDE INDUS BASIN CATCHMENT IN PAKISTAN (pink)

Modified version of Map 3.7, Pakistan's Memorial



AREAS IN INDUS CATCHMENT IRRIGATED BY EASTERN RIVERS IN INDIA (blue)

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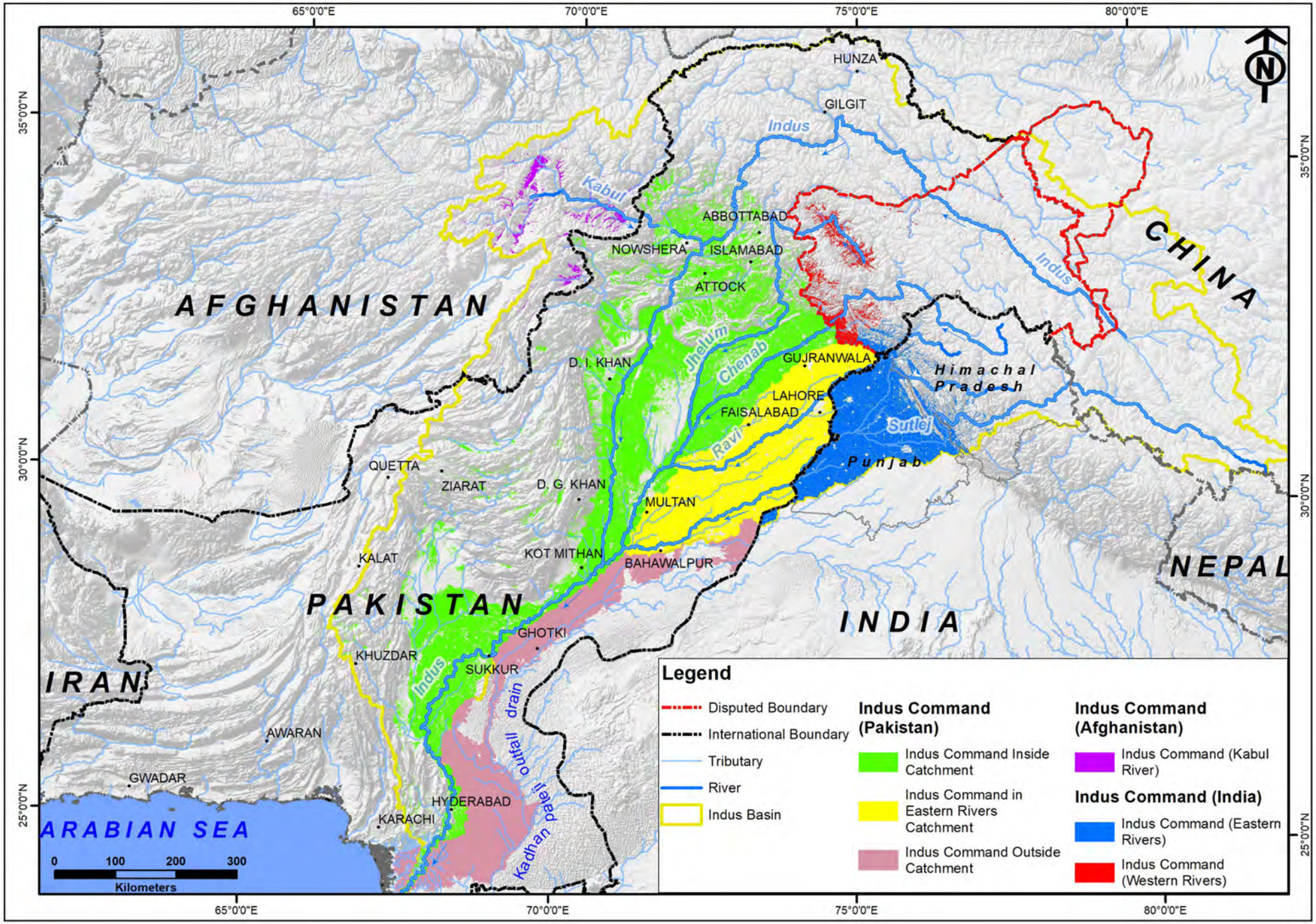
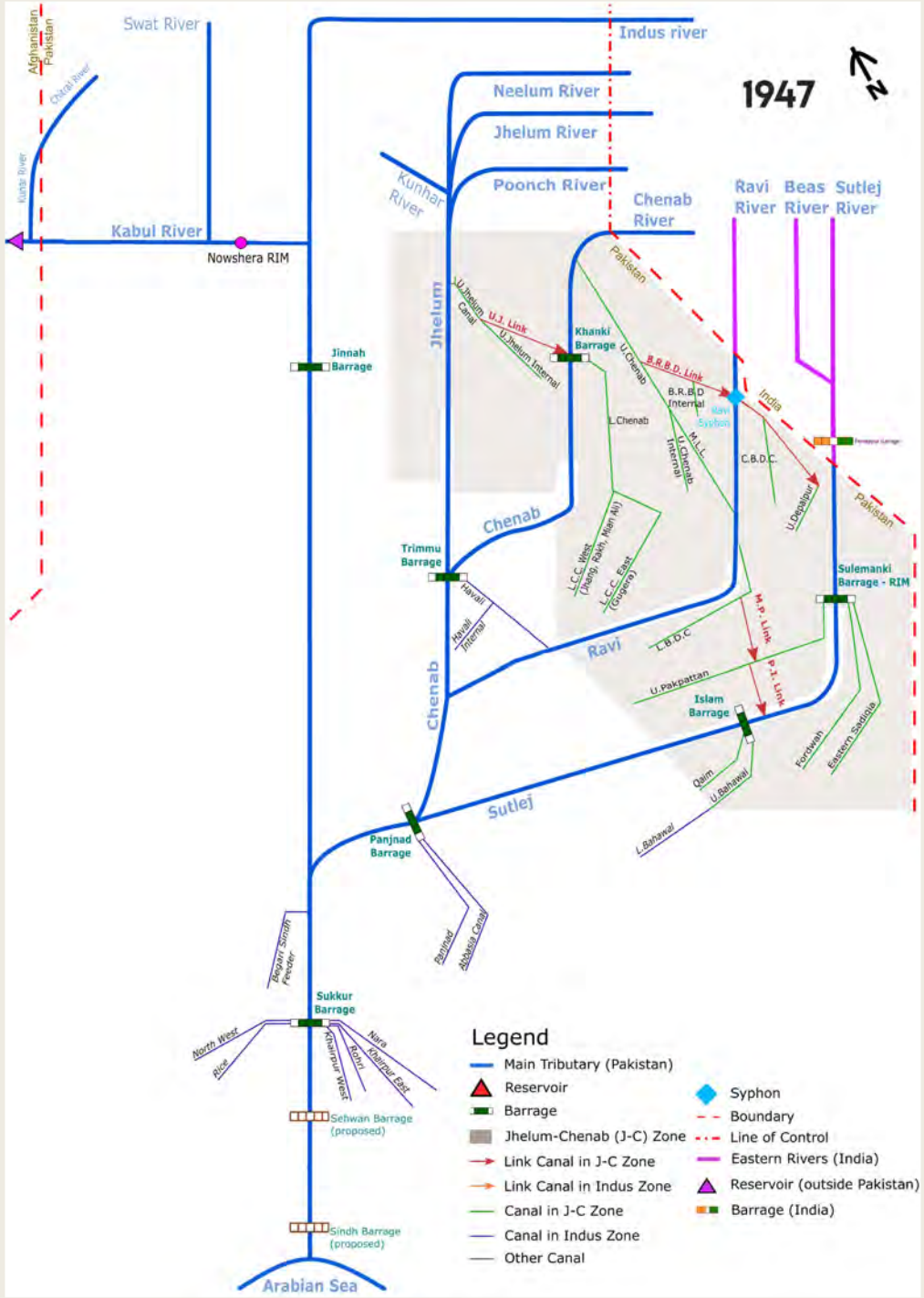


AREAS IN INDUS CATCHMENT IRRIGATED BY WESTERN RIVERS IN INDIAN ADMINISTERED TERRITORY (red) AND BY KABUL RIVER IN AFGHANISTAN (purple)

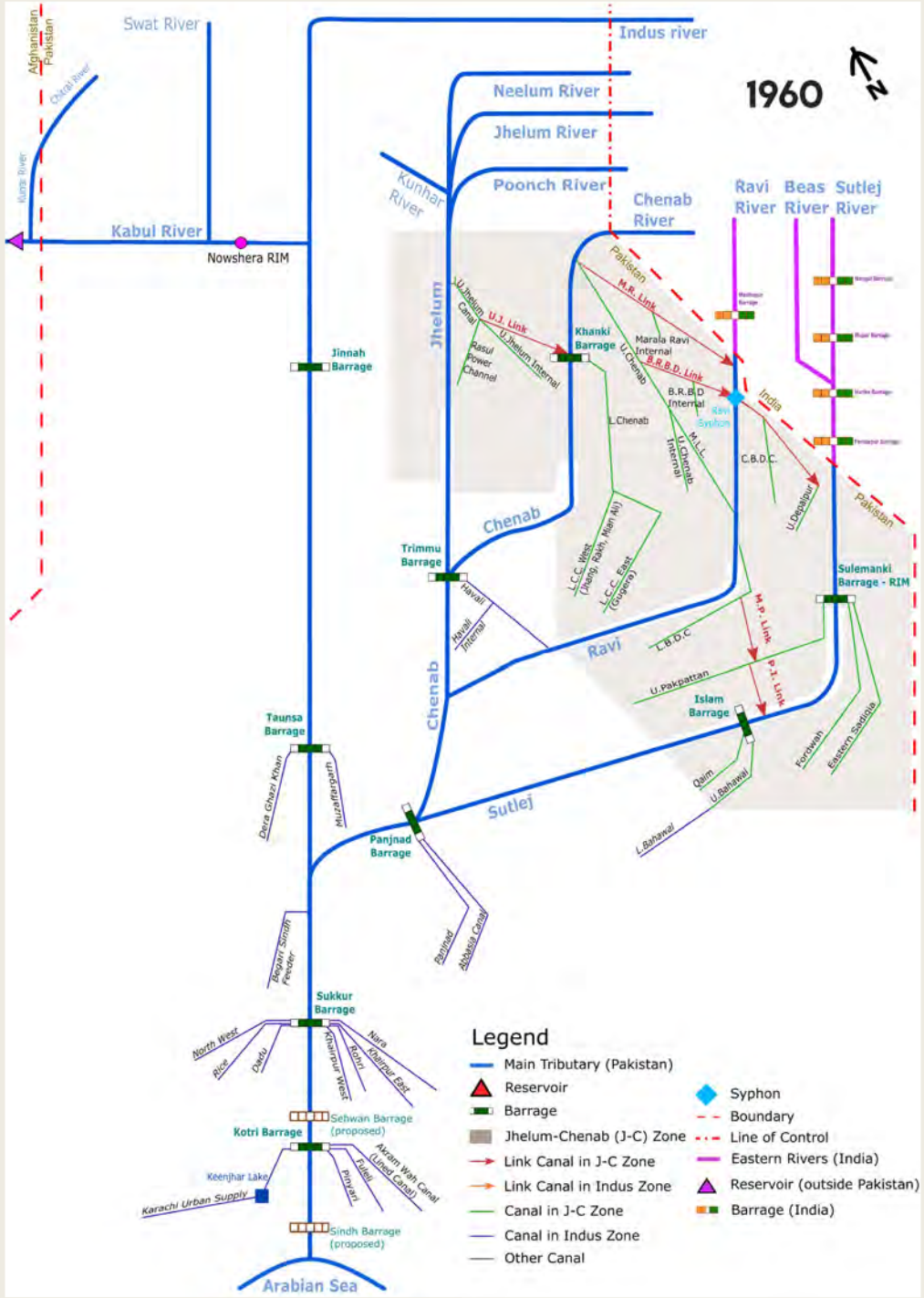
Modified version of Map 3.7, Pakistan's Memorial

IRRIGATION SYSTEM ON THE WESTERN AND EASTERN RIVERS IN PAKISTAN: 1947



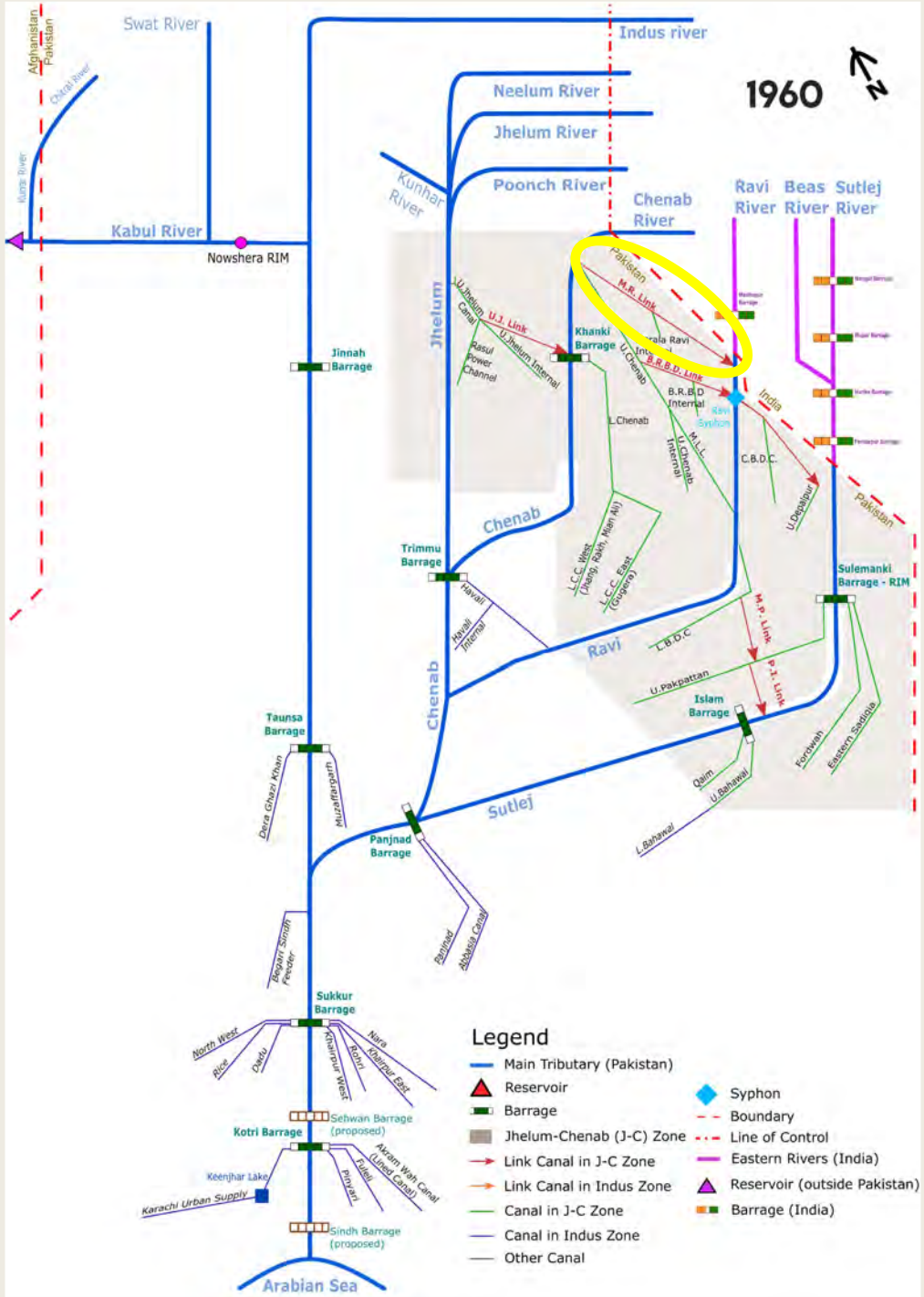
Modified version of Figure 3.7, Pakistan's Memorial – based on diagram of Pakistan's irrigation network in ***Exhibit P-0278***

