CASE STUDY: GULPUR HYDROPOWER PROJECT, PAKISTAN

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GULPUR HPP (PAKISTAN)

102 MW greenfield run-of-the-river HP project in the Kolti District, Eastern Pakistan / Azad Jammu and Kashmir (AJK) region.

Main construction to begun on late 2015

Components:

- **dam 66 m high.**
- **@ 1000 meter diversion tunnels.**
- **power house and a switch yard.**
- **700 meters dewatered stretch.**
- **True run-of-river, no peak generation**
- **No new access roads.**
- **Existing transmission line.**

IFC's proposed US$ 50 million A-Loan (15% total project cost of US$332 million) and mobilization of up to US$93 million.

Co-financed with ADB, CDC, MIGA and others

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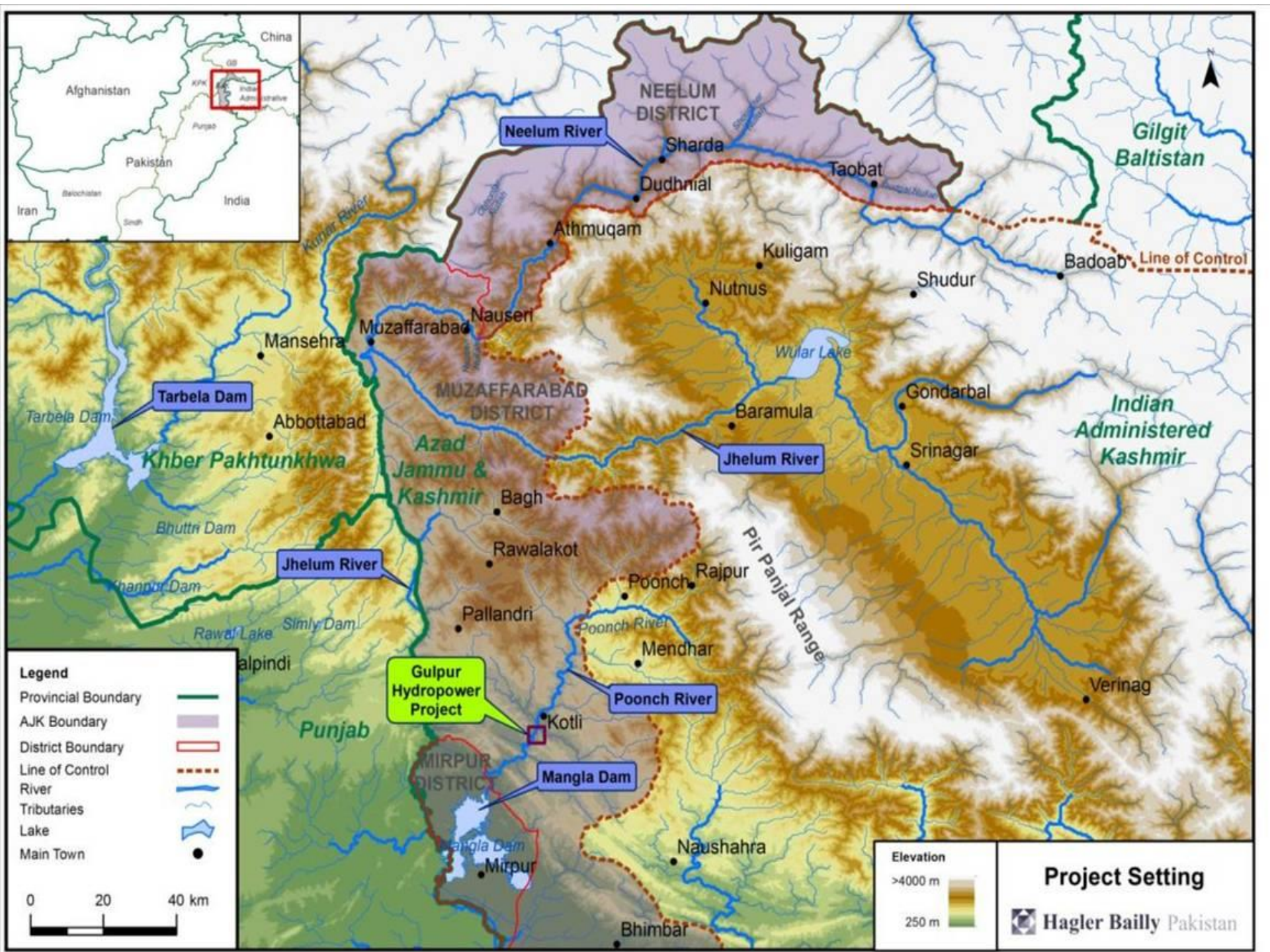

China
Afghanistan
Pakistan
India
Iran
Balochistan
Punjab
Sindh
KPK
GB
Indian Administrative
NEELUM DISTRICT
Neelum River
Sharda
Dudhnial
Taobat
Athmuqam
Kuligam
Nutnus
Shudur
Badoab
Line of Control
Gilgit Baltistan
Kunhar River
Nauseri
Muzaffarabad
Mansehra
MUZAFFARABAD DISTRICT
Wular Lake
Gondarbal
Baramula
Srinagar
Indian Administered Kashmir
Tarbela Dam
Abbottabad
Khber Pakhtunkhwa
Azad Jammu & Kashmir
Jhelum River
Bagh
Bhuttri Dam
Rawalakot
Pir Panjal Range
Poonch
Rajpur
Pallandri
Simly Dam
Rawal Lake
Poonch River
Mendhar
Verinag
Gulpur Hydropower Project
Kotli
Punjab
MIRPUR DISTRICT
Mangla Dam
Naushahra
Mirpur
Bhimbar
Legend
Provincial Boundary
AJK Boundary
District Boundary
Line of Control
River
Tributaries
Lake
Main Town
0
20
40 km
Elevation
>4000 m
250 m
Project Setting
Hagler Bailly Pakistan

Critical Habitat – Mahaseer National Park

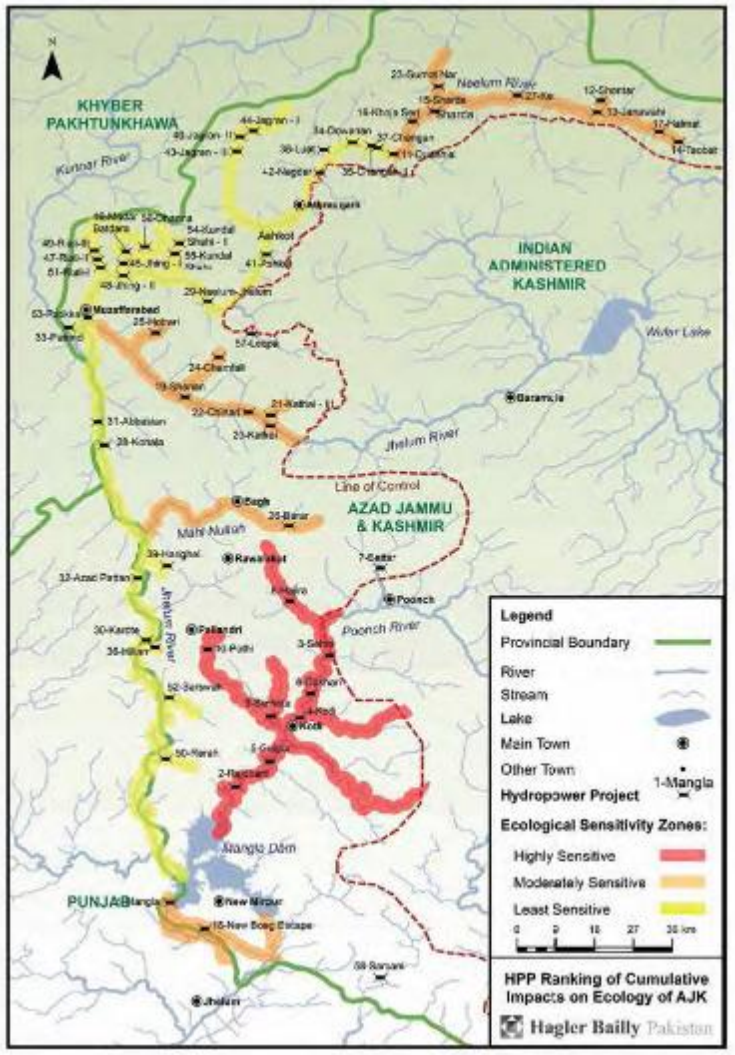
2014 IUCN Strategic Environmental Assessment concluded that Poonch River is Ecologically "Highly Sensitive"

IFC determined that the Gulpur HPP Is located in Critical Habitat (per PS6) based on:

- **Regionally important population of Endangered migratory fish, Golden Mahaseer (*Tor putitora*)**
- **Critically Endangered Kashmir Catfish (Glyptothorax kasmirensis)**

Gulpur HPP is located within the Poonch River Mahaseer National Park

Golden Mahaseer



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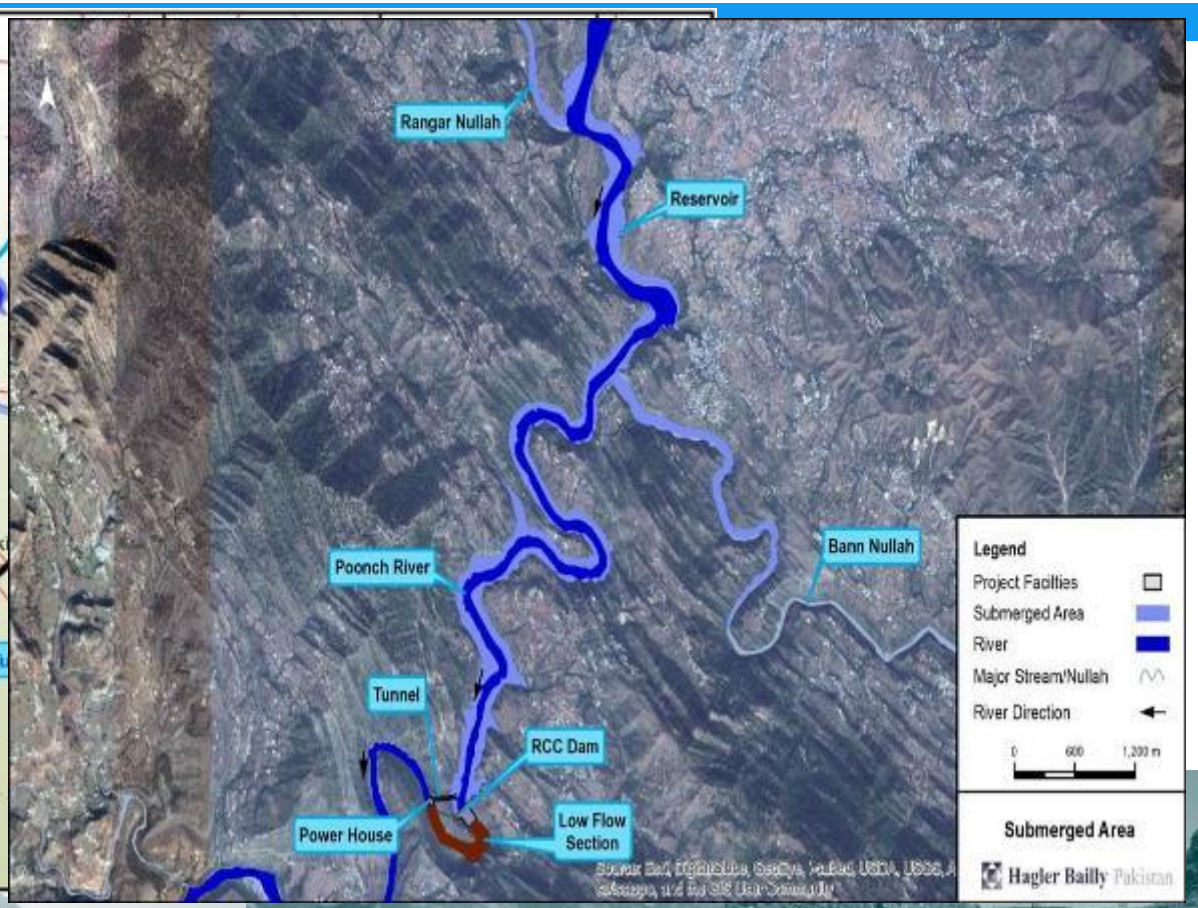
PROJECT APPROACH: ALTERNATIVE ANALYSIS



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Powerhou
se
Diversion
Tunnels
Intake
Cofferdam
Weir and
Spillway
Stilling
Basin
Capacity: 102 MW RoR
DAELIM