IRRIGATION SYSTEM ON THE WESTERN AND EASTERN RIVERS IN PAKISTAN: 1960

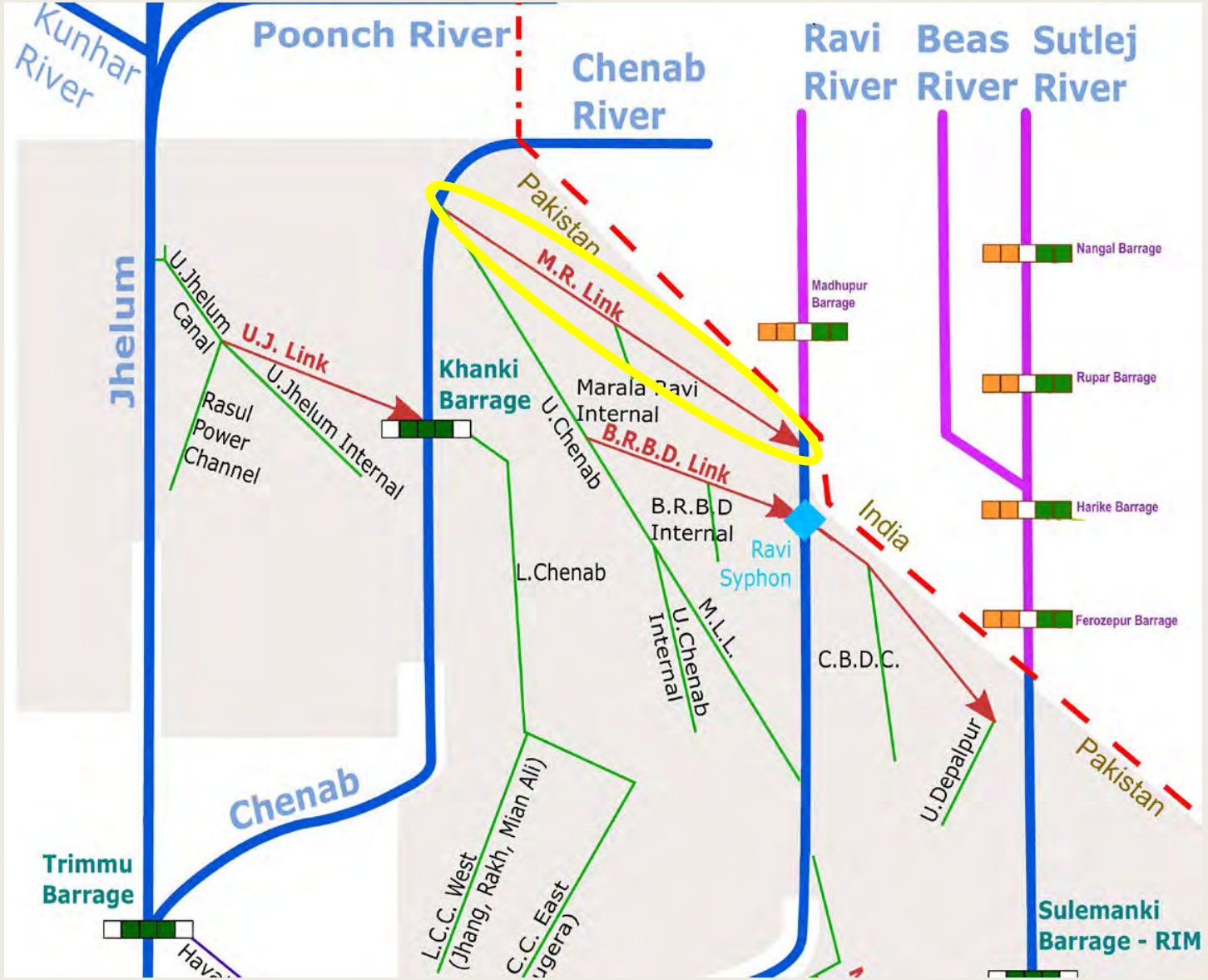


Modified version of Figure 3.7, Pakistan's Memorial – based on diagram of Pakistan's irrigation network in ***Exhibit P-0278***

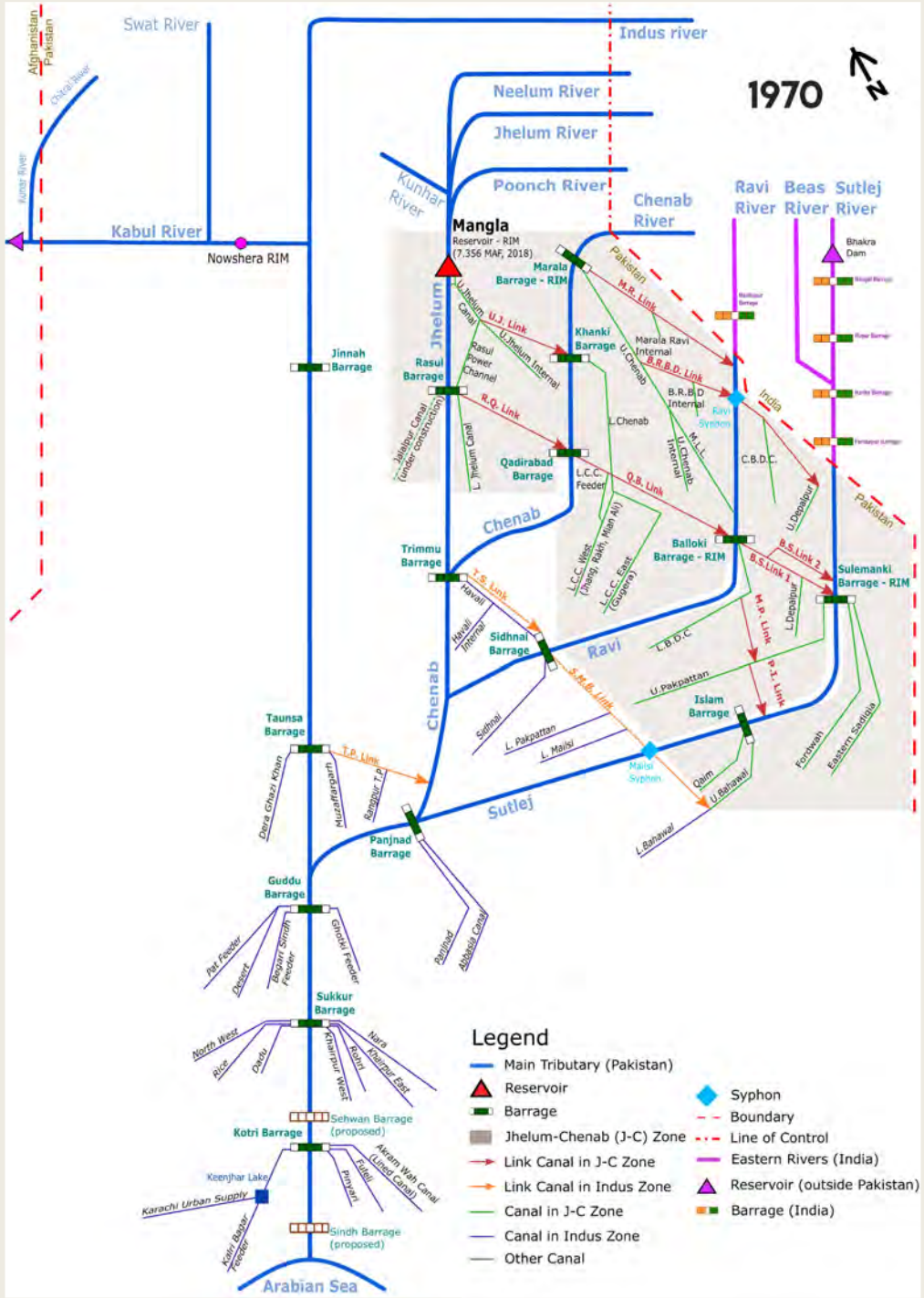
IRRIGATION SYSTEM ON THE WESTERN AND EASTERN RIVERS IN PAKISTAN: 1960



Modified version of Figure 3.7, Pakistan's Memorial – based on diagram of Pakistan's irrigation network in ***Exhibit P-0278***

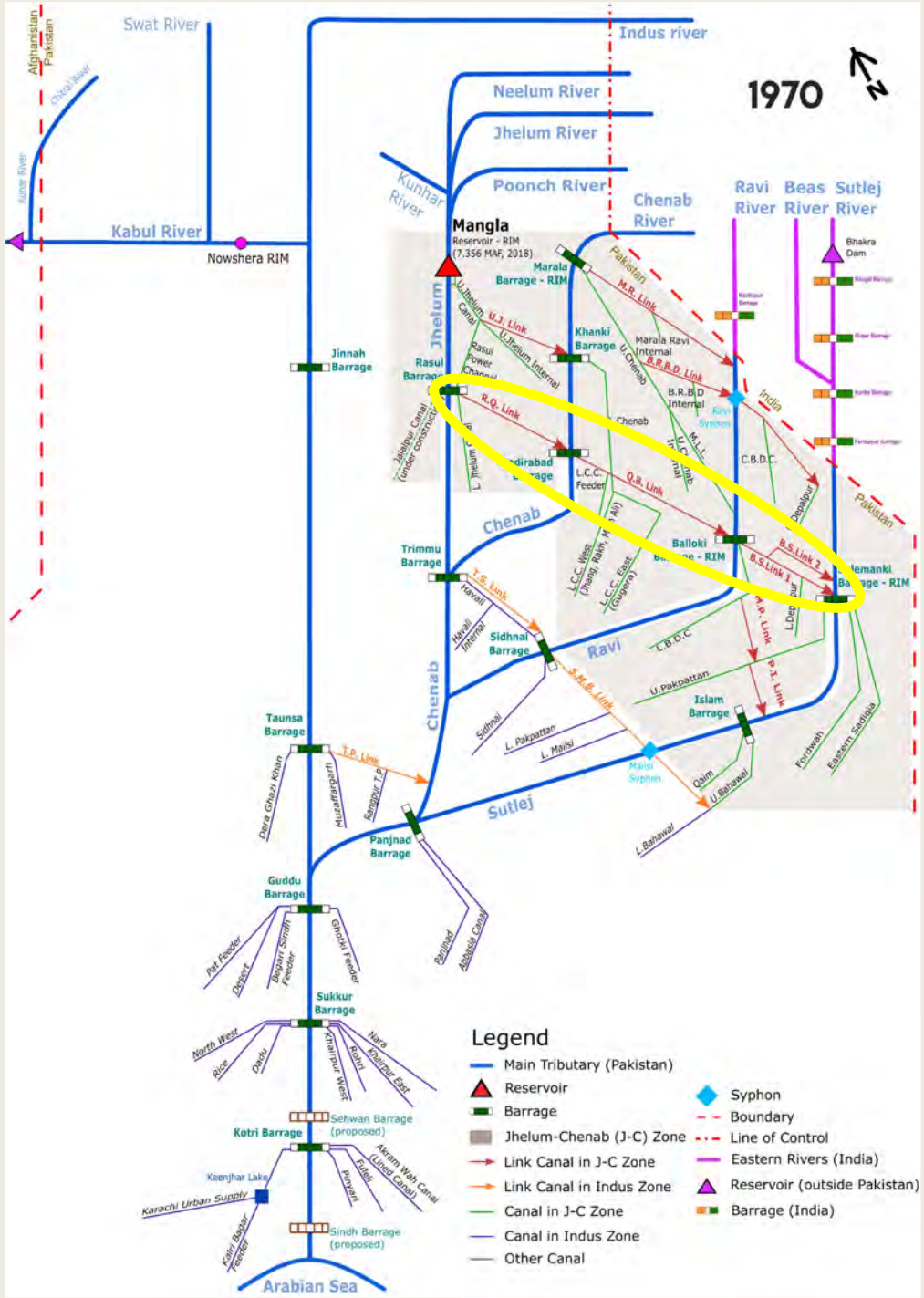

Kunhar River
Poonch River
Chenab River
Ravi River
Beas River
Sutlej River
Pakistan
M.R. Link
Jhelum
U.Jhelum Canal
U.J. Link
U.Jhelum Internal
Rasul Power Channel
Khanki Barrage
Marala Ravi Internal
U.Chenab
B.R.B.D. Link
B.R.B.D Internal
Ravi Syphon
India
L.Chenab
M.L.L.
U.Chenab Internal
C.B.D.C.
U.Depalpur
Pakistan
Madhupur Barrage
Nangal Barrage
Rupar Barrage
Harike Barrage
Ferozepur Barrage
Chenab
Trimmu Barrage
L.C.C. West (Jhang, Rakh, Mian Ali)
C.C. East
Sulemanki Barrage - RIM

IRRIGATION SYSTEM ON THE WESTERN AND EASTERN RIVERS IN PAKISTAN: 1970

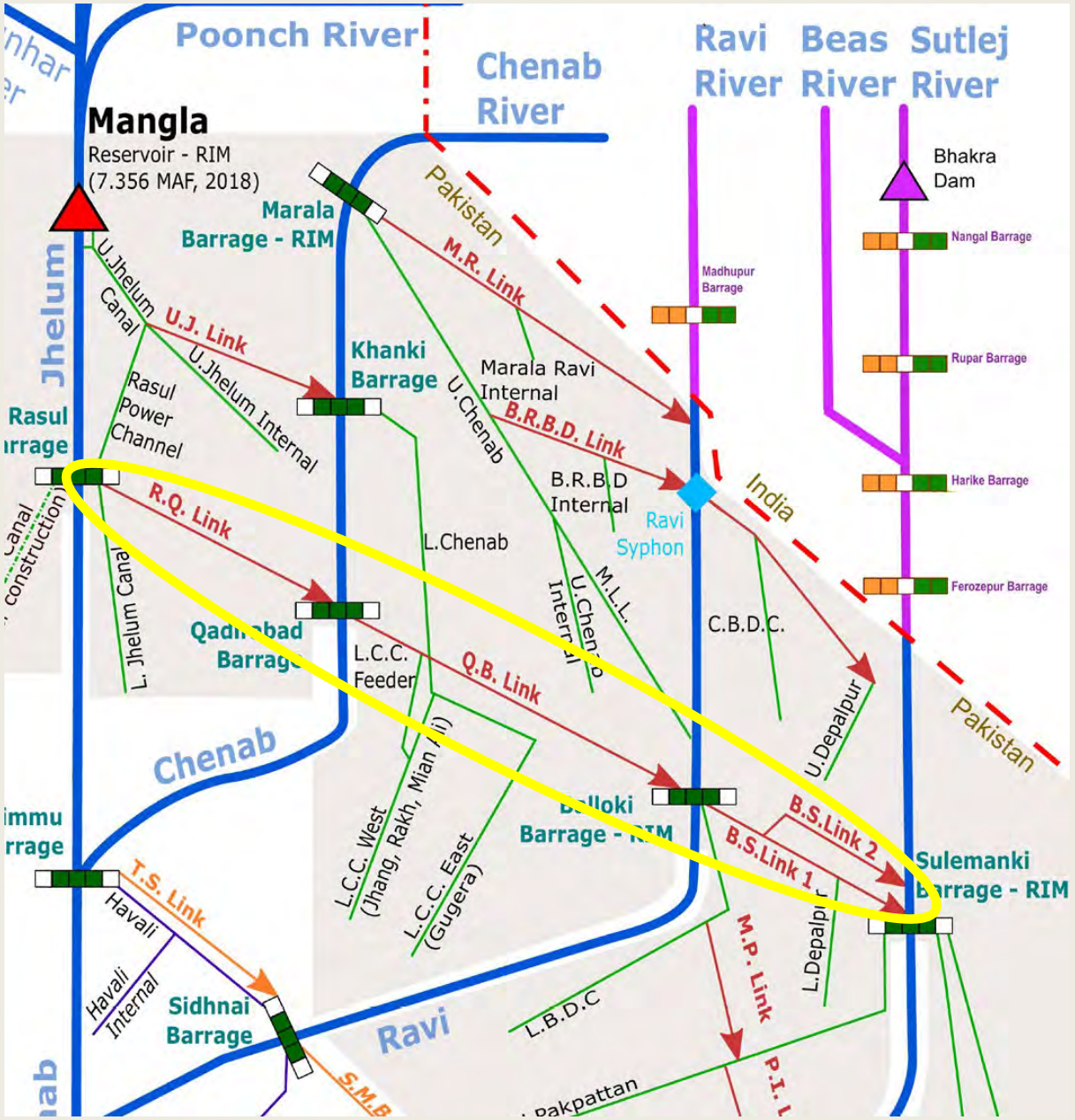


Modified version of Figure 3.7, Pakistan's Memorial – based on diagram of Pakistan's irrigation network in ***Exhibit P-0278***

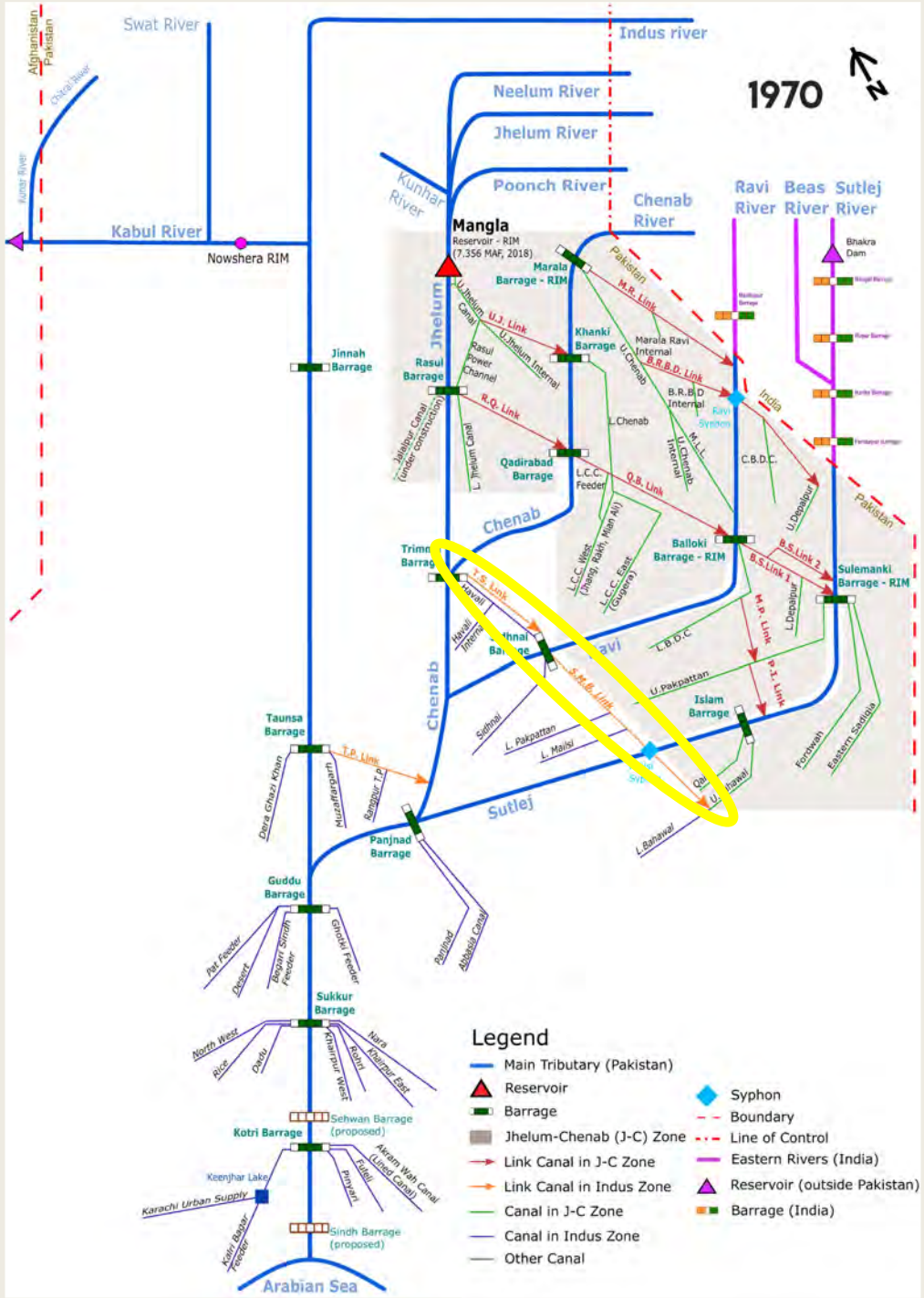
IRRIGATION SYSTEM ON THE WESTERN AND EASTERN RIVERS IN PAKISTAN: 1970



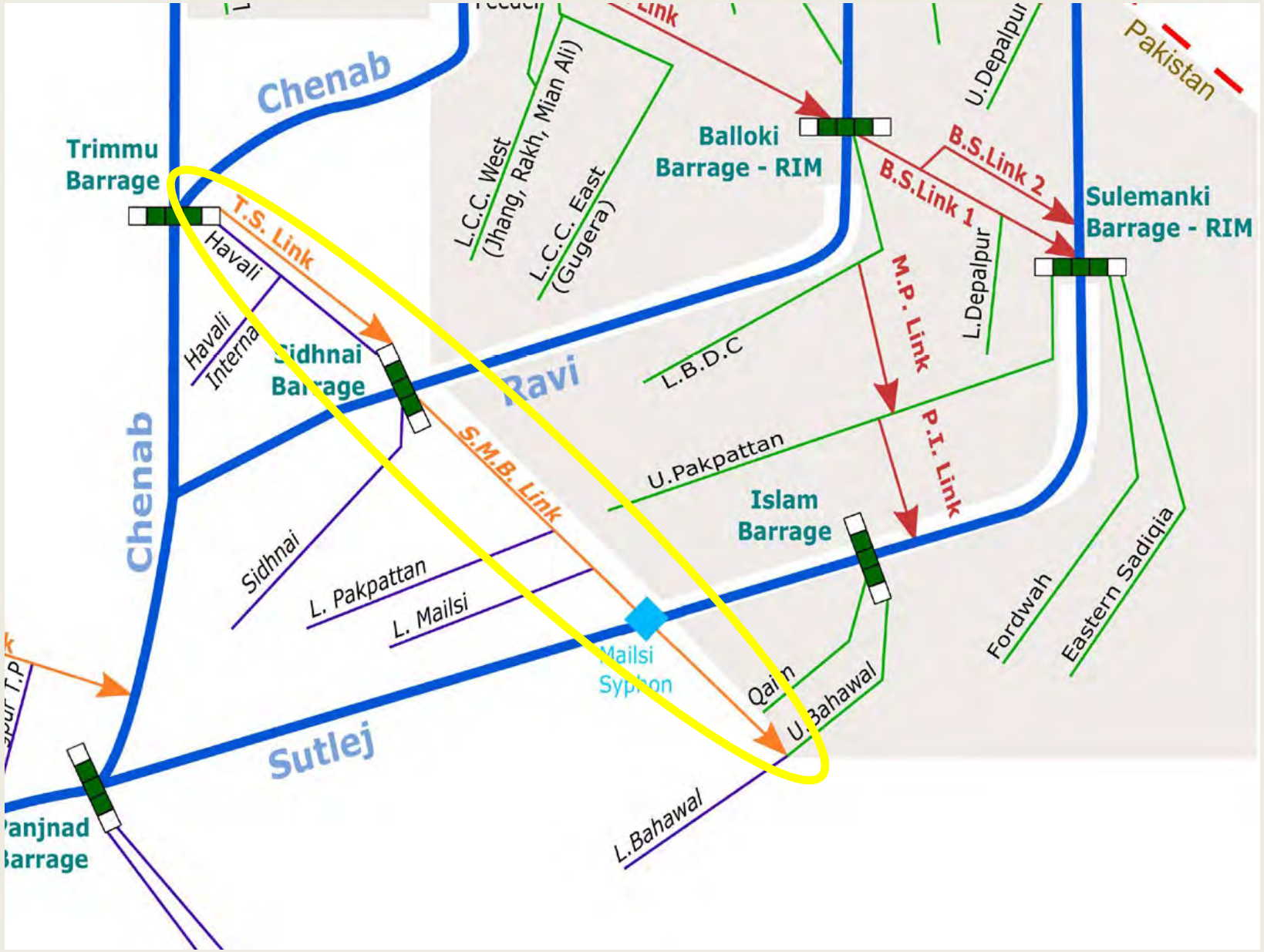
Modified version of Figure 3.7, Pakistan's Memorial – based on diagram of Pakistan's irrigation network in ***Exhibit P-0278***


Poonch River
Chenab River
Ravi River
Beas River
Sutlej River
Mangla
Reservoir - RIM
(7.356 MAF, 2018)
Marala Barrage - RIM
Bhakra Dam
Nangal Barrage
Madhupur Barrage
Rupar Barrage
Harike Barrage
Ferozepur Barrage
Pakistan
India
Pakistan
M.R. Link
U.J. Link
U.Jhelum Canal
U.Jhelum Internal
Rasul Power Channel
Rasul Barrage
Khanki Barrage
Marala Ravi Internal
U.Chenab
B.R.B.D. Link
B.R.B.D Internal
Ravi Syphon
R.Q. Link
L.Chenab
L. Jhelum Canal
Qadirabad Barrage
L.C.C. Feeder
M.L.L.
U.Chenab Internal
C.B.D.C.
U.Depalpur
Q.B. Link
Jhelum
Chenab
Ravi
Balloki Barrage - RIM
B.S.Link 2
B.S.Link 1
Sulemanki Barrage - RIM
L.C.C. West (Jhang, Rakh, Mian Ali)
L.C.C. East (Gugera)
T.S. Link
Havali
Havali Internal
Sidhnai Barrage
L.B.D.C
M.P. Link
L.Depalpur
Pakpattan

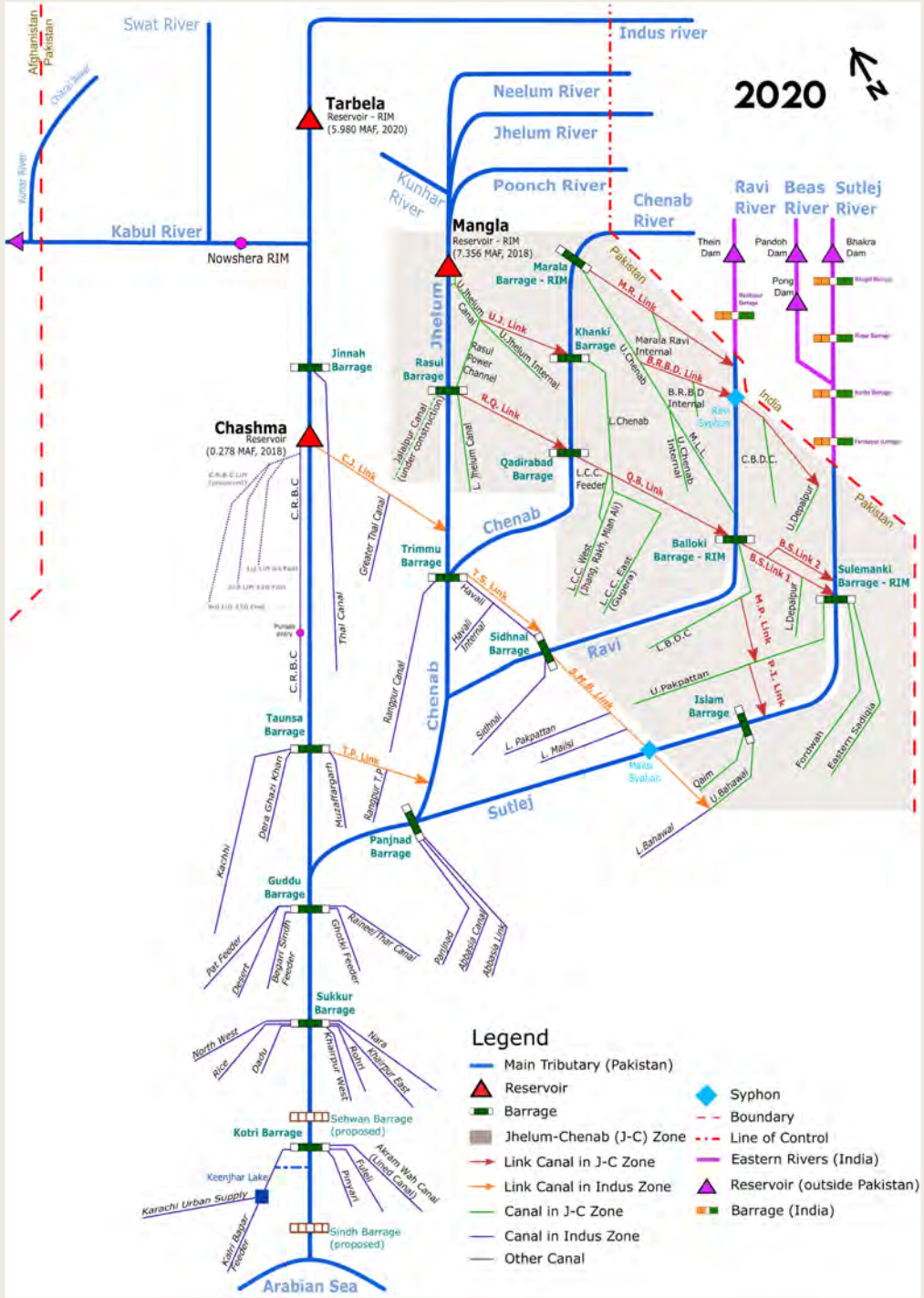
IRRIGATION SYSTEM ON THE WESTERN AND EASTERN RIVERS IN PAKISTAN: 1970



Modified version of Figure 3.7, Pakistan's Memorial – based on diagram of Pakistan's irrigation network in ***Exhibit P-0278***

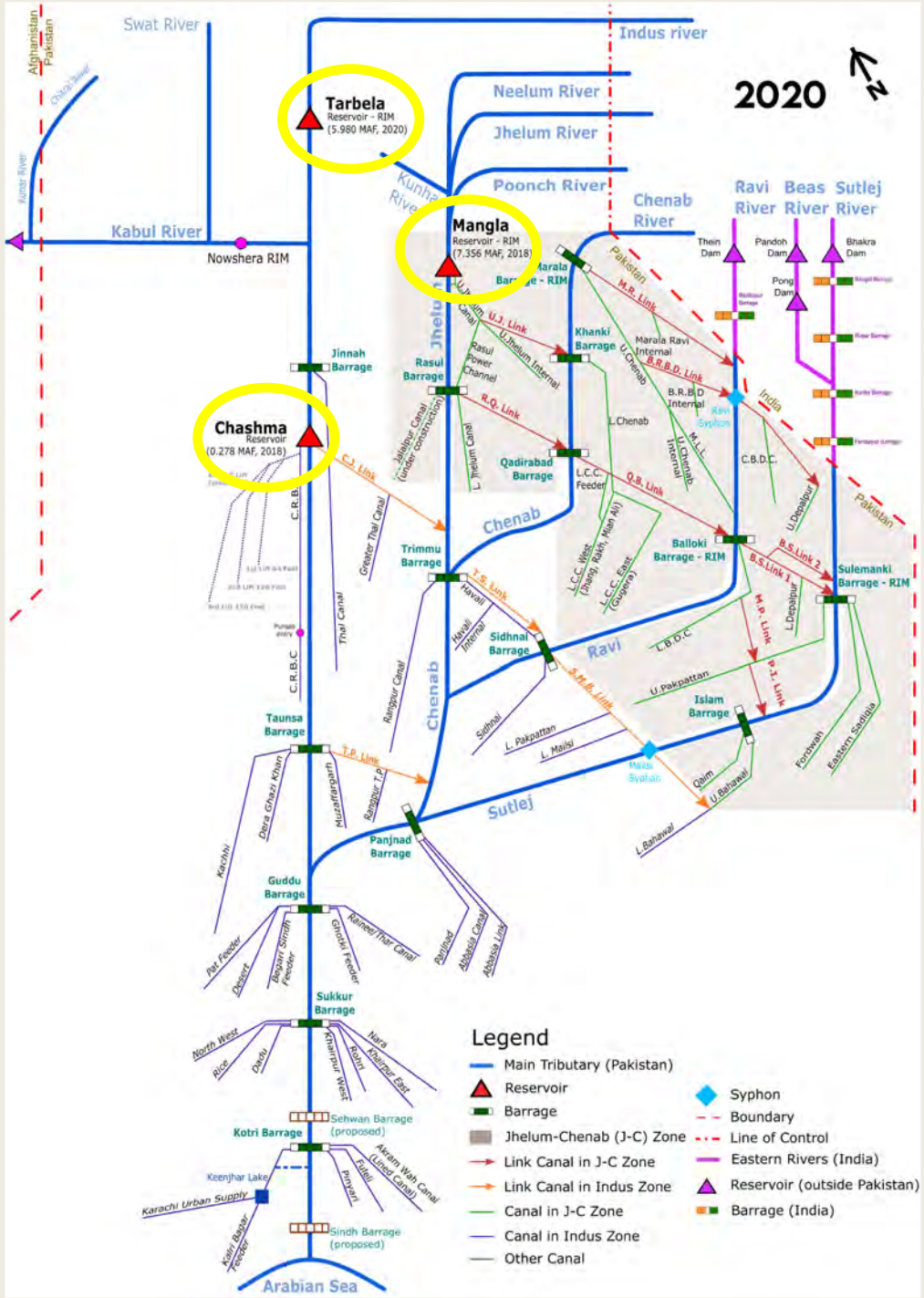

Chenab
Trimmu Barrage
T.S. Link
Havali
Havali Interna
Sidhnai Barrage
Ravi
Balloki Barrage - RIM
L.C.C. West (Jhang, Rakh, Mian Ali)
L.C.C. East (Gugera)
B.S.Link 1
B.S.Link 2
Sulemanki Barrage - RIM
U.Depalpur
L.Depalpur
M.P. Link
P.I. Link
L.B.D.C
U.Pakpattan
Islam Barrage
S.M.B. Link
Sidhnai
L. Pakpattan
L. Mailsi
Mailsi Syphon
Qaim
U.Bahawal
L.Bahawal
Fordwah
Eastern Sadiqia
Sutlej
Panjnad Barrage
Pakistan