WEIR
DAM

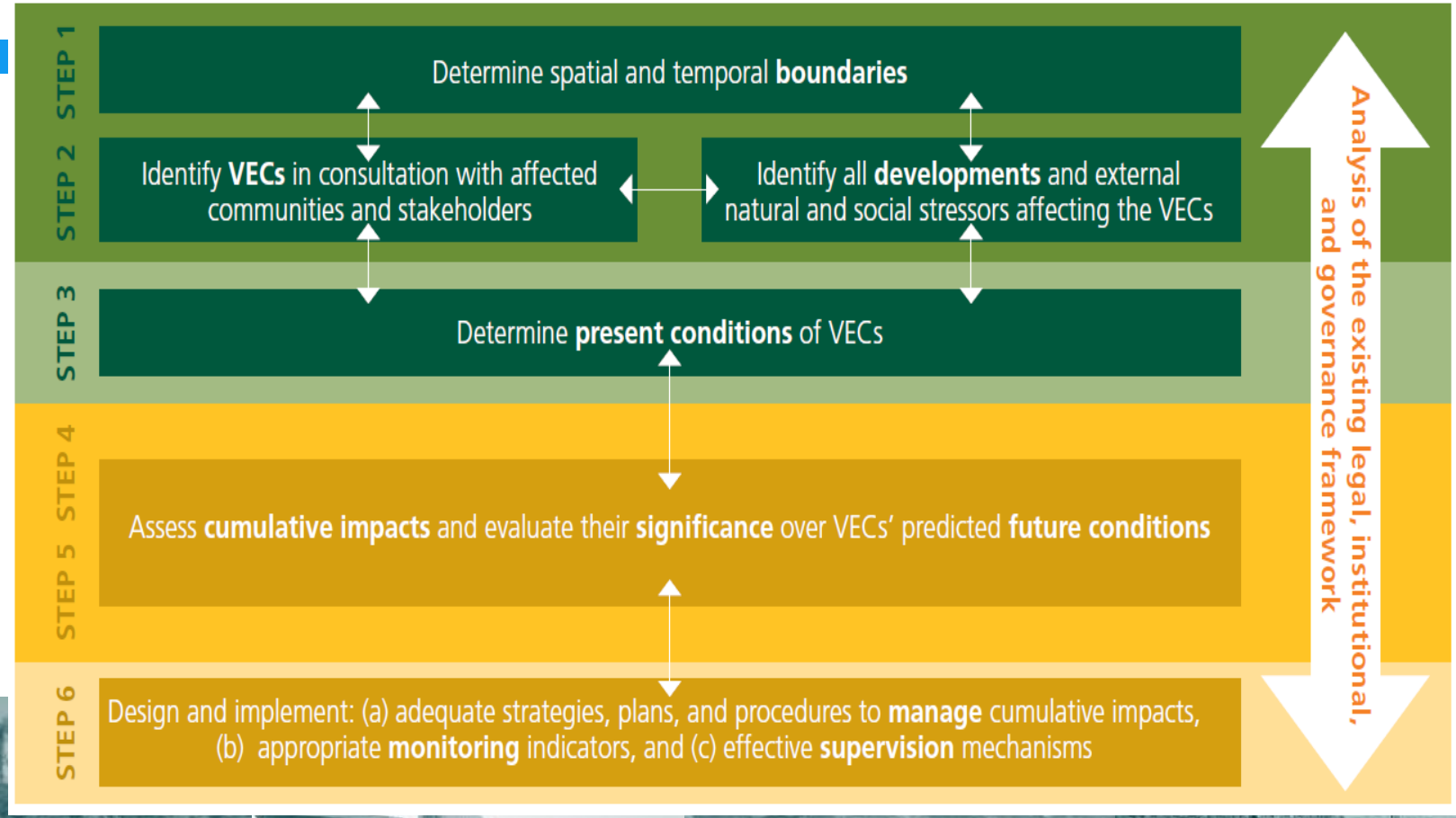

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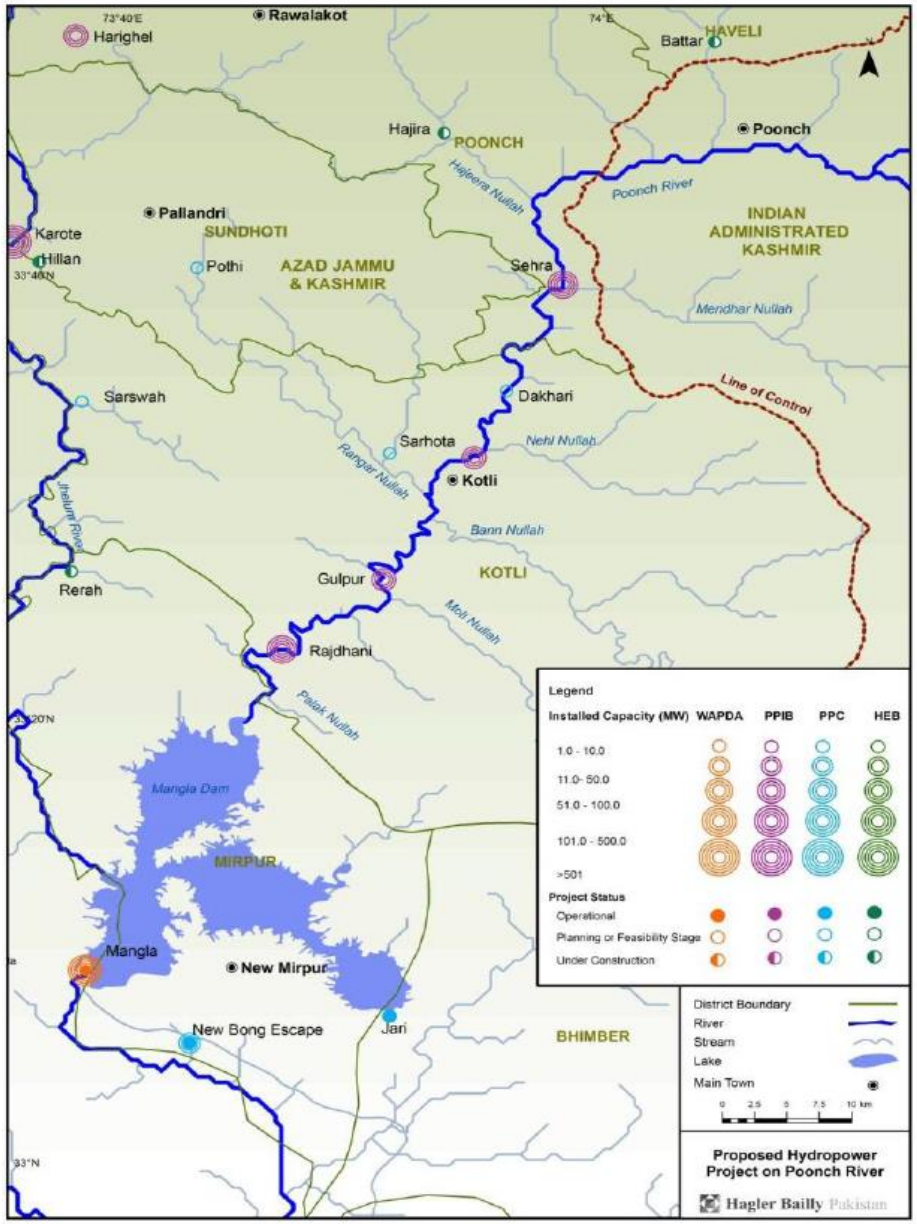
Exhibit 2.4: Proposed Hydropower Projects on Poonch River



- **Total of 62 HPPs in the AJK**
- **Four in the Poonch River**

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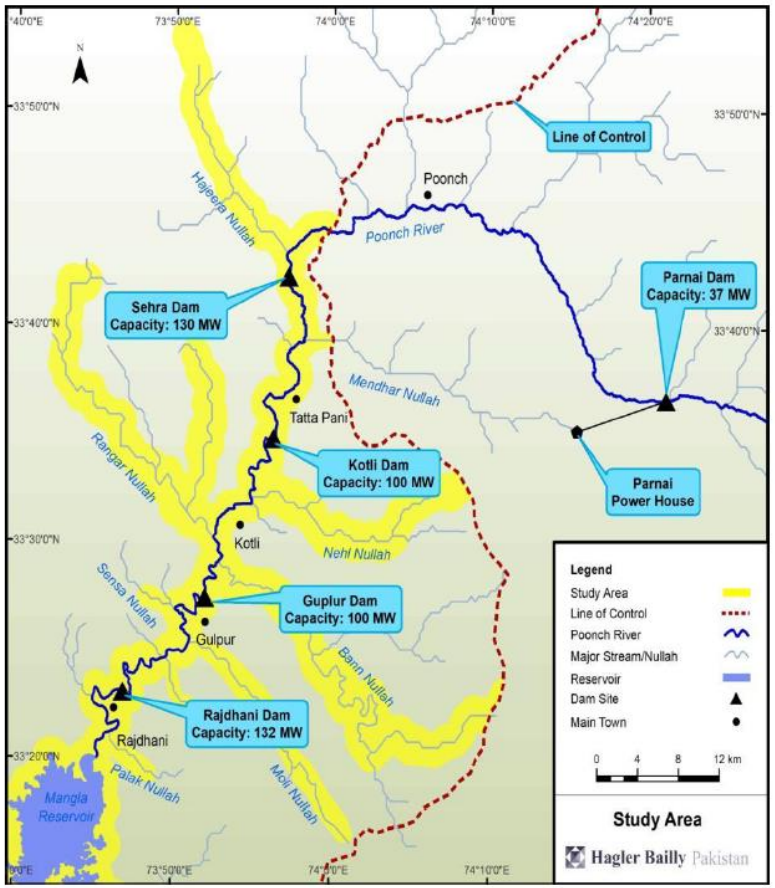
STUDY AREA – SPATIAL BOUNDARIES

Exhibit 3.5: Study Area



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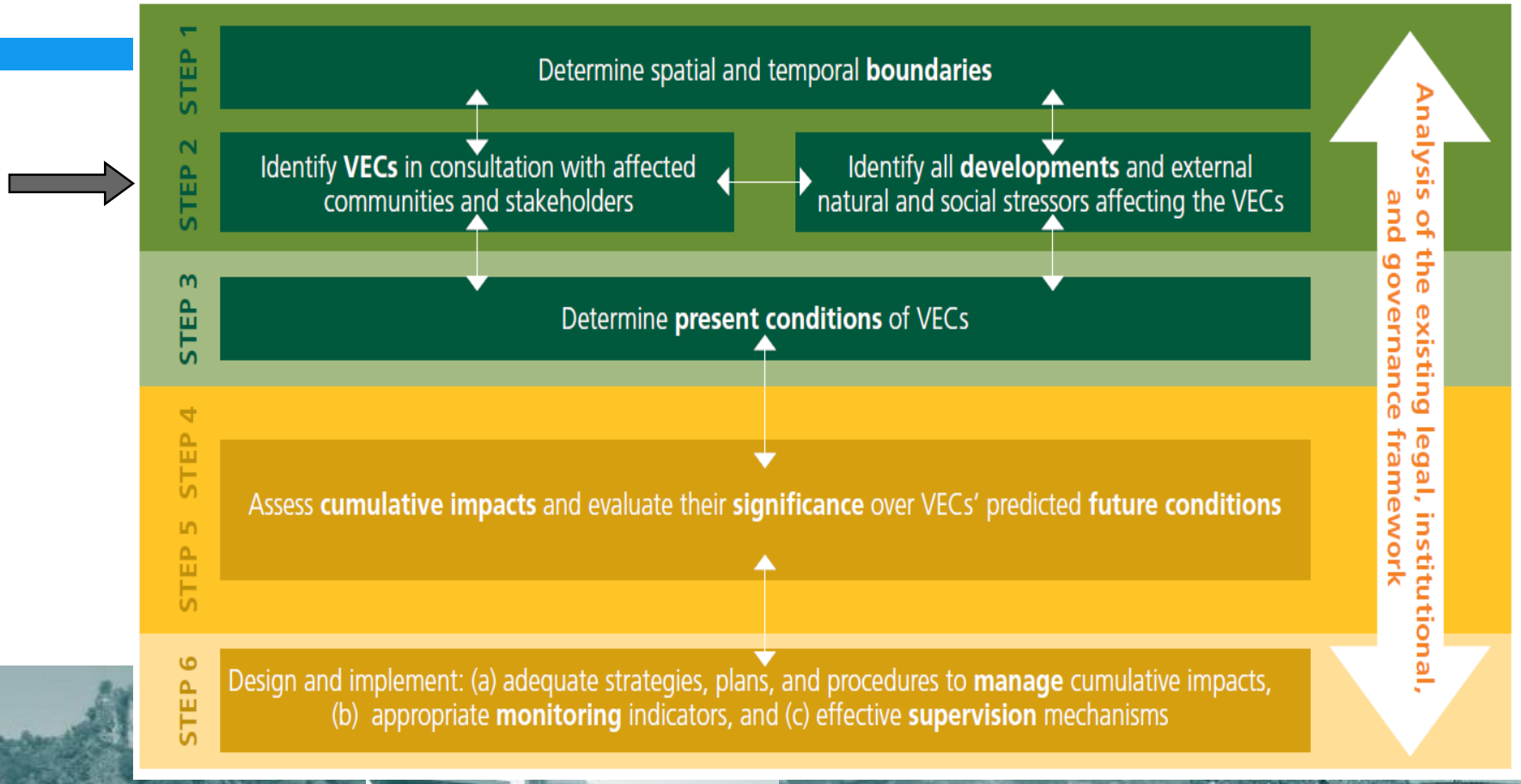