IRRIGATION SYSTEM ON THE WESTERN AND EASTERN RIVERS IN PAKISTAN: 2020

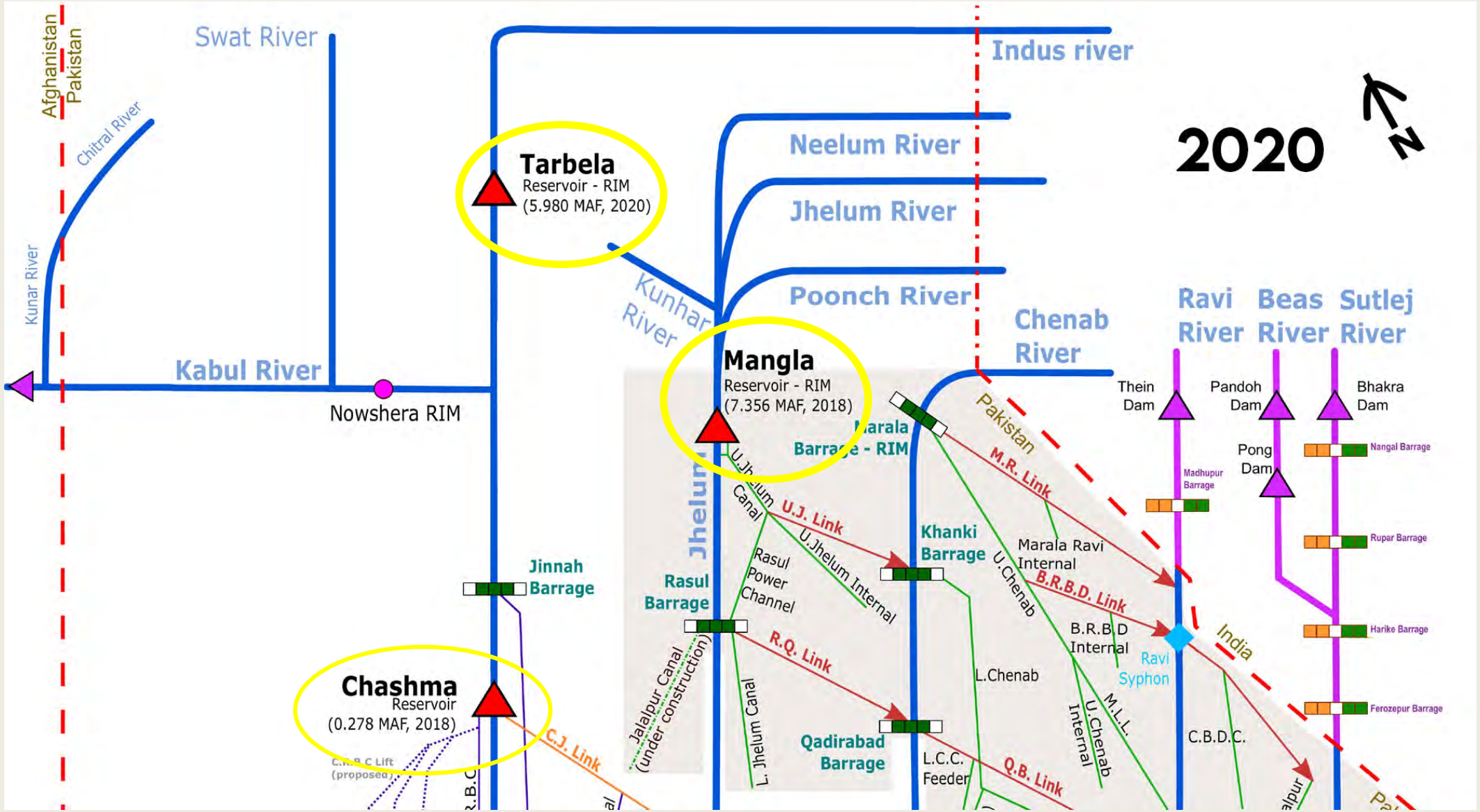


Modified version of Figure 3.7, Pakistan's Memorial – based on diagram of Pakistan's irrigation network in ***Exhibit P-0278***

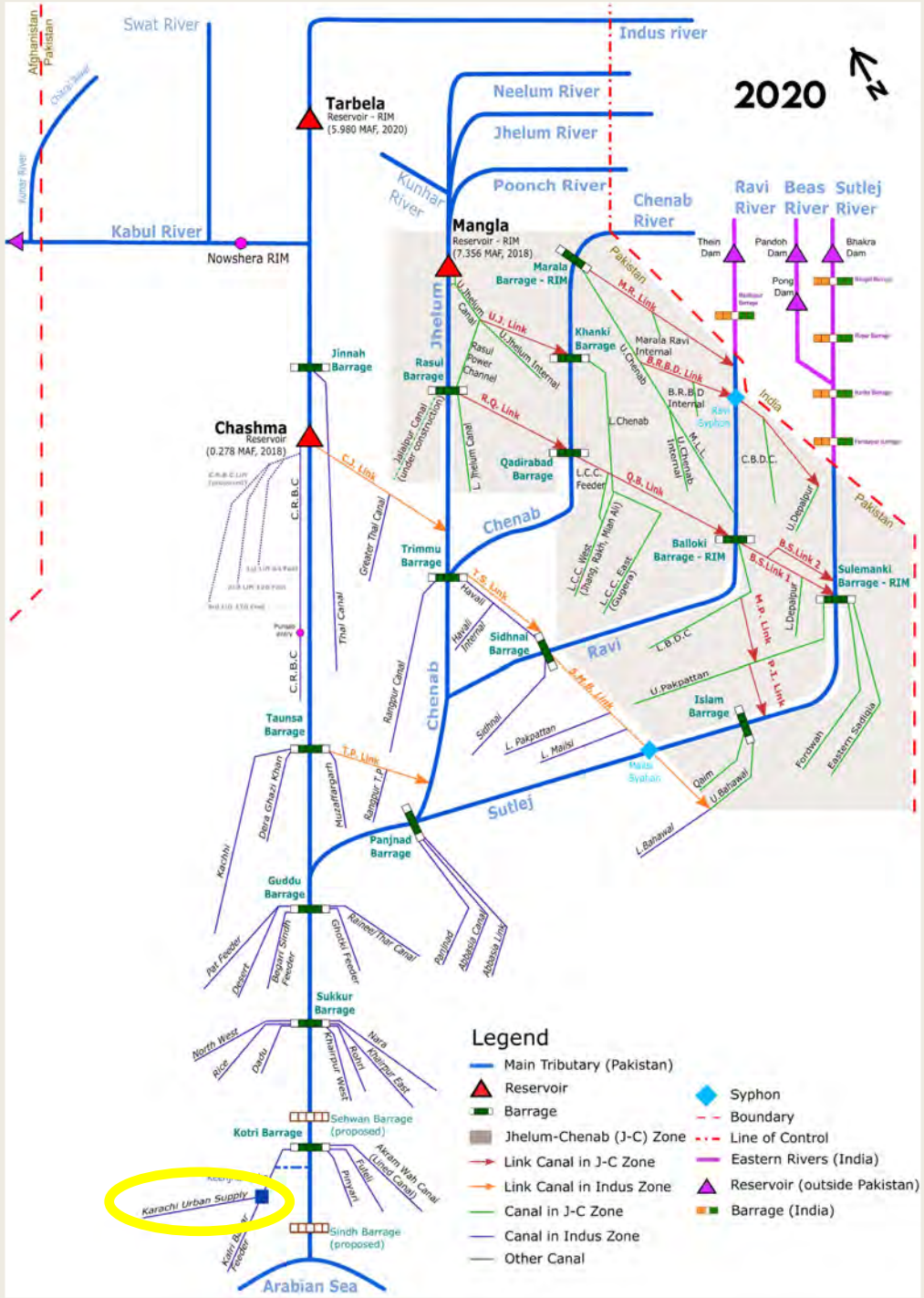
IRRIGATION SYSTEM ON THE WESTERN AND EASTERN RIVERS IN PAKISTAN: 2020



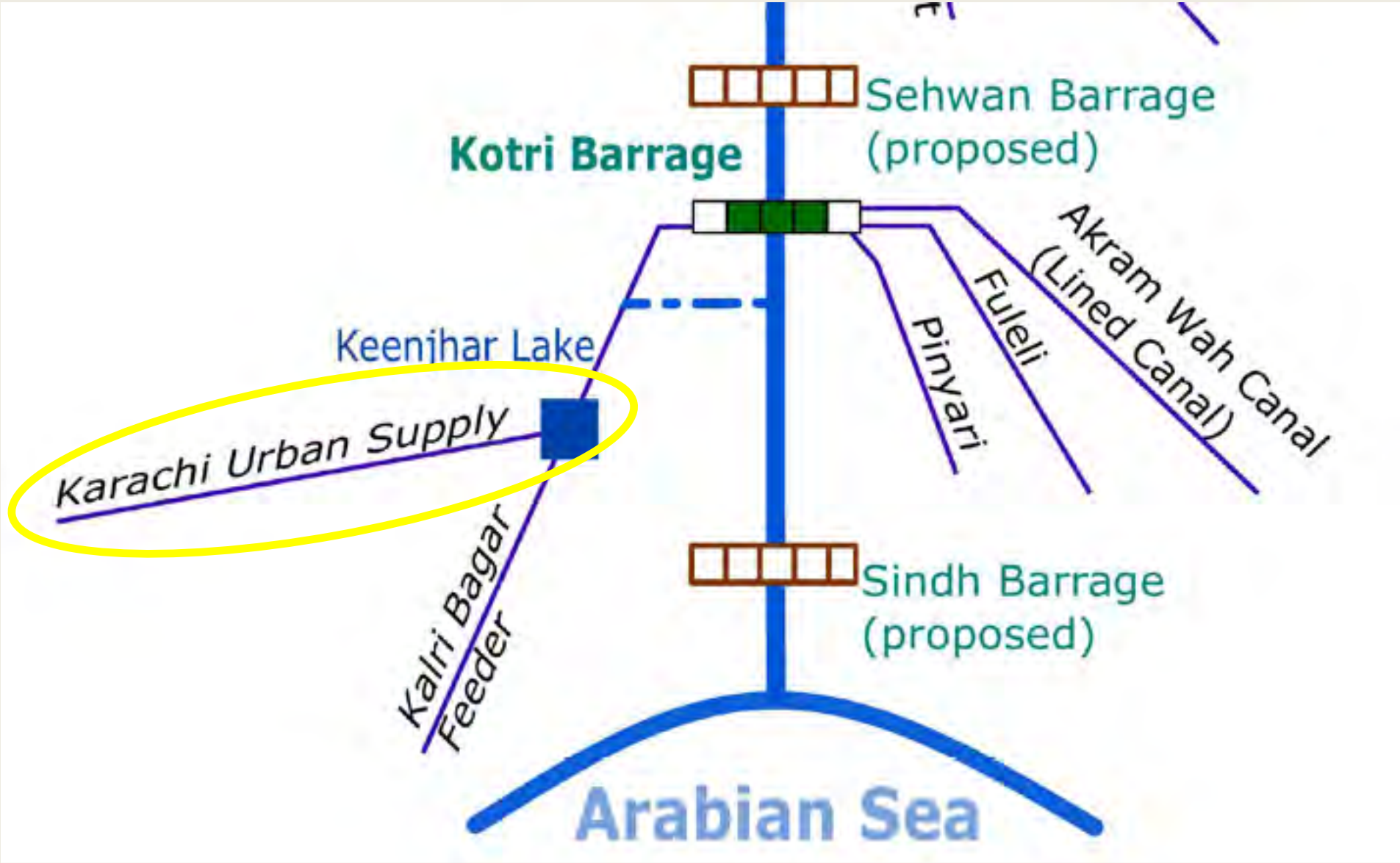
Modified version of Figure 3.7, Pakistan's Memorial – based on diagram of Pakistan's irrigation network in ***Exhibit P-0278***


2020
Afghanistan
Pakistan
Swat River
Chitral River
Kunar River
Kabul River
Nowshera RIM
Tarbela
Reservoir - RIM
(5.980 MAF, 2020)
Kunhar River
Indus river
Neelum River
Jhelum River
Poonch River
Chenab River
Mangla
Reservoir - RIM
(7.356 MAF, 2018)
Marala Barrage - RIM
Ravi River
Beas River
Sutlej River
Thein Dam
Pandoh Dam
Bhakra Dam
Pong Dam
Nangal Barrage
Madhupur Barrage
Rupar Barrage
Harike Barrage
Ferozepur Barrage
Pakistan
India
M.R. Link
U.J. Link
U.Jhelum Canal
Khanki Barrage
Marala Ravi Internal
U.Chenab
B.R.B.D. Link
B.R.B.D Internal
Ravi Syphon
Jinnah Barrage
Rasul Barrage
Rasul Power Channel
R.Q. Link
Jalalpur Canal (under construction)
L. Jhelum Canal
L.Chenab
M.L.L.
U.Chenab Internal
C.B.D.C.
Qadirabad Barrage
L.C.C. Feeder
Q.B. Link
Chashma
Reservoir
(0.278 MAF, 2018)
C.J. Link
C.R.B.C Lift (proposed)