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THE VECS

- Fish Fauna
- Sediment Load of the River
- Surface Water Quantity – Flow
- Landscape

Community Consultation with Men

Consultation with NGOs and Scientists

Community Consultation with Women

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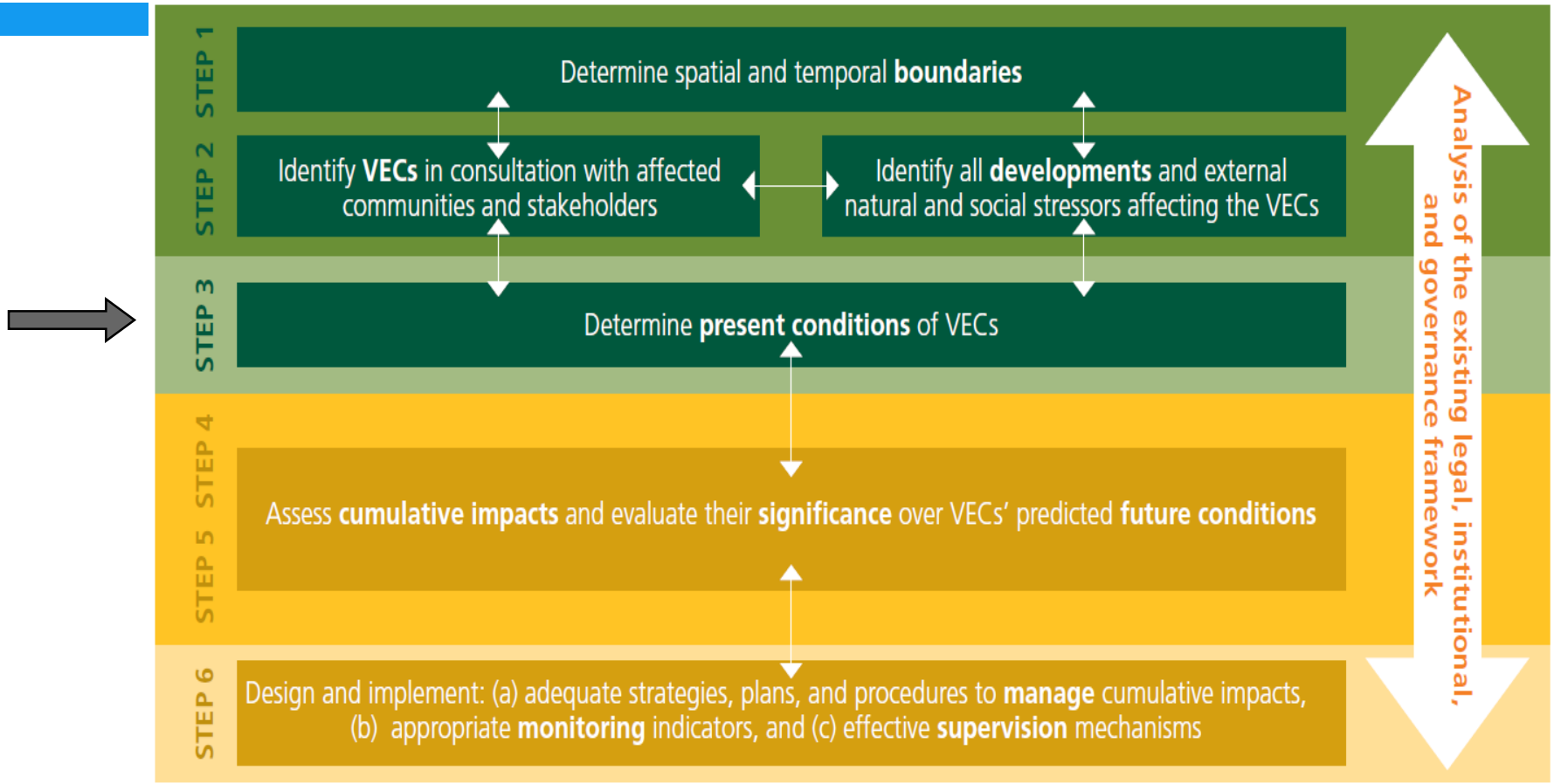

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AQUATIC STUDY

Extensive additional Baseline Data Collected Oct 2013 and April 2014

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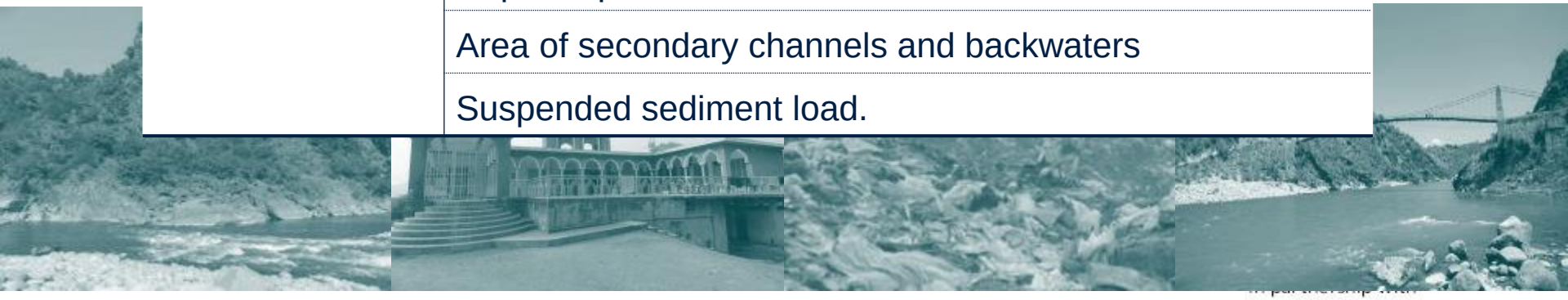
HYDRAULIC AND GEOMORPHOLOGY INDICATORS

Hydraulics	Minimum 5-day dry season fish breeding habitat
	Depth
	Minimum 5-day average velocity (across the cross-section)
Geomorphology	Active channel width
	Area of silt/mixed bars (regardless of level of inundation)
	Area of cobble bars (regardless of level of inundation)
	Median bed sediment size (armouring)
	Depth of pools
	Area of secondary channels and backwaters
	Suspended sediment load.



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HYDROLOGY INDICATORS

- Mean annual runoff
- Dry season onset
- Dry season minimum 5-day discharge
- Dry season duration
- Dry season average daily volume
- Wet season onset
- Wet season maximum 5-day discharge
- Wet season duration
- Wet season flood volume
- Wet season minimum instantaneous discharge
- Transition 1 maximum instantaneous discharge
- Transition 2 average daily volume




FISH AND WILDLIFE INDICATORS

Fish	Pakistani labeo
	Mahaseer
	Twin-banded loach
	Kashmir catfish
	Garua bachwaa
	Snow trout
Wildlife	Fish-eating wildlife (Otter, common leopard)
	Wildlife that drink from the main river (Barking deer)
	Riverine insectivores (White-capped redstart)




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FISH BASELINE – INDICATOR SPECIES

Tor putitora

Labeo dyocheilus

Schizothorax plagiostomus

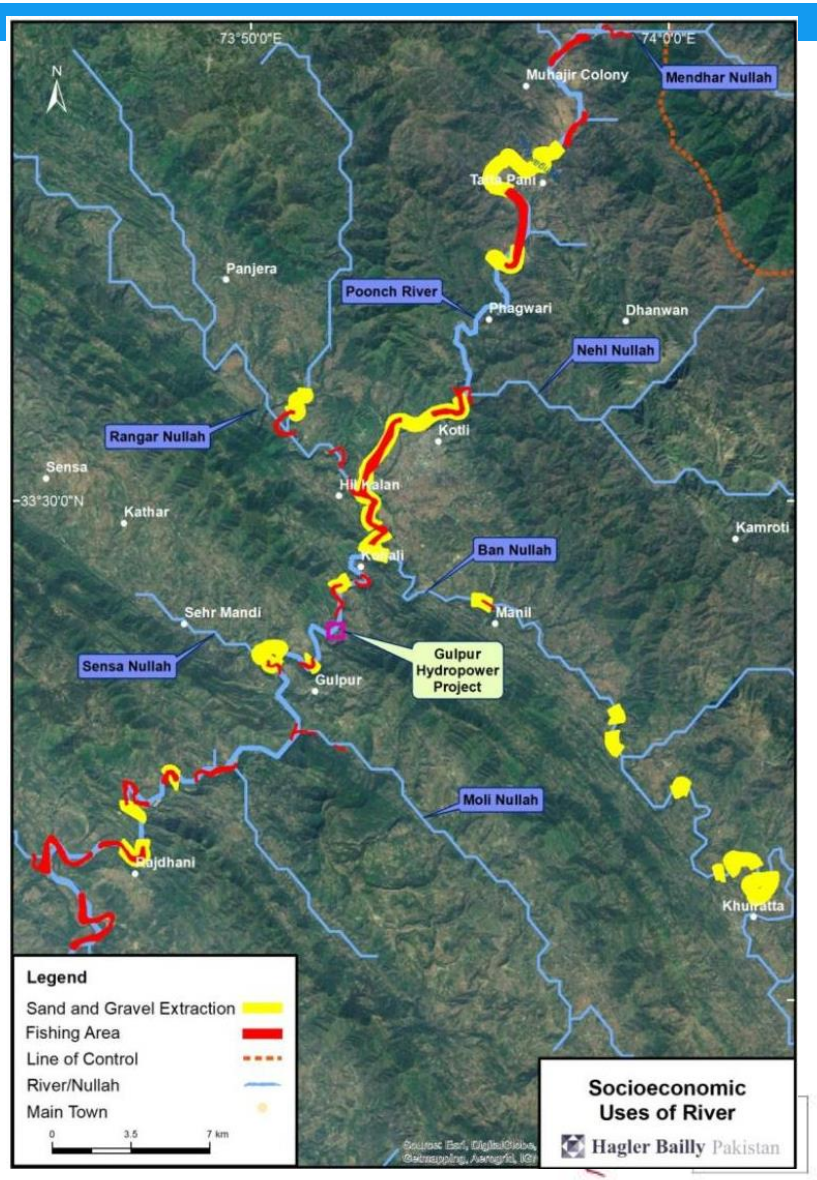
Botia rostrata

Clupisoma garua

Glyptothorax kashmirensis

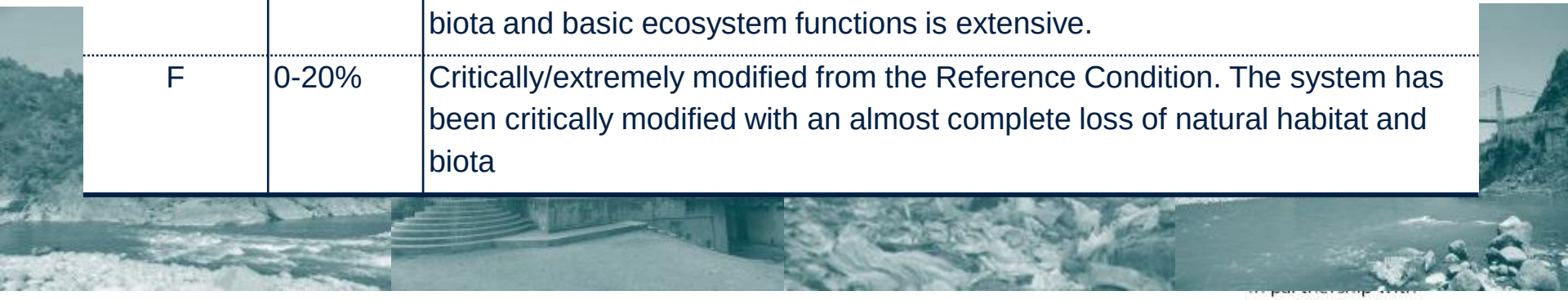
MAPPED THE SOCIOECONOMIC USES OF WATER AND PRESSURES OVER THE AQUATIC AND RIPARIAN ECOSYSTEM

- **Selective Fishing Pressure**
- **Non-selective Fishing Pressure**
- **Mining – Sand and Gravel**
- **Mining – Cobble and Boulder**
- **Water Quality**



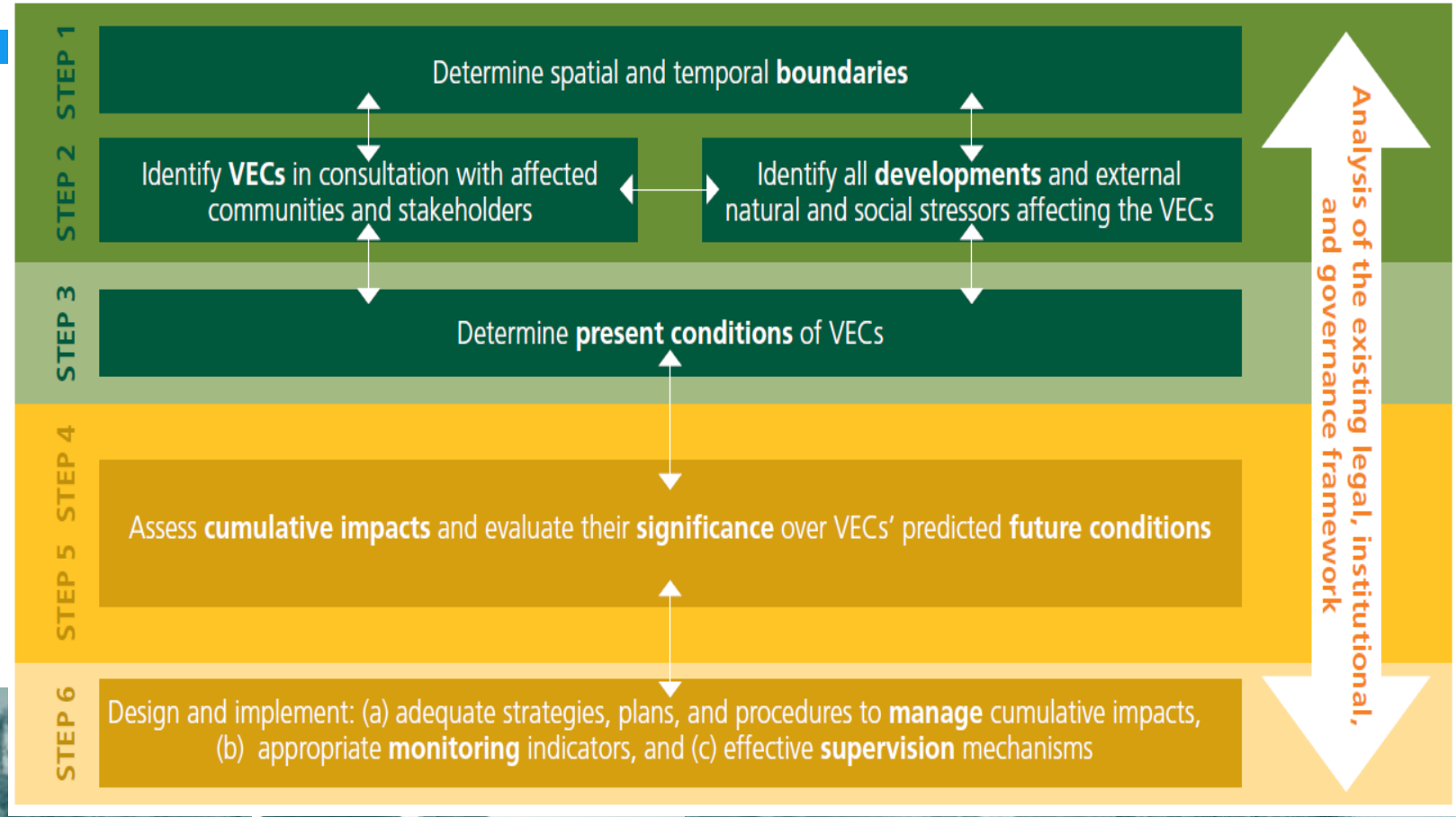
DEFINITION OF PRESENT ECOLOGICAL STATE

Ecological Category	*PES % Score*	*Description of the Habitat*
A	90-100%	Still in a Reference Condition.
B	80-90%	Slightly modified from the Reference Condition. A small change has taken place, but the ecosystem functions are essentially unchanged.
C	60-80%	Moderately modified from the Reference Condition. Loss and change of natural habitat and biota has occurred, but the basic ecosystem functions are still predominantly unchanged.
D	40-60%	Largely modified from the Reference Condition. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
E	20-40%	Seriously modified from the Reference Condition. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	0-20%	Critically/extremely modified from the Reference Condition. The system has been critically modified with an almost complete loss of natural habitat and biota