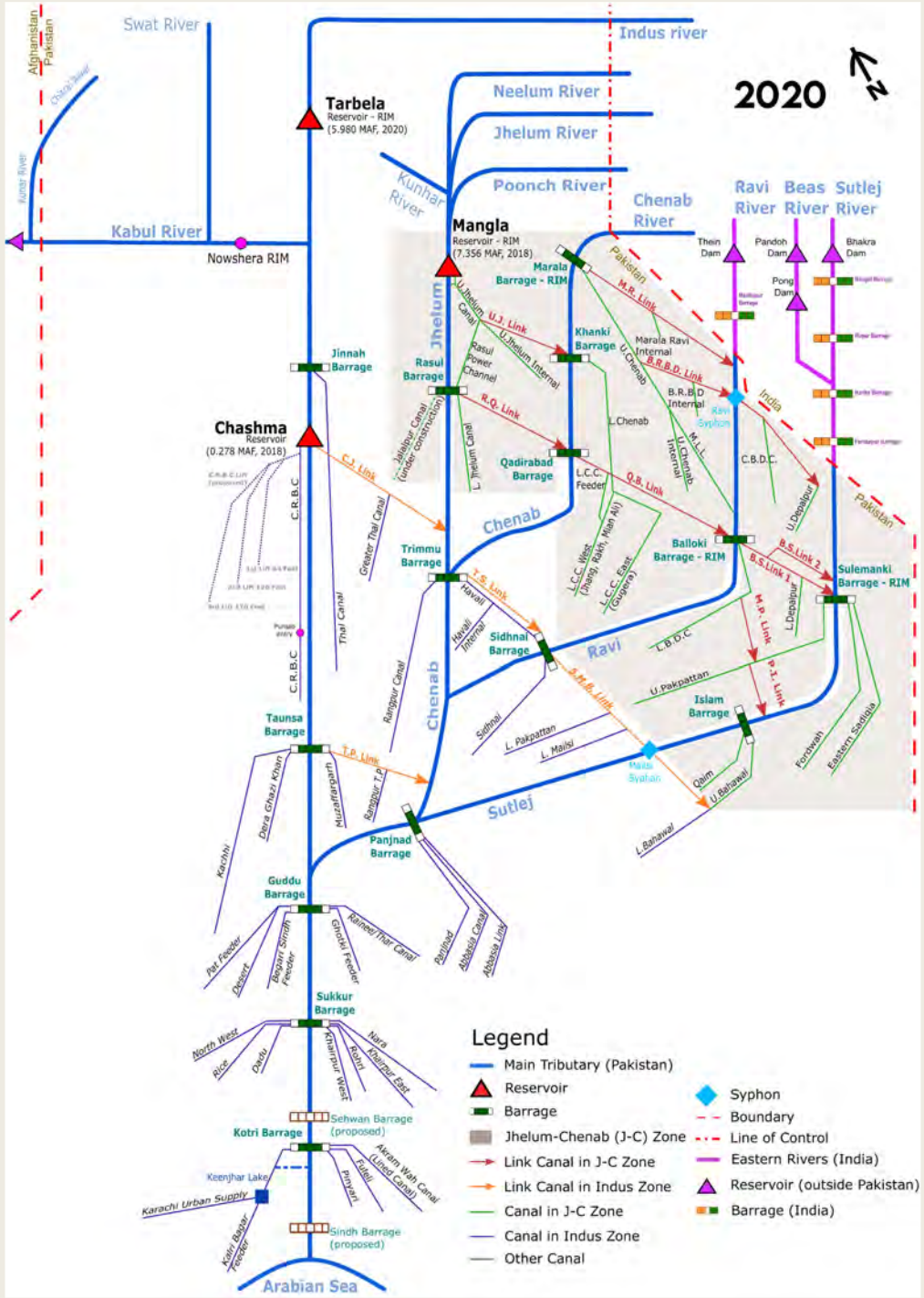
IRRIGATION SYSTEM ON THE WESTERN AND EASTERN RIVERS IN PAKISTAN: 2020



Modified version of Figure 3.7, Pakistan's Memorial – based on diagram of Pakistan's irrigation network in ***Exhibit P-0278***

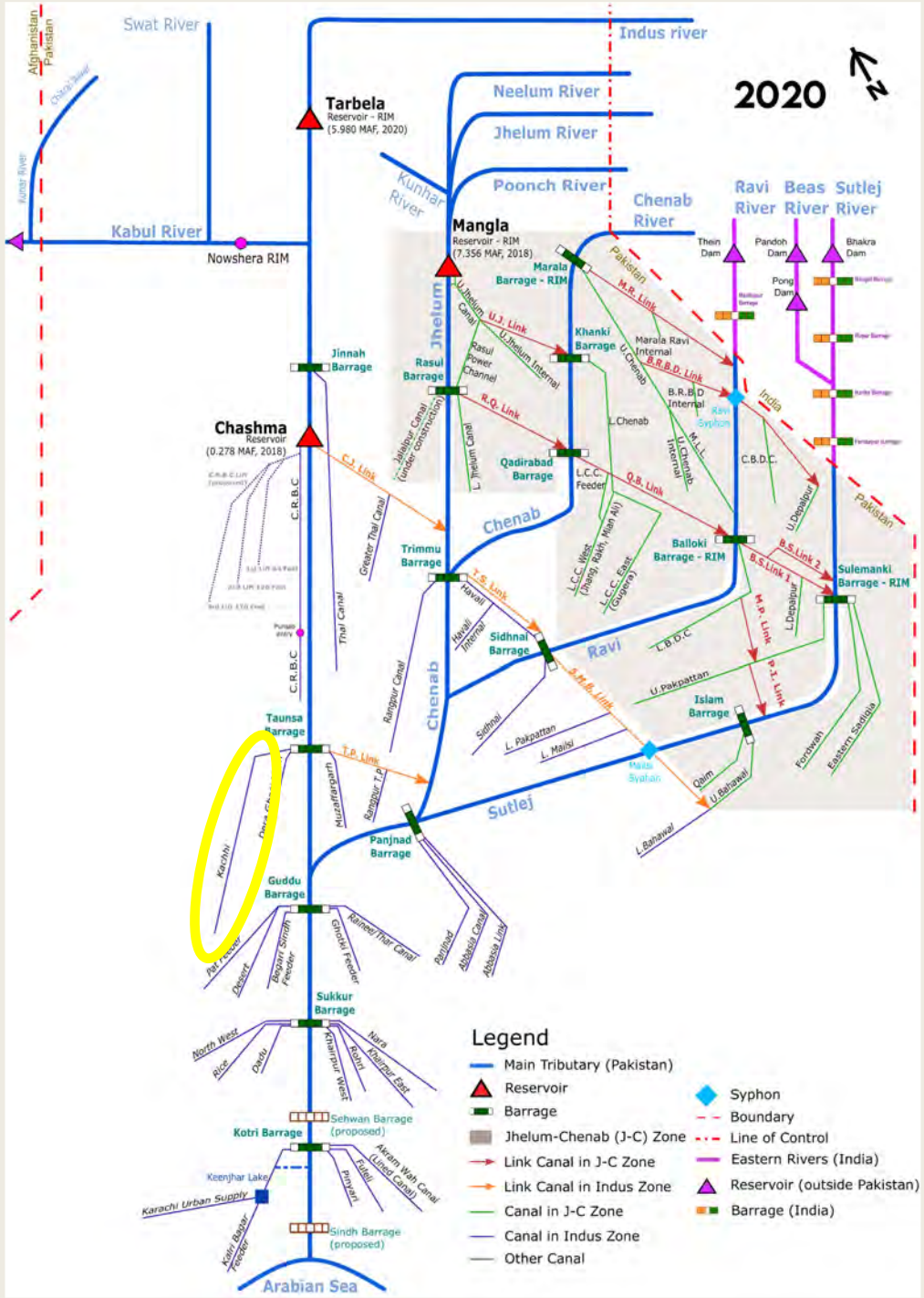

Sehwan Barrage
(proposed)
Kotri Barrage
Akram Wah Canal
(Lined Canal)
Fuleli
Pinyari
Keenjhar Lake
Karachi Urban Supply
Kalri Bagar
Feeder
Sindh Barrage
(proposed)
Arabian Sea

IRRIGATION SYSTEM ON THE WESTERN AND EASTERN RIVERS IN PAKISTAN: 2020

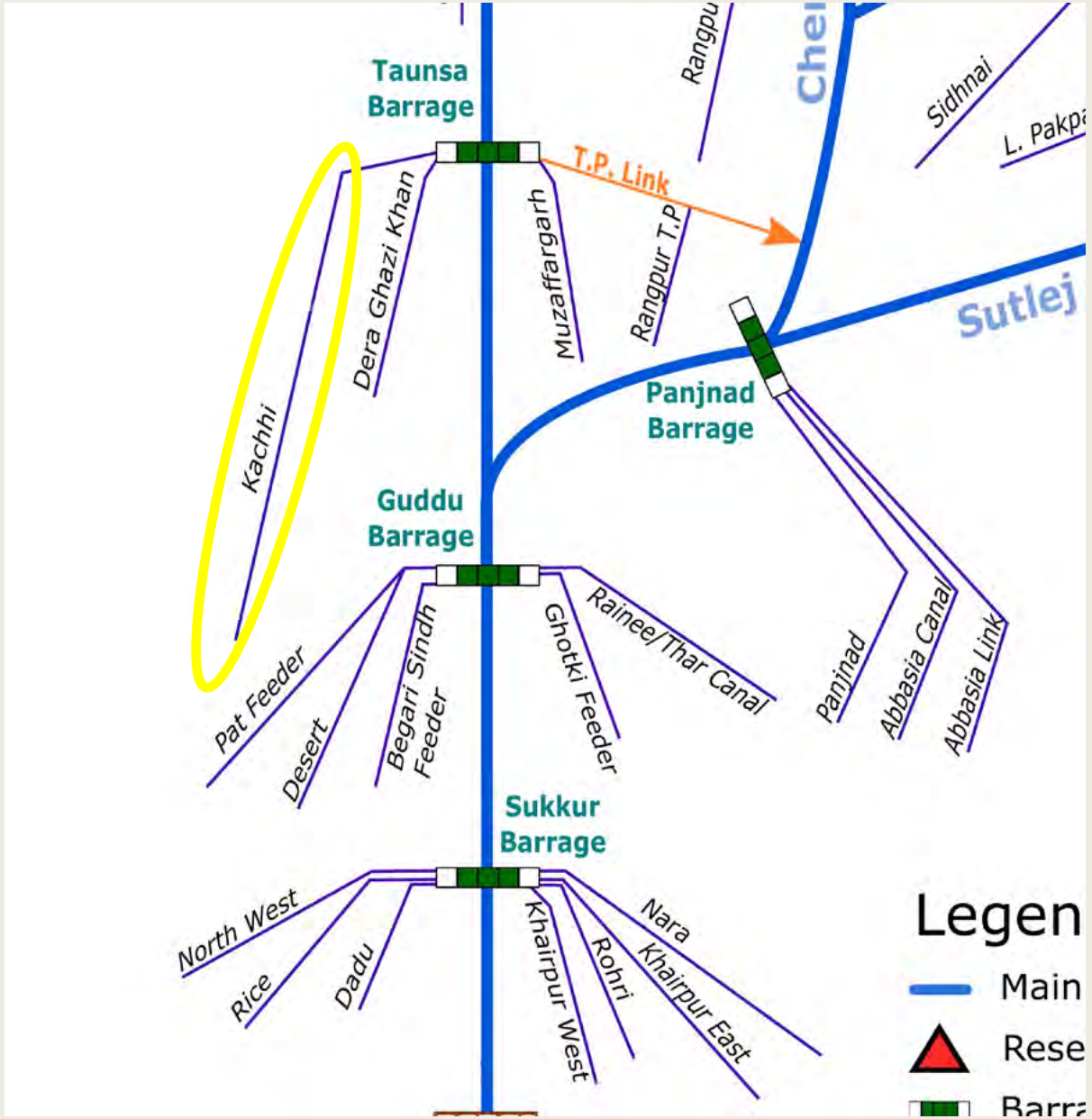


Modified version of Figure 3.7, Pakistan's Memorial – based on diagram of Pakistan's irrigation network in ***Exhibit P-0278***

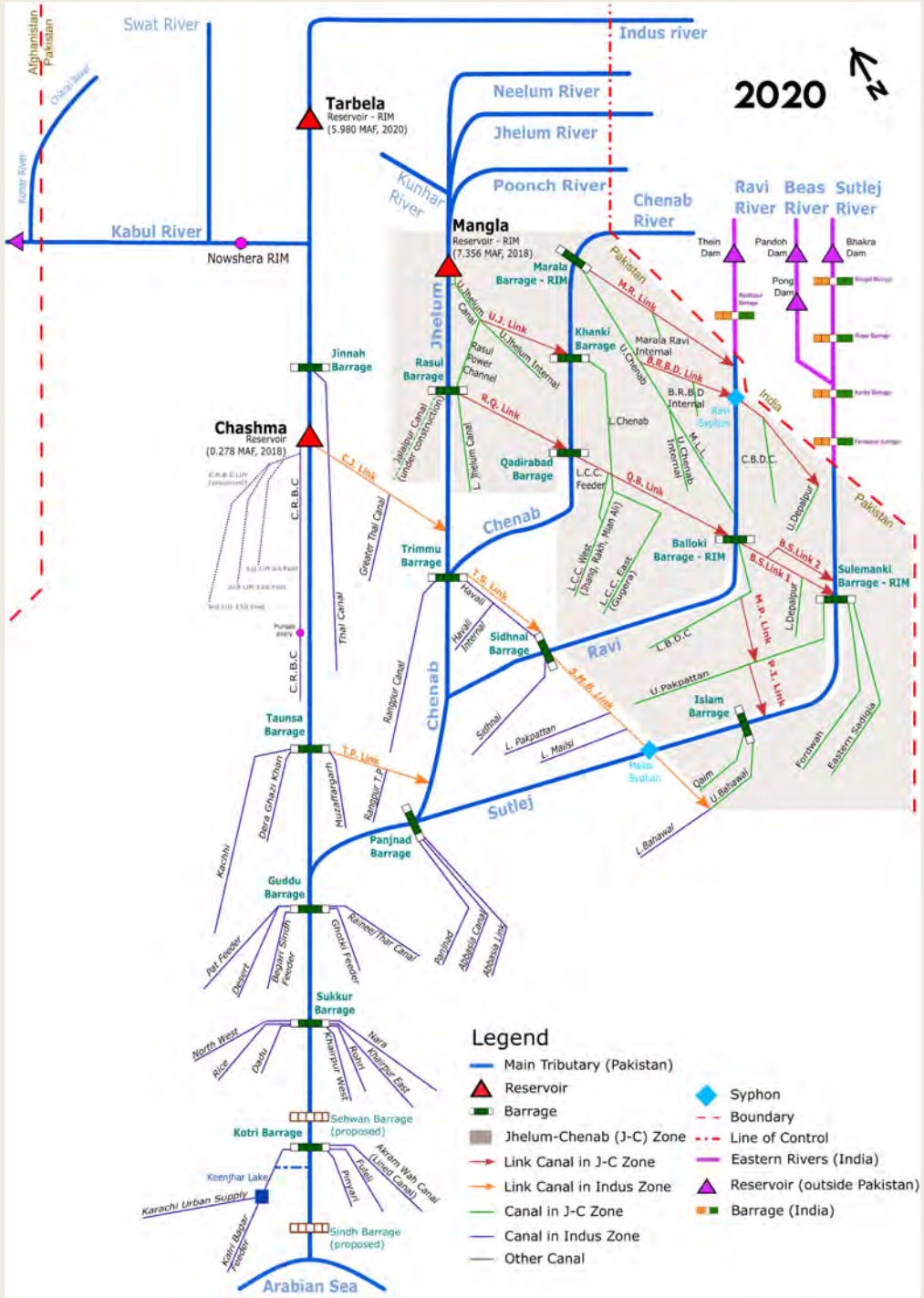
IRRIGATION SYSTEM ON THE WESTERN AND EASTERN RIVERS IN PAKISTAN: 2020



Modified version of Figure 3.7, Pakistan's Memorial – based on diagram of Pakistan's irrigation network in ***Exhibit P-0278***