PRESENT ECOLOGICAL STATUS OF EF SITES

EF Site No.	*Site*	*Description*	*Present Ecological State*
1	Kallar Bridge	Situated upstream of the full supply level of the reservoir.	C
2	Borali Bridge	Situated between the weir and the tailrace	C
3	Gulpur Bridge	Situated c. 7 km downstream of the tailrace.	C
4	Billiporian Bridge	Situated c. 16 km downstream of the tailrace, c. 12 km upstream of the full supply level of Mangla Dam.	C



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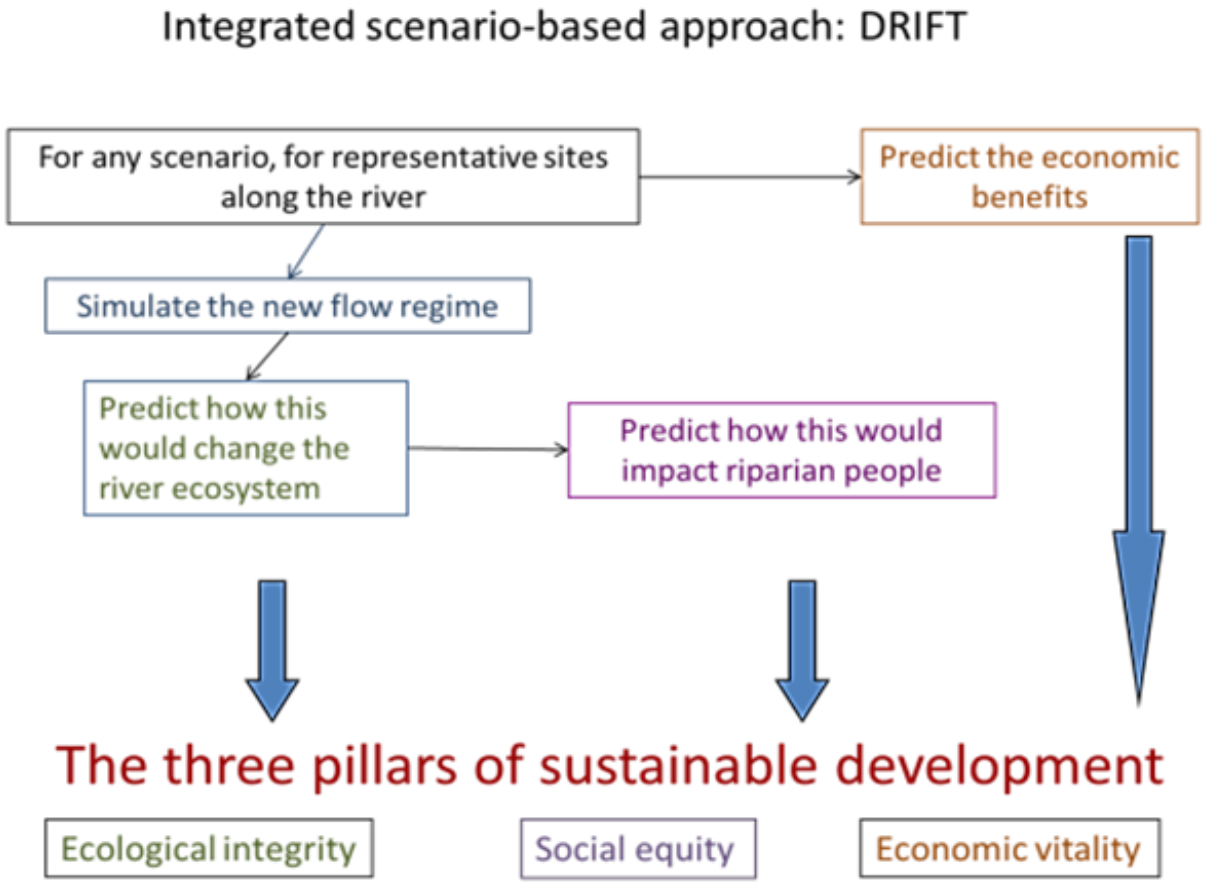
APPROACH FOR CUMULATIVE IMPACT ASSESSMENT

Cumulative Impact Assessment in the Study Area was carried out in two phases:

- Impact of the project and other activities on VECs at basin wide level was first studied using a holistic environmental flow model
- Impact of planned and foreseeable hydropower projects on the VECs in the basin was then examined in light of the first study




The DRIFT approach: Integrating Ecological, Social and Economic Knowledge



Key features: approach; hydrology; indicators; DSS

DRIFT = Downstream Response to Imposed Flow Transformation

Southern Waters: Ecological Flow Assessment

Applied *Downstream Response to Imposed Flow Transformations* model (DRIFT):

This Ecological Flow modeling in addition to the standard hydrological averages, and often used wet-perimeter/ hydraulic data (e.g. depth, min 5-day average velocity, 5-day dry season fish breeding habitat), included

Indicator	
Geomorphology	Active channel width
	Area of silt/mixed deposits
	Area of cobble bars
	Median bed sediment size (armouring)
	Depth of pools
	Area of 2° channels and backwaters
Water quality	Nutrients
	Temperature
Algae	Periphyton biomass
Riparian vegetation	Dry bank trees and shrubs
Macro-invertebrates	Simuliidae
	EPT biomass
Fish	Pakistani labeo
	Mahasheer
	Twin-banded loach
	Kashmir catfish
	Garua bachwaa
	Snow trout
Wildlife	Fish-eating wildlife
	Wildlife water needs
	Riverine insectivores

- Hydrological Data Included in DRIFT
- Mean annual runoff
- Dry season onset
- Dry season minimum 5-day discharge
- Dry season duration
- Dry season average daily volume
- Wet season onset
- Wet season maximum 5-day discharge
- Wet season duration
- Wet season flood volume
- Wet season minimum instantaneous discharge
- Transition 1 maximum instantaneous discharge
- Transition 2 average daily volume

) with

DRIFT modeling scenarios: Poonch River Protection Level vs Project design

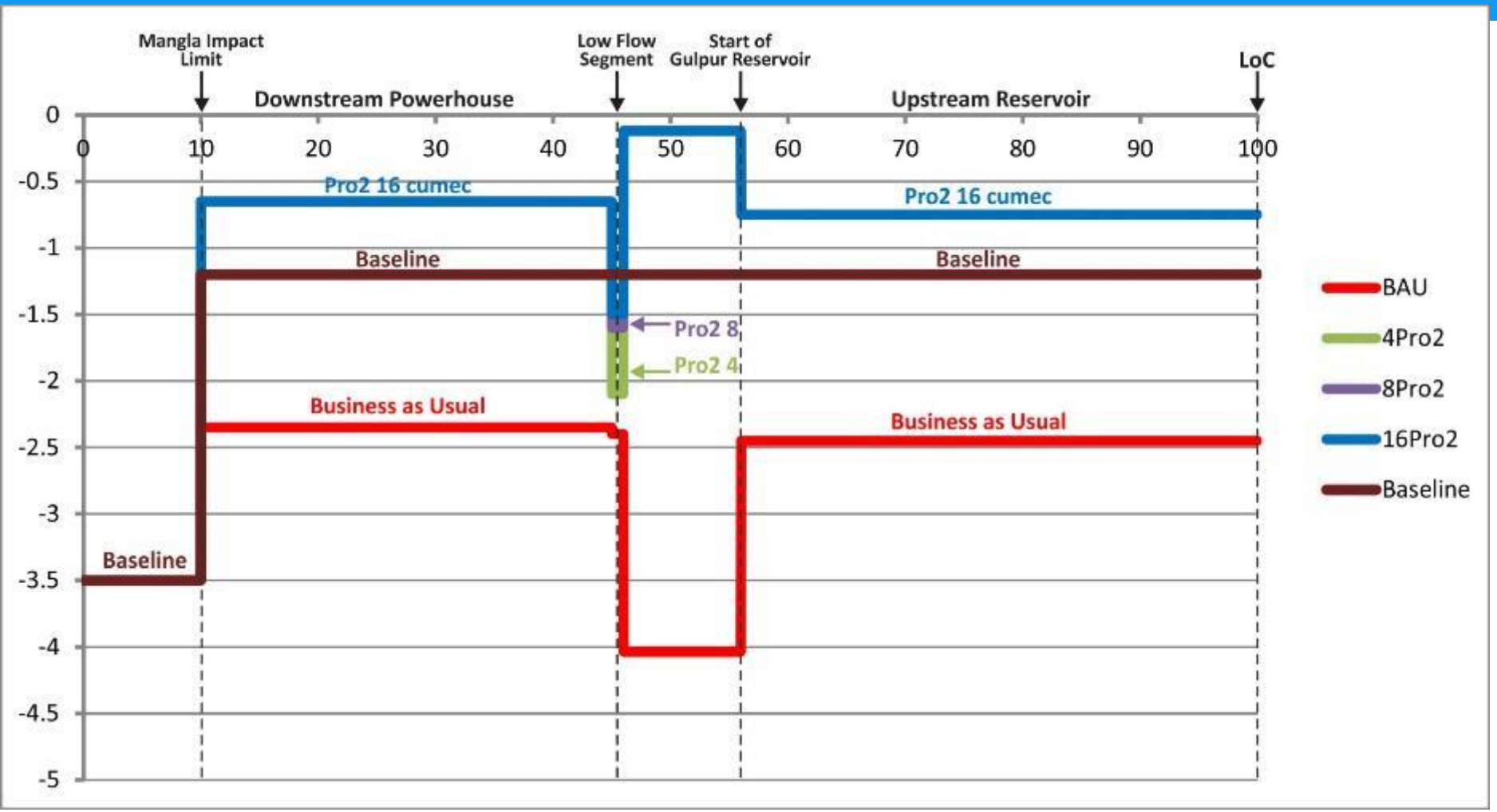
Protection Level

- **Business as usual (BAU)** = increase pressures in line with 2013 trends, i.e., 2013 pressures double in intensity over the next fifty years.
- **Protection Level 1 (Pro 1)** = maintain 2013 pressure levels on the river; i.e., no increase in human-induced pressures over time
- **Protection Level 2 (Pro 2)** = reduce 2013 levels of pressures by 50%, i.e., decline in pressures (relative to 2013) over time

- **No Dam in Place**
  - NDBAU: No dam in place; Protection Level BAU
  - NDPro1: No dam in place; Protection Level 1
  - NDPro2: No dam in place; Protection Level 2
- **Varying Levels of EFlows**
  - Minimum release of 4, 6, 8, 12, and 16 m^3 were simulated for BAU and Pro 2 protection levels.
- **Peaking**
  - An 8.0 m^3 minimum release and peaking-power releases. Protection level BAU.

Biodiversity Action Plan will be required for implementation of Protection Level 2 Scenario as it assumes a basin level protection

ECOSYSTEM INTEGRITY ALONG THE LENGTH OF THE RIVER



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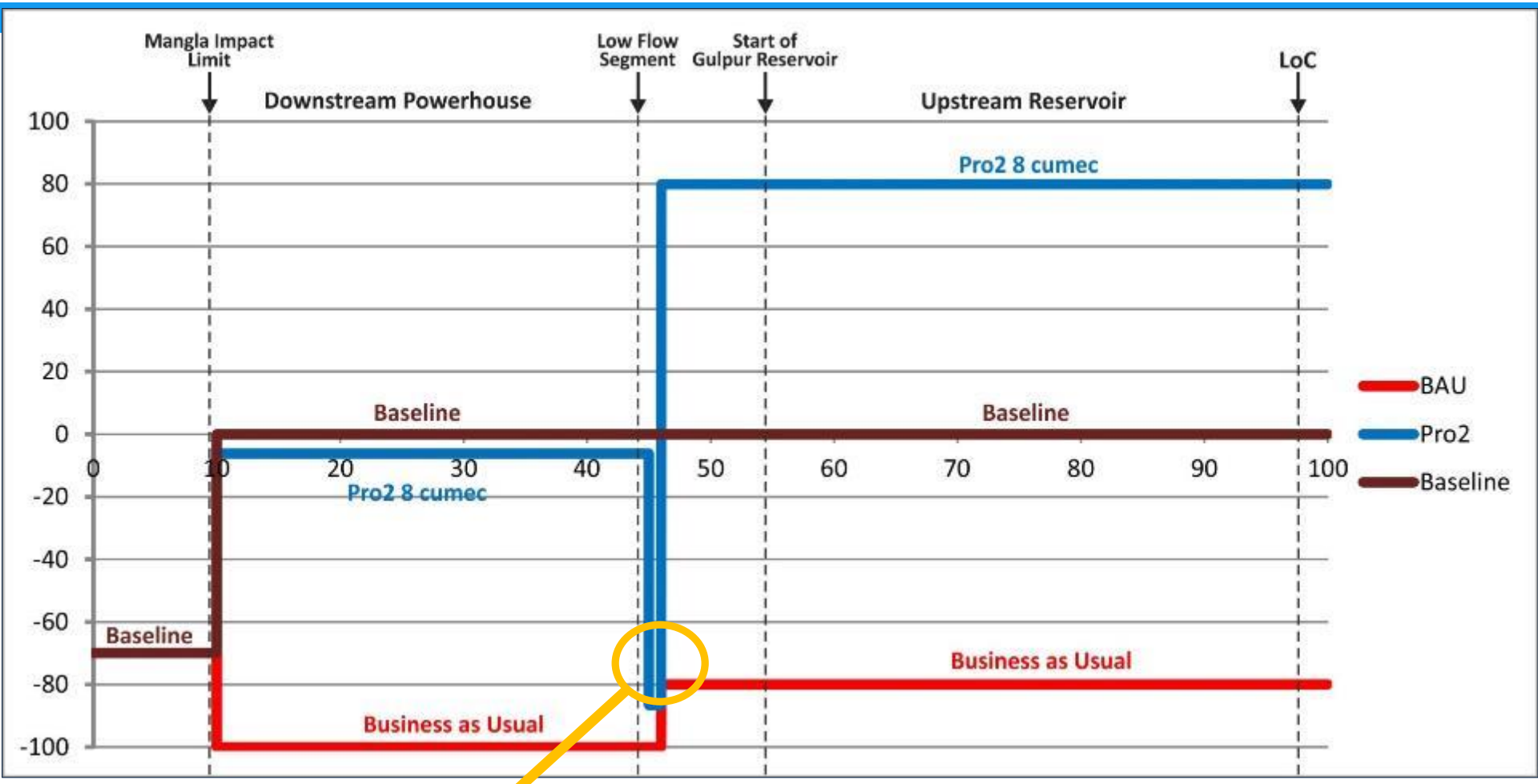
IMPACT ON KASHMIR CATFISH



Please note that in the low-flow segment still there is an 92% loss of Kashmir Catfish

IMPACTS JUST DOWNSTREAM OF DAM – LOW FLOW ZONE – EFLOW SITE 2

Indicators	*NDPro1*	*NDBAU*	*NDPro2*	*G4BAU*	*G4Pro2*	*G8BAU*	*G8Pro2*	*G16BAU*	*G16Pro2*
Pakistani labeo	-59	-77	58	-100	-26	-99	-5	-98	7
Mahasheer	-55	-91	51	-100	-93	-100	-87	-100	-41
Twin-banded loach	-1	-47	46	-100	-90	-100	-80	-88	-21
Kashmir catfish	-8	-57	15	-100	-91	-100	-88	-97	-54
Garua bachwaa	-60	-93	86	-95	-89	-95	-88	-95	-12

NDPro1: No dam in place; Protection Level 1
NDBAU: No dam in place; Protection Level BAU
NDPro2: No dam in place; Protection Level 2
G4BAU A 4 m3s-1 minimum release. Protection level BAU.
G4Pro2 A 4 m3s-1 minimum release. Protection Level 2.
G8BAU An 8.0 m3s-1 minimum release. Protection level BAU.
G8Pro2 An 8.0 m3s-1 minimum release. Protection Level 2.
16BAU A 16 m3s-1 minimum release. Protection level BAU.
G16Pro2 A 16 m3s-1 minimum release. Protection Level 2.

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IMPACTS DOWNSTREAM OF TAIL RACE – EFLOW SITE 3

Indicators	*NDPro1*	*NDBAU*	*NDPro2*	*G4BAU*	*G4Pro2*	*G8BAU*	*G8Pro2*	*G8PeakBAU*	*G16BAU*	*G16Pro2*
Pakistani labeo	-59	-87	59	-88	63	-88	63	-100	-88	63
Mahasheer	-58	-93	51	-100	-6	-100	-6	-100	-100	-6
Twin-banded loach	-1	-46	48	24	93	24	93	-100	24	93
Kashmir catfish	-8	-56	20	-13	76	-13	76	-100	-13	76
Garua bachwaa	-60	-93	80	-97	67	-97	67	-100	-97	67

NDPro1: No dam in place; Protection Level 1
NDBAU: No dam in place; Protection Level BAU
NDPro2: No dam in place; Protection Level 2
G4BAU: A 4 m3s-1 minimum release. Protection level BAU.
G4Pro2: A 4 m3s-1 minimum release. Protection Level 2.
G8BAU: An 8.0 m3s-1 minimum release. Protection level BAU.
G8Pro2: An 8.0 m3s-1 minimum release. Protection Level 2.
16BAU: A 16 m3s-1 minimum release. Protection level BAU.
G16Pro2: A 16 m3s-1 minimum release. Protection Level 2.