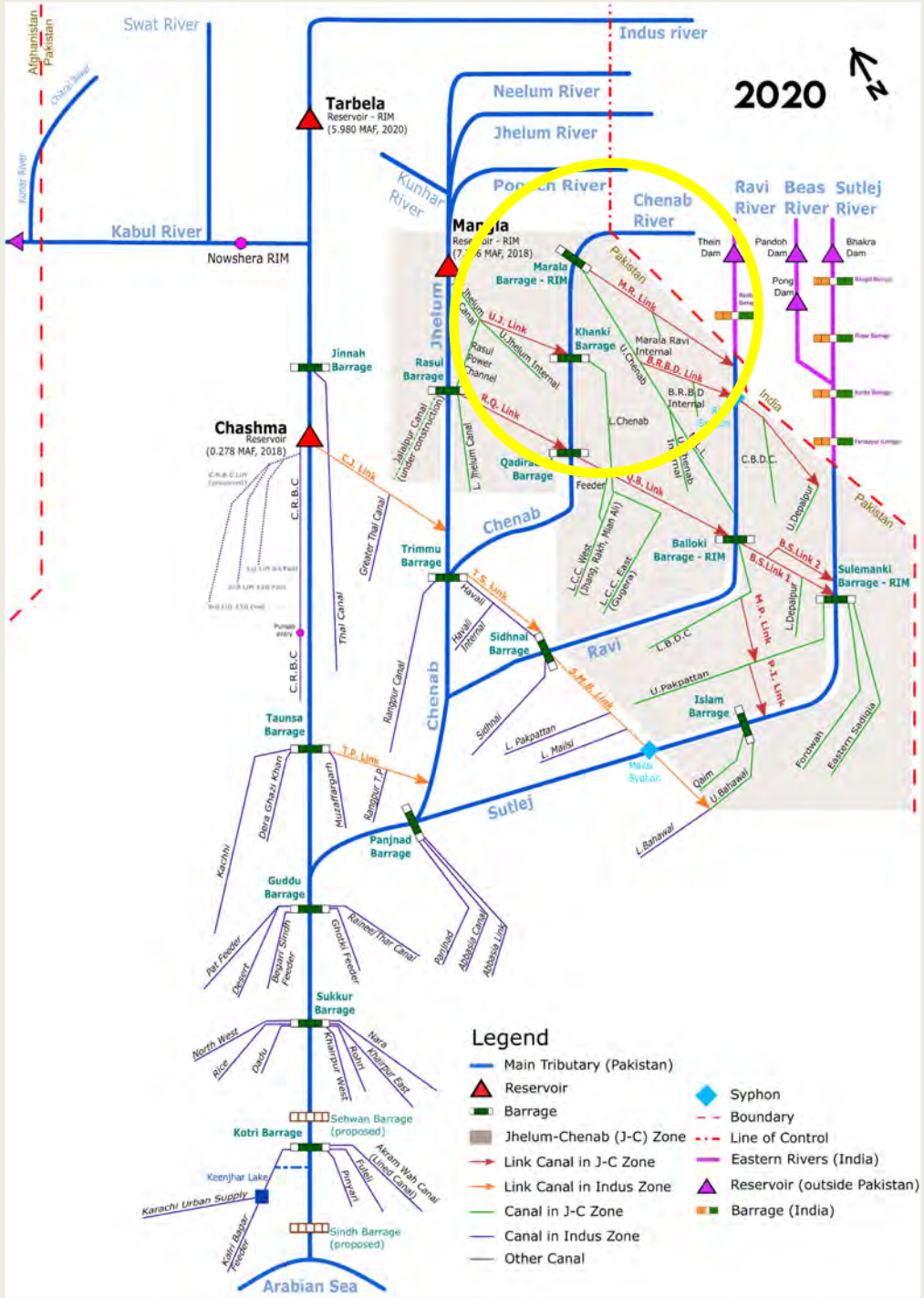

Taunsa Barrage
T.P. Link
Rangpur
Sidhnai
L. Pakpa
Dera Ghazi Khan
Muzaffargarh
Rangpur T.P.
Sutlej
Kachhi
Panjnad Barrage
Guddu Barrage
Pat Feeder
Desert
Begari Sindh Feeder
Ghotki Feeder
Rainee/Thar Canal
Panjnad
Abbasia Canal
Abbasia Link
Sukkur Barrage
North West
Rice
Dadu
Khairpur West
Rohri
Khairpur East
Nara
Legen
Main
Rese
Barra

IRRIGATION SYSTEM ON THE WESTERN AND EASTERN RIVERS IN PAKISTAN: 2020

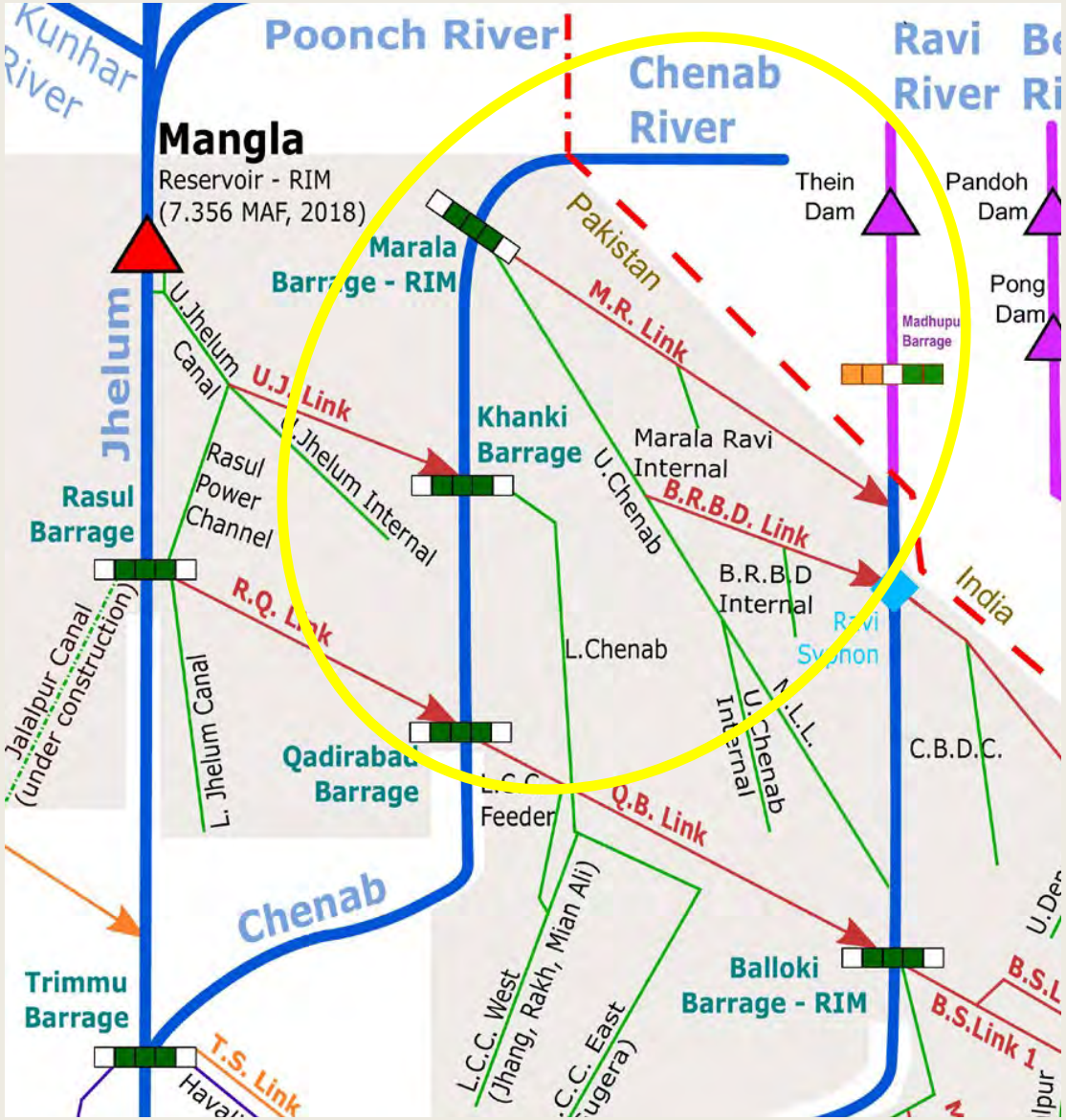


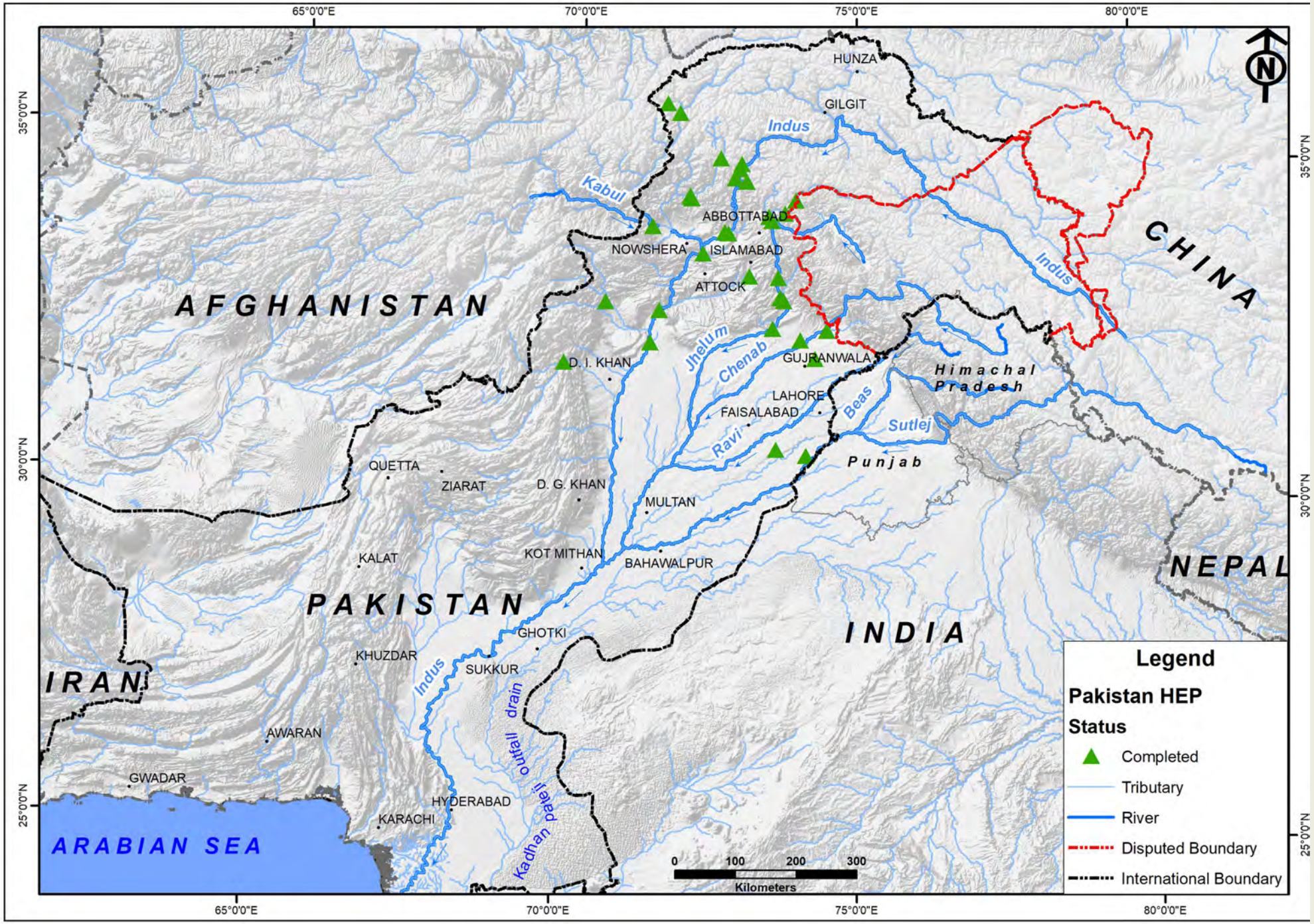
Modified version of Figure 3.7, Pakistan's Memorial – based on diagram of Pakistan's irrigation network in ***Exhibit P-0278***

IRRIGATION SYSTEM ON THE WESTERN AND EASTERN RIVERS IN PAKISTAN: 2020



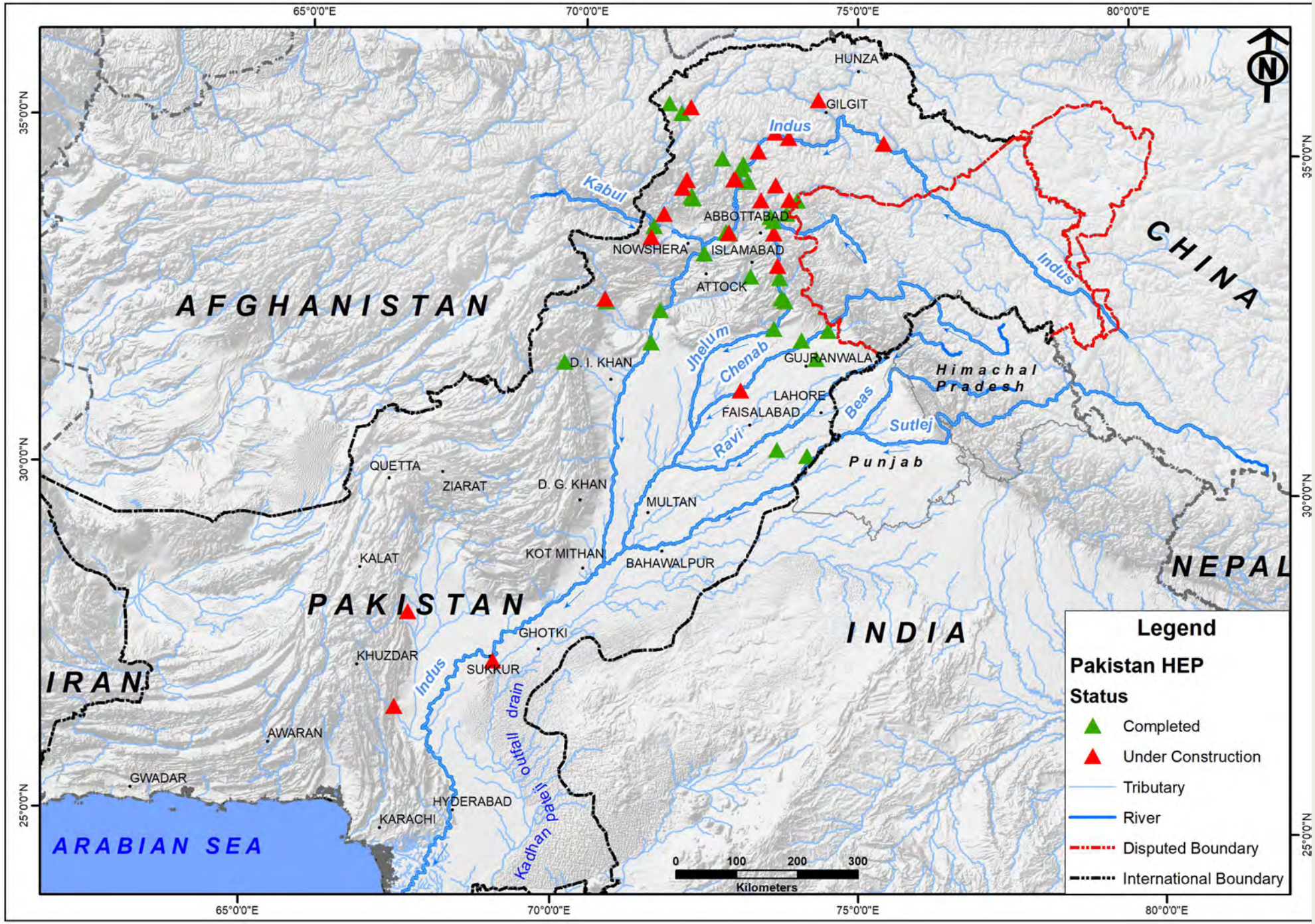
Modified version of Figure 3.7, Pakistan's Memorial – based on diagram of Pakistan's irrigation network in ***Exhibit P-0278***


Kunhar River
Poonch River
Chenab River
Ravi River
Mangla
Reservoir - RIM
(7.356 MAF, 2018)
Jhelum
Marala Barrage - RIM
Thein Dam
Pandoh Dam
Pong Dam
Pakistan
M.R. Link
Madhupur Barrage
U.Jhelum Canal
U.J. Link
U.Jhelum Internal
Khanki Barrage
Marala Ravi Internal
U.Chenab
B.R.B.D. Link
Rasul Barrage
Rasul Power Channel
B.R.B.D Internal
India
R.Q. Link
Jalalpur Canal (under construction)
L. Jhelum Canal
L.Chenab
Ravi Syphon
Qadirabad Barrage
U.Chenab Internal
M.L.L.
C.B.D.C.
Feeder
Q.B. Link
Chenab
Trimmu Barrage
T.S. Link
L.C.C. West (Jhang, Rakh, Mian Ali)
L.C.C. East
Balloki Barrage - RIM
B.S.Link 1



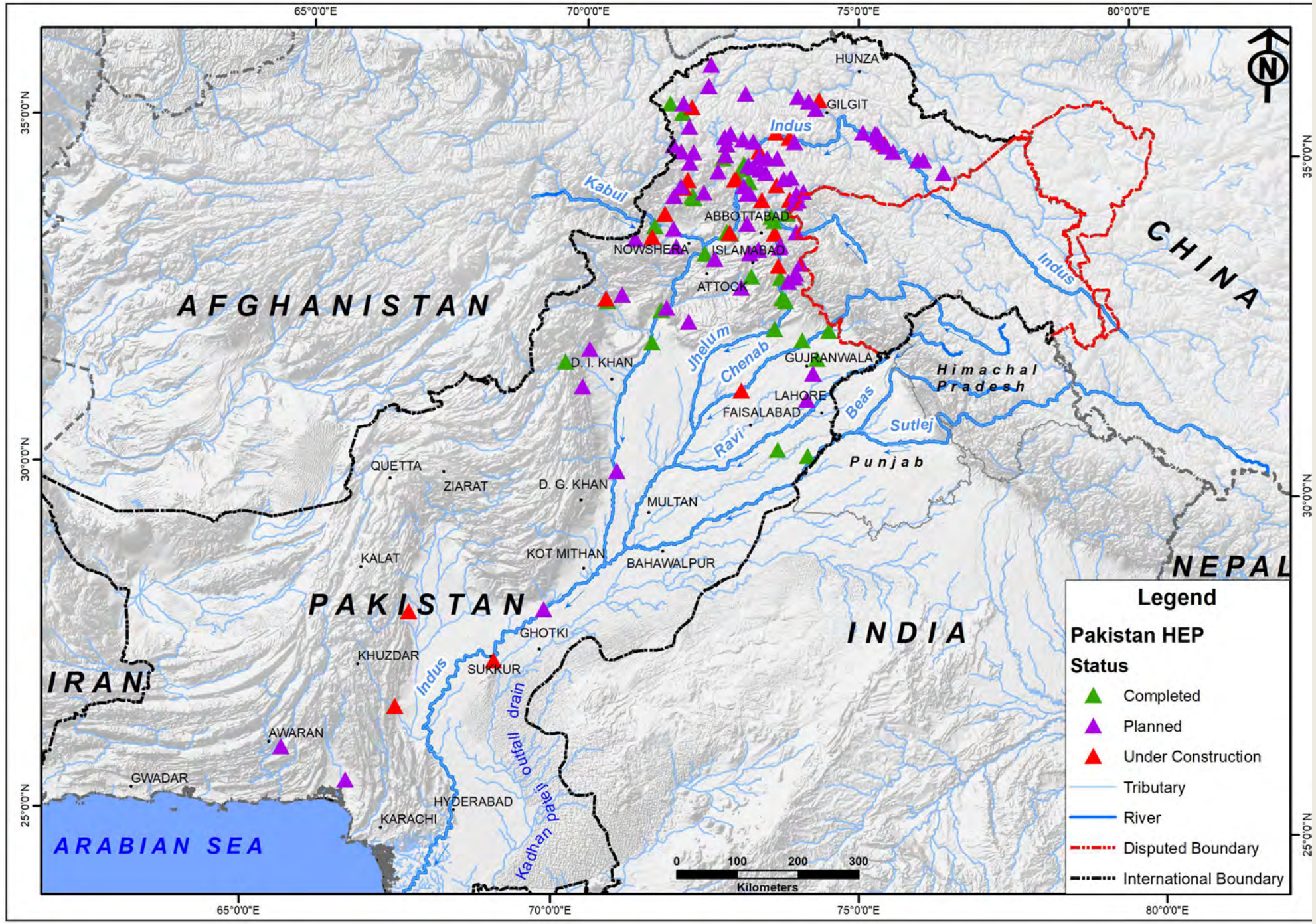
PAKISTAN'S HEPS ON THE WESTERN RIVERS: COMPLETED (GREEN)

Based on Map 3.8, Pakistan's Memorial using information on the location of HEPs in reports and maps prepared by provincial governments in Pakistan and WAPDA



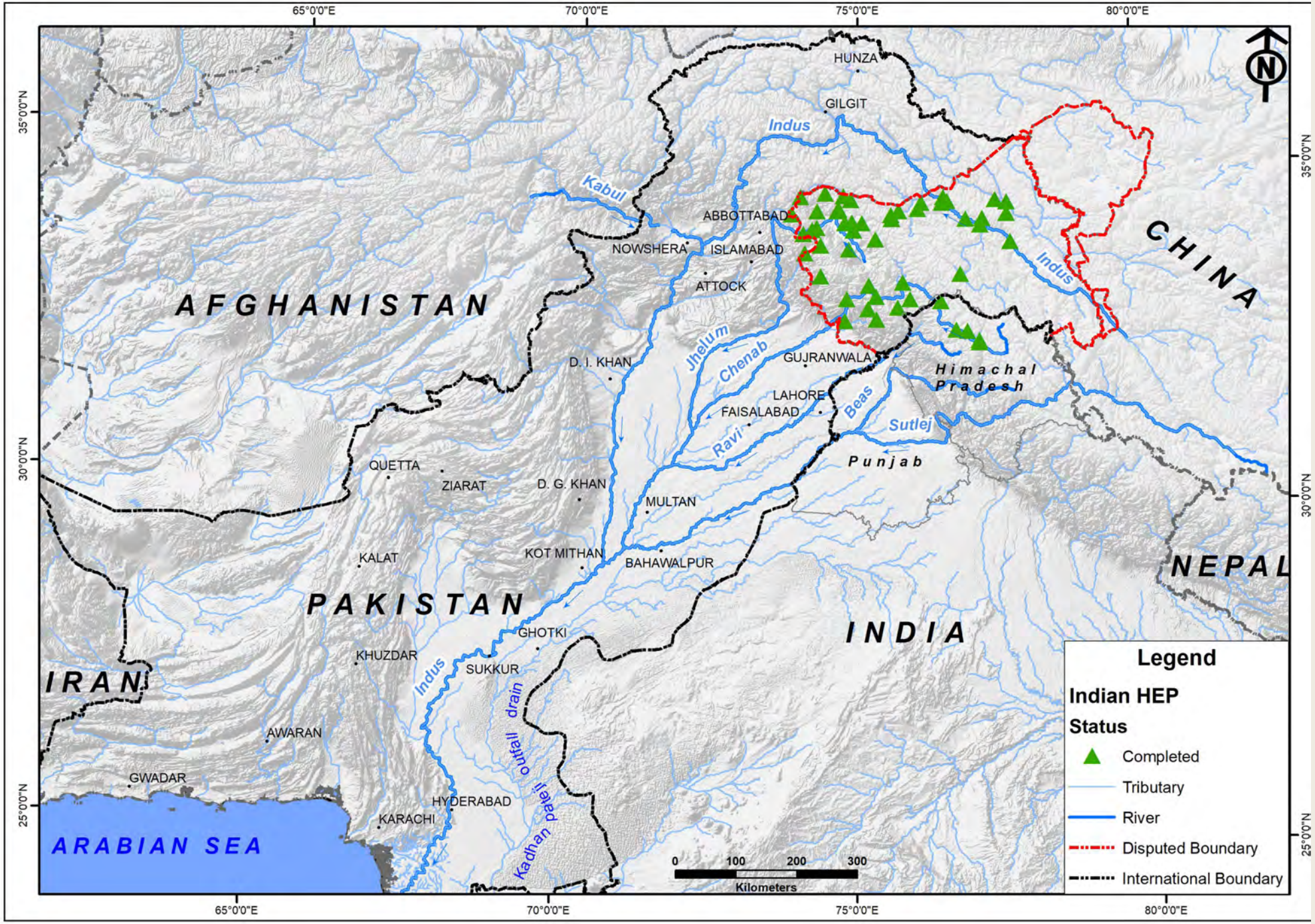
PAKISTAN'S HEPS ON THE WESTERN RIVERS: UNDER CONSTRUCTION (RED)

Based on Map 3.8, Pakistan's Memorial using information on the location of HEPs in reports and maps prepared by provincial governments in Pakistan and WAPDA



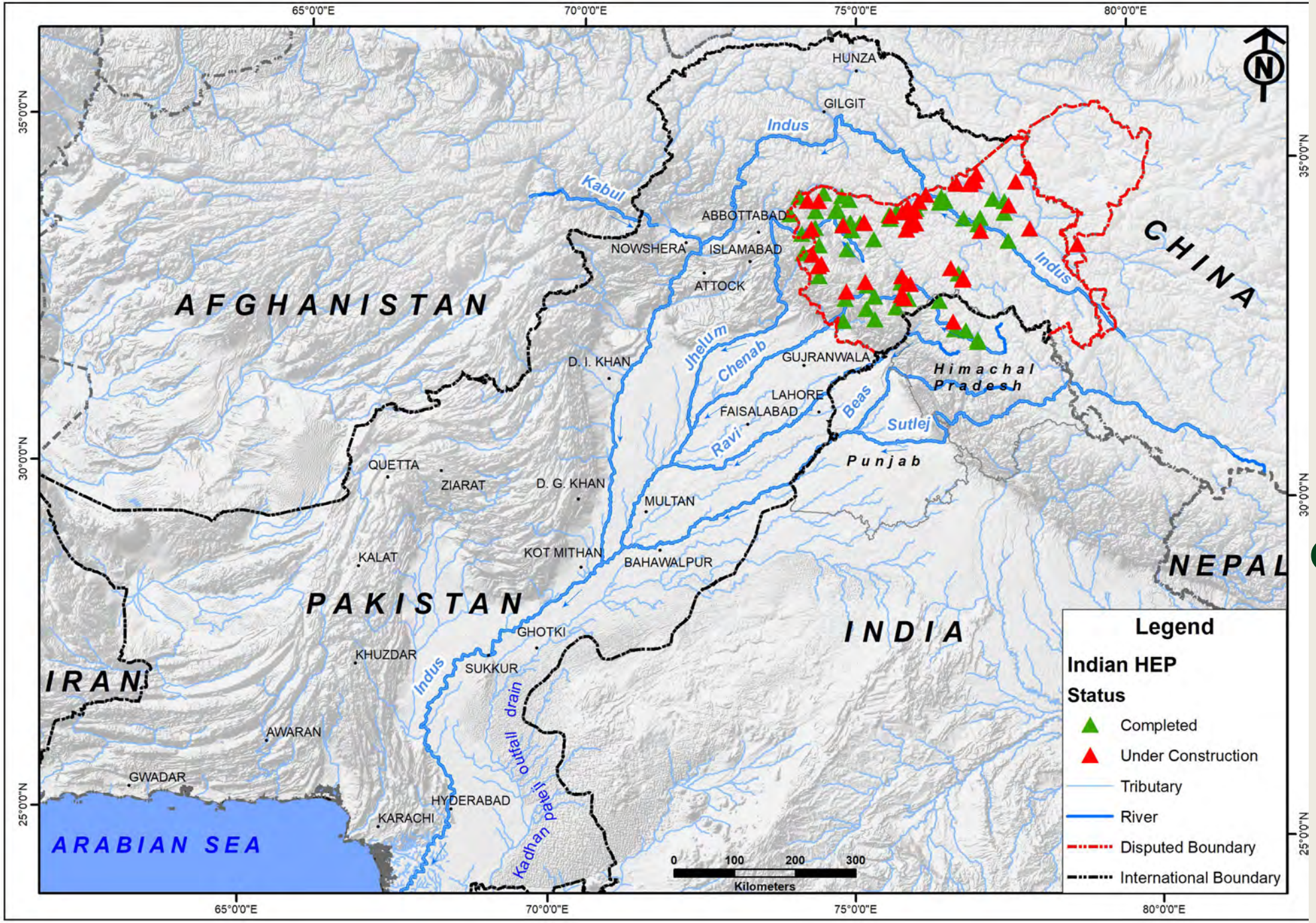
PAKISTAN'S HEPS ON THE WESTERN RIVERS: PLANNED (PURPLE)

Based on Map 3.8, Pakistan's Memorial using information on the location of HEPs in reports and maps prepared by provincial governments in Pakistan and WAPDA



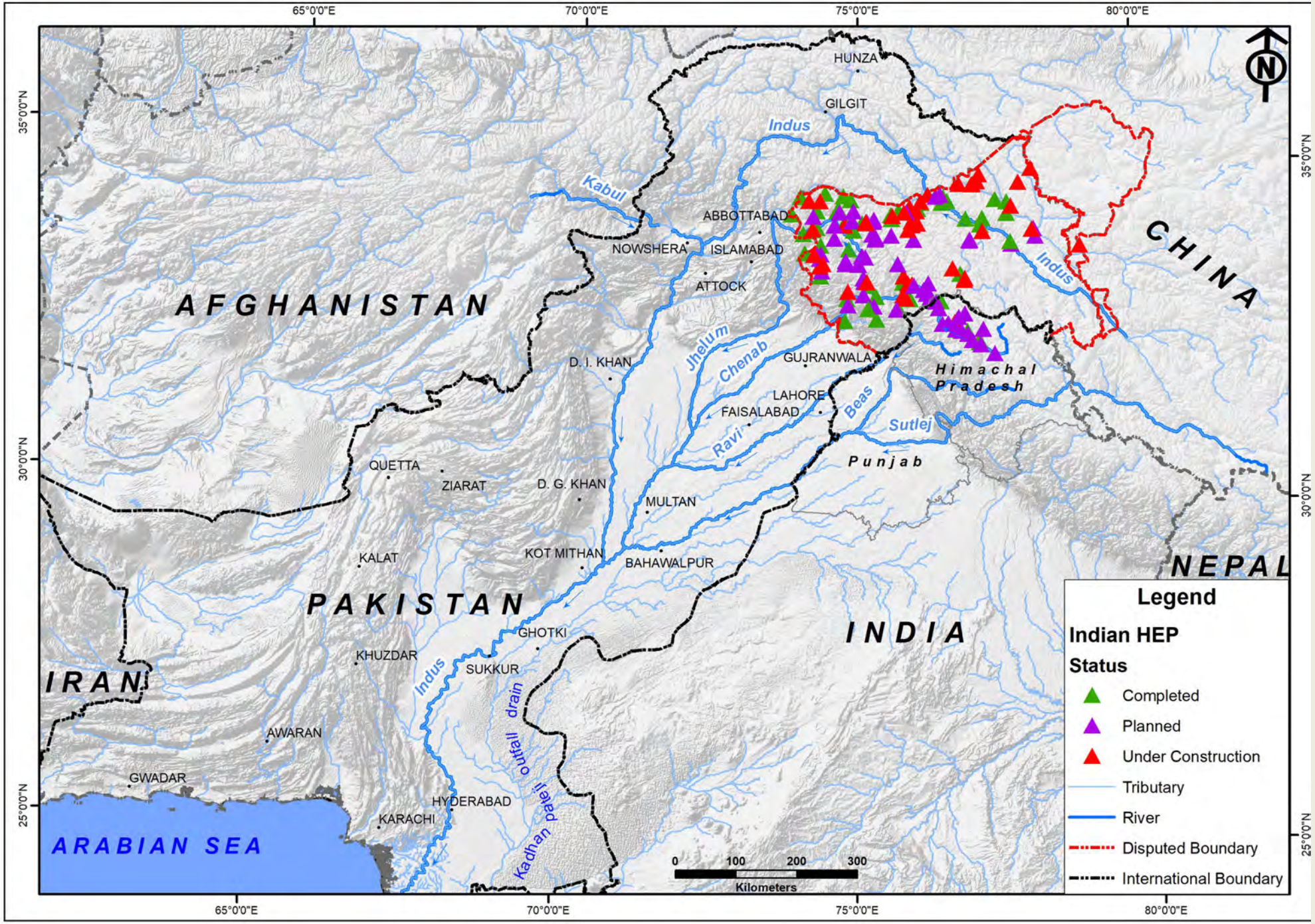
INDIA'S HEPS ON THE WESTERN RIVERS: COMPLETED (GREEN)

*Based on information submitted in **Appendix C1 and** maps submitted in **Appendix C2***



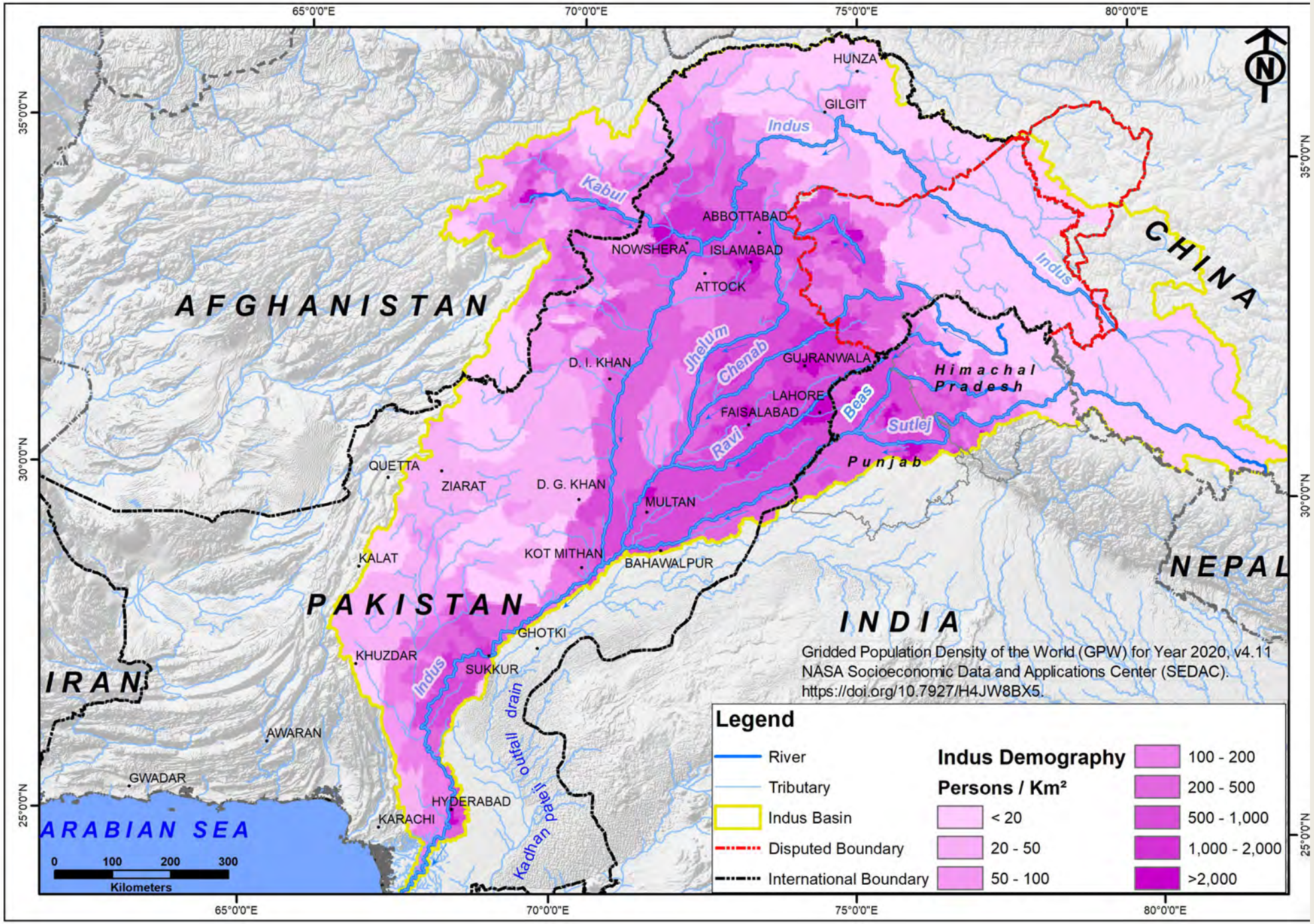
INDIA'S HEPS ON THE WESTERN RIVERS: UNDER CONSTRUCTION (RED)

*Based on information submitted in **Appendix C1 and** maps submitted in **Appendix C2***



INDIA'S HEPS ON THE WESTERN RIVERS: PLANNED (PURPLE)

*Based on information submitted in **Appendix C1 and** maps submitted in **Appendix C2***



PAKISTAN'S POPULATION IS CONCENTRATED AROUND THE INDUS RIVERS, PARTICULARLY IN AREAS PREVIOUSLY SUPPLIED BY THE EASTERN RIVERS

Modified version of Map 3.5, Pakistan's Memorial

PAKISTAN'S POPULATION IS GROWING MORE QUICKLY THAN INDIA'S

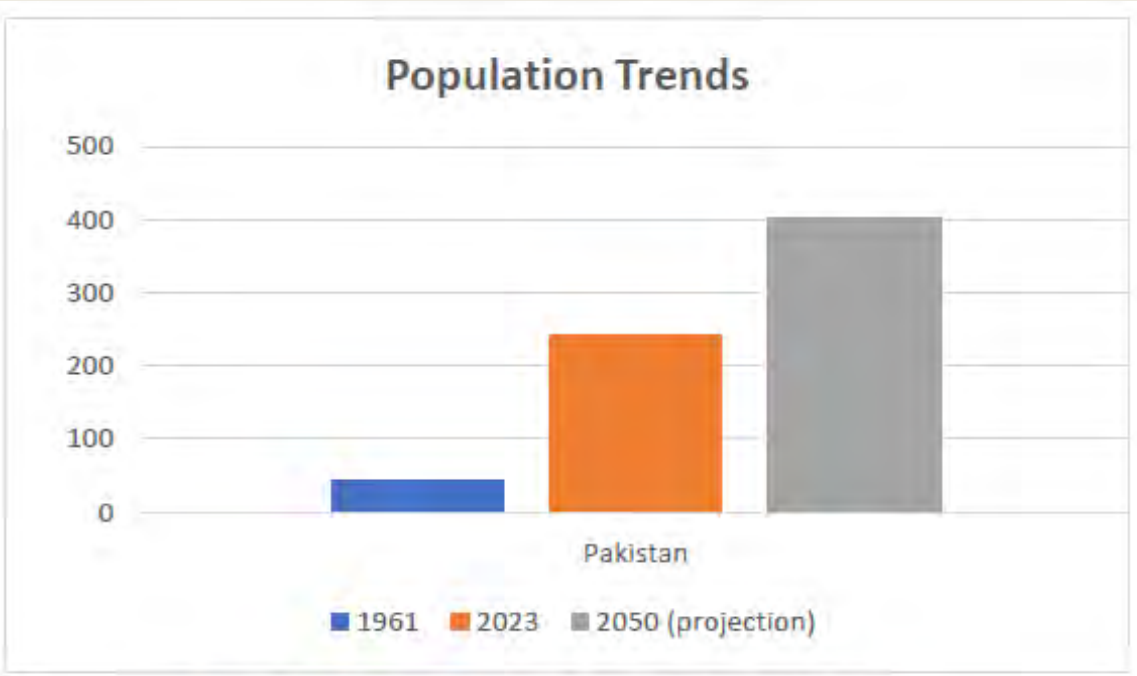


Figure 3.2 - Population growth in Pakistan

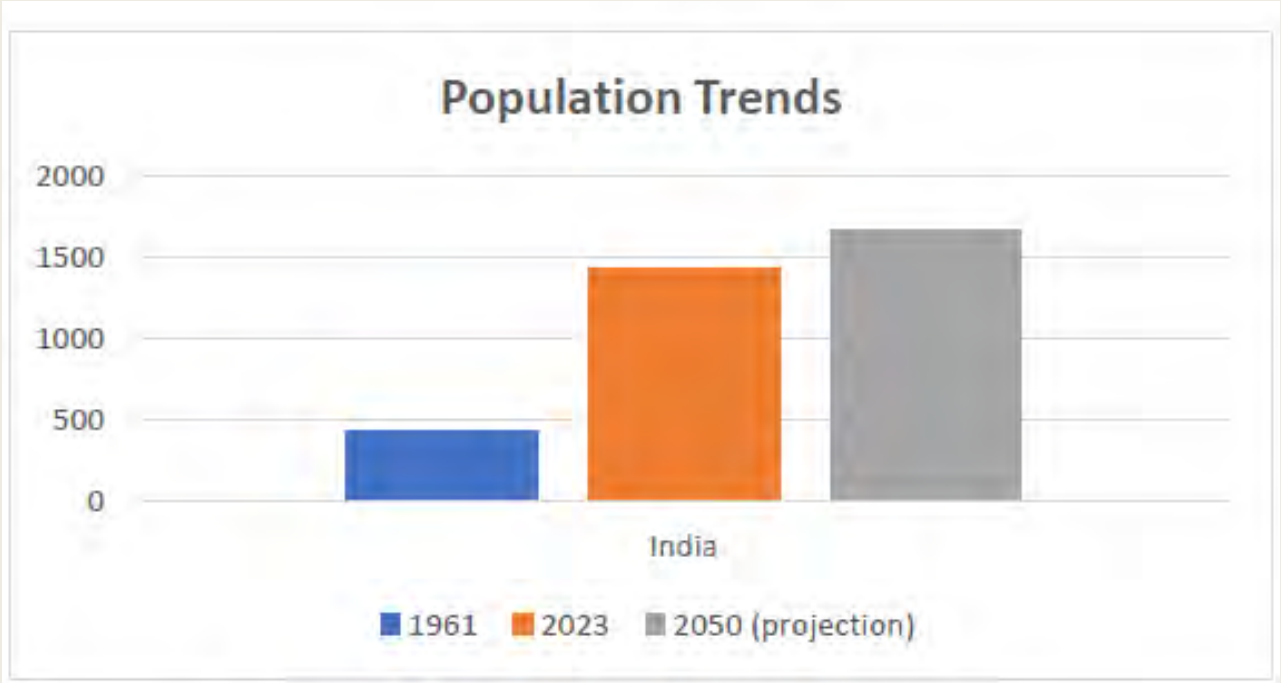


Figure 3.3 - Population growth in India

Figures 3.2 and 3.3, Pakistan's Memorial – based on population information for Pakistan in ***Exhibits P-0257-P-0259*** *and population information for India in* ***Exhibits P-0257*** *and* ***P-0260-P-0261***

THERE HAS BEEN A DECLINE IN FLOWS OF THE WESTERNS RIVER INTO PAKISTAN SINCE THE TREATY

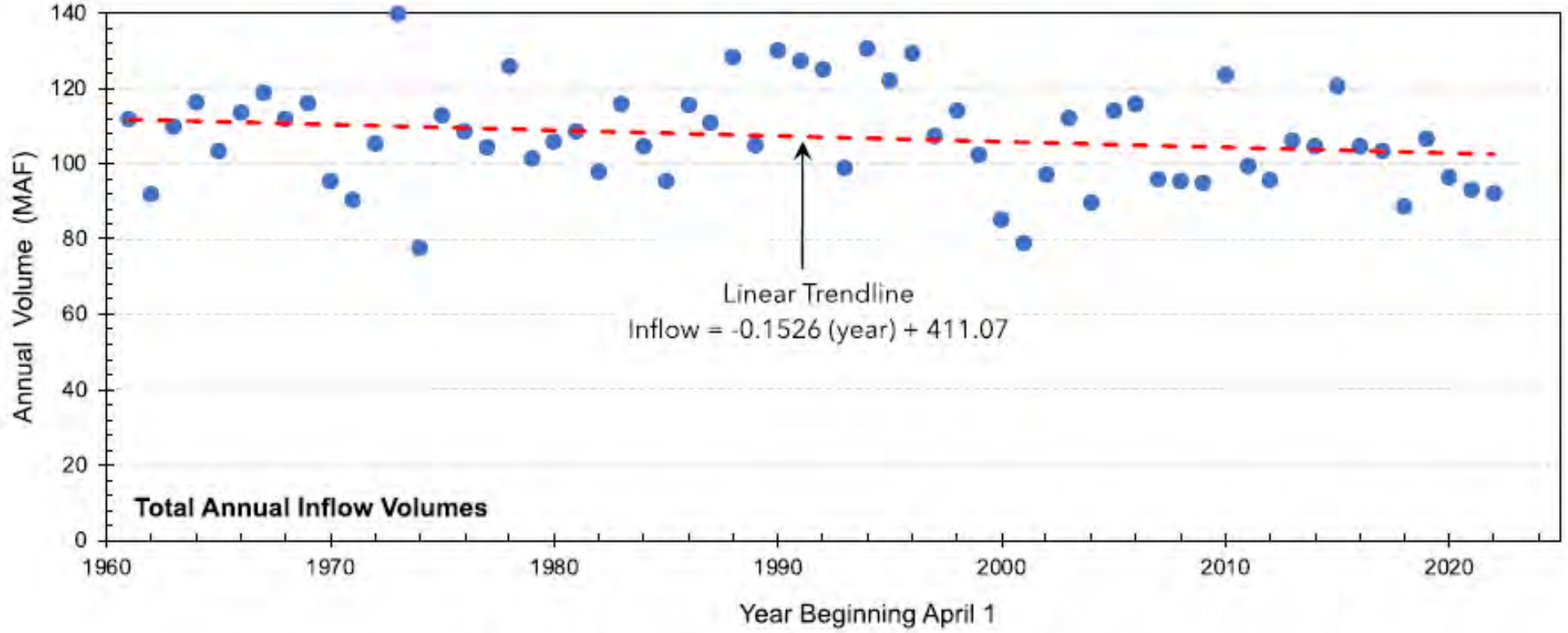


Figure 3.5 - Annual inflow volumes of the Western Rivers from 1961-2022[258]

*Pakistan's Memorial, Figure 3.5 – Graph prepared by Dr Gregory Morris, based on 10-day flow data for the Western Rivers from 1961-2023 (**Exhibit P-0402**)*

THE INDUS BASIN IS PARTICULARLY VULNERABLE TO CLIMATE CHANGE BUT THE PRECISE EXTENT AND TIMING OF ITS IMPACTS ARE UNCERTAIN

"The majority of the flow comes from glaciers, so the Indus basin is particularly vulnerable in terms of climate change that causes higher warming trends and loss of glacial mass. Global warming will initially increase the water flow, causing flash floods and glacial lake outburst floods, but will be followed by a reduction in the water flow. However, the future response of the glaciers in the Indus Basin to the runoff is not very clear. [...] Any changes in precipitation and temperature in the basin are important parameters and must be taken into consideration. [...] Although several studies have been carried out to project future temperature and precipitation, a comprehensive assessment of the current state of climatic components is largely missing."

A. B. Shrestha and others, "A Review on the Projected Changes in Climate Over the Indus Basin", ***Exhibit P-0295***, *p. 147*

EXPERTS PREDICT GLACIER LOSS OF BETWEEN 30% AND 80% IN THE HINDU KUSH AND HIMALAYAS BY 2100

TEMPERATURE RISE (GLOBAL WARMING LEVEL)	GLACIER LOSS (PERCENTAGE)
1.5 - 2°C	30 - 50%
3°C	55 - 75%
4°C	70 - 80%

Projections of glacier loss by 2100 compared to 2015

M. Jackson and others, "Consequences of climate change for the cryosphere in the Hindu Kush Himalaya", ICIMOD, ***Exhibit P-0296****, pp. 39-40*


ایمان اتحاد نظم