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EVALUATION OF BARRIER TO FISH MOVEMENT

- Upstream migration will be halted by the weir, but there will be some downstream movement through the spills.
- The bulk of the tributaries of the Poonch River that are used for breeding by Pakistani Labeo, Mahaseer are located upstream of Gulpur HPP.
- Fish restricted to the lower part of the Poonch River will breed in the main river to some extent
- Pakistani Labeo, Snow Trout and Mahaseer will most likely colonize the reservoir, which may lead to a slight increase in their populations upstream of the dam.
- Bulk of the favoured breeding sites for Garua are located downstream of the Gulpur weir. Garua is also unlikely to colonize the reservoir. Thus, it is expected that the population upstream of the dam will be compromised by the weir.

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PEAKING OPERATION DISCARDED

- A peaking operation can be detrimental to the ecology downstream of the dam.
- Low flows normally occur in the section of the river starting just below the dam, to the point where water is added back into the river at the outlet of the of the power house.
- With a peaking operation low flows are extended downstream of the power house as well during the period the power house is shut down to accumulate water in the reservoir upstream.
- The river ecology which is adapted to normal daily and seasonal variations in flows is severely impacted by the daily long dry spells.
- **A peaking operation will result in deterioration starting from a Mid Category C river (Moderately Modified from Reference Condition) to a Mid-Category E river (Seriously Modified) under which the loss of ecosystem functions is extensive.**

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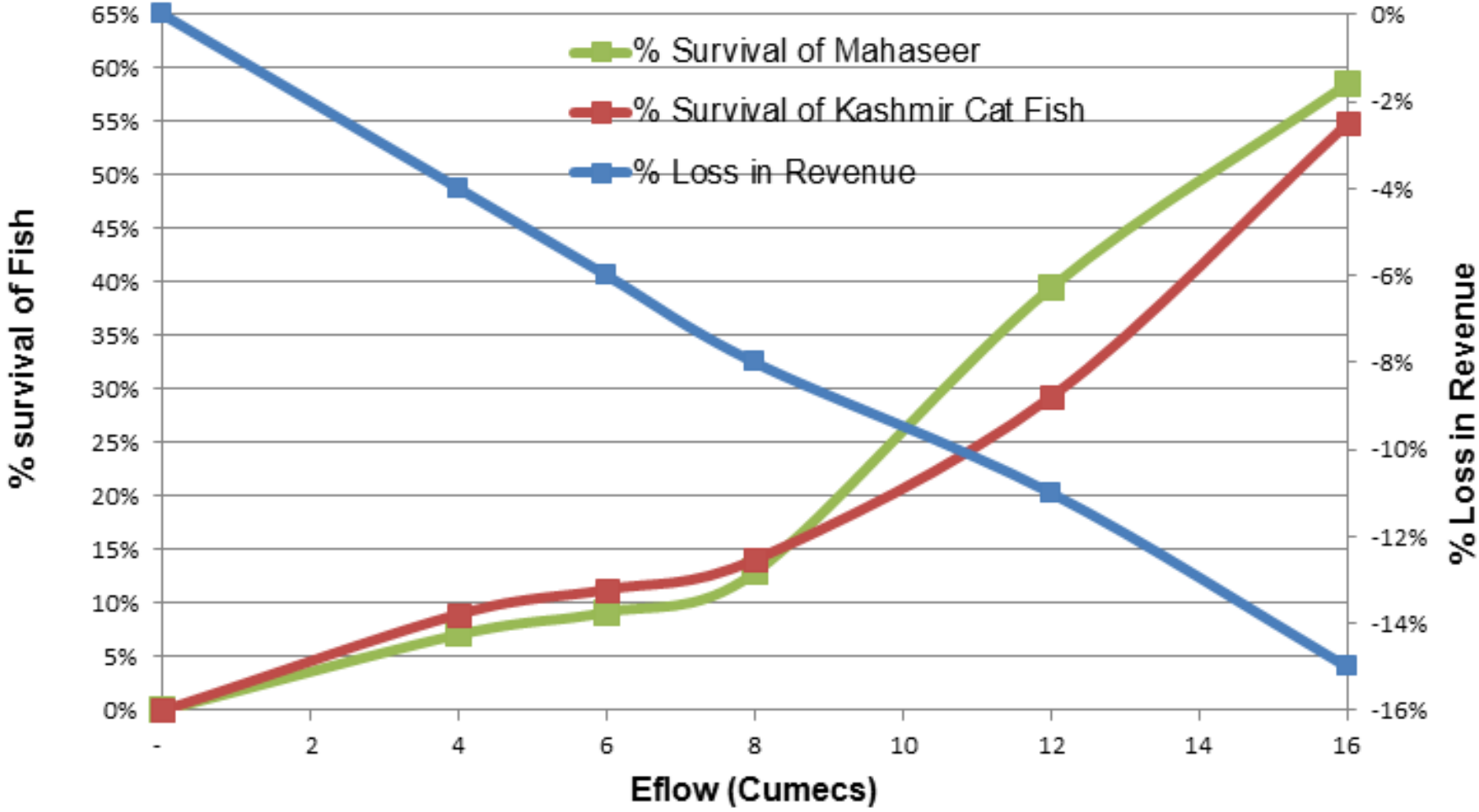
TRADEOFFS: ECONOMIC BENEFITS VS SURVIVAL OF FISH POPULATIONS



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ENVIRONMENTAL FLOW AND EFLOW MANAGEMENT PLAN

Given the limited length of the low flow section for the Project (0.7 km) and commitment to a non-peaking operation, there is limited advantage gained by increasing Eflow at the expense of power generation. After consultation with the stakeholders the **EPA approved a minimum release of 4 cumec at dam subject to implementation of a BAP to achieve Enhanced Protection.**

An Eflow management plan was prepared to specify operating rules and monitoring mechanisms

FINDINGS AND CONCLUSIONS FROM E-FLOW ASSESSMENT

Non-Project Scenario:

- With Business as Usual (BAU) or Pro1 -> low Category D
- Pro2 -> low Category B river.

Project Scenario:

- Slightly deterioration with dam in place under BAU – Pro1 –> main impact on dewatered segment.
- The barrier effect of the dam as felt upstream of the dam will be minimal under all BAU, Pro1 and Pro2 scenarios.
- BAU -> mid-Category E.
- Under Pro2 - > border line between Category B and C.
- A peaking operation -> to a Mid-Category E under all scenarios

Conclusions:

- **Need to operate as true run-of-river (non-peaking).**
- **The impact of poor protection will be far higher than that of dam and the reduced flows.**
- **The contribution of good protection measures will more than compensate for harm done by the HPP.**
- **Given the limited length of the low flow section, increasing minimum flow release from 4-16 m^3 will not result in any significant improvement in the ecological condition of the river. Thus eflow of 4 m^3/s was suggested.**

Cumulative Impacts

Power Projects	Segments	River/ km	Reservoir/ km	Low flow Section/km	Total
Parnai Power House	Parnai Dam to Sehra Reservoir			50.0	50.0
Sehra Power House	LoC to Start of Sehra Reservoir	4.6			
Sehra Power House	Sehra Reservoir to Sehra Dam		2.8		
Sehra Power House	Sehra Dam to Sehra Power House			16.4	23.8
Kotli Power House	Sehra Power House to Start of Kotli Reservoir				
Kotli Power House	Kotli Reservoir to Kotli Dam		4.5		
Kotli Power House	Kotli Dam to Kotli Power House			11.0	15.5
Gulpur Power House	Kotli Power House to Start of Gulpur Reservoir	4.0			
Gulpur Power House	Gulpur Reservoir to Gulpur Dam		10.8		
Gulpur Power House	Gulpur Dam to Gulpur Power House			3.7	14.7
Rajdhani Power House	Gulpur Power House to Start of Rajdhani Reservoir	1.6			
Rajdhani Power House	Rajdhani Reservoir to Rajdhani Dam/Power House		21.8		23.4
Mangla Dam	Rajdhani Power House to Maximum Reservoir Level after Mangla Raising	11.0			
Mangla Dam	Maximum Reservoir Level after Mangla Raising to Maximum Reservoir Level before Mangla Raising		10.0		21.0
	Total	21.2	40.3	79.1	141.6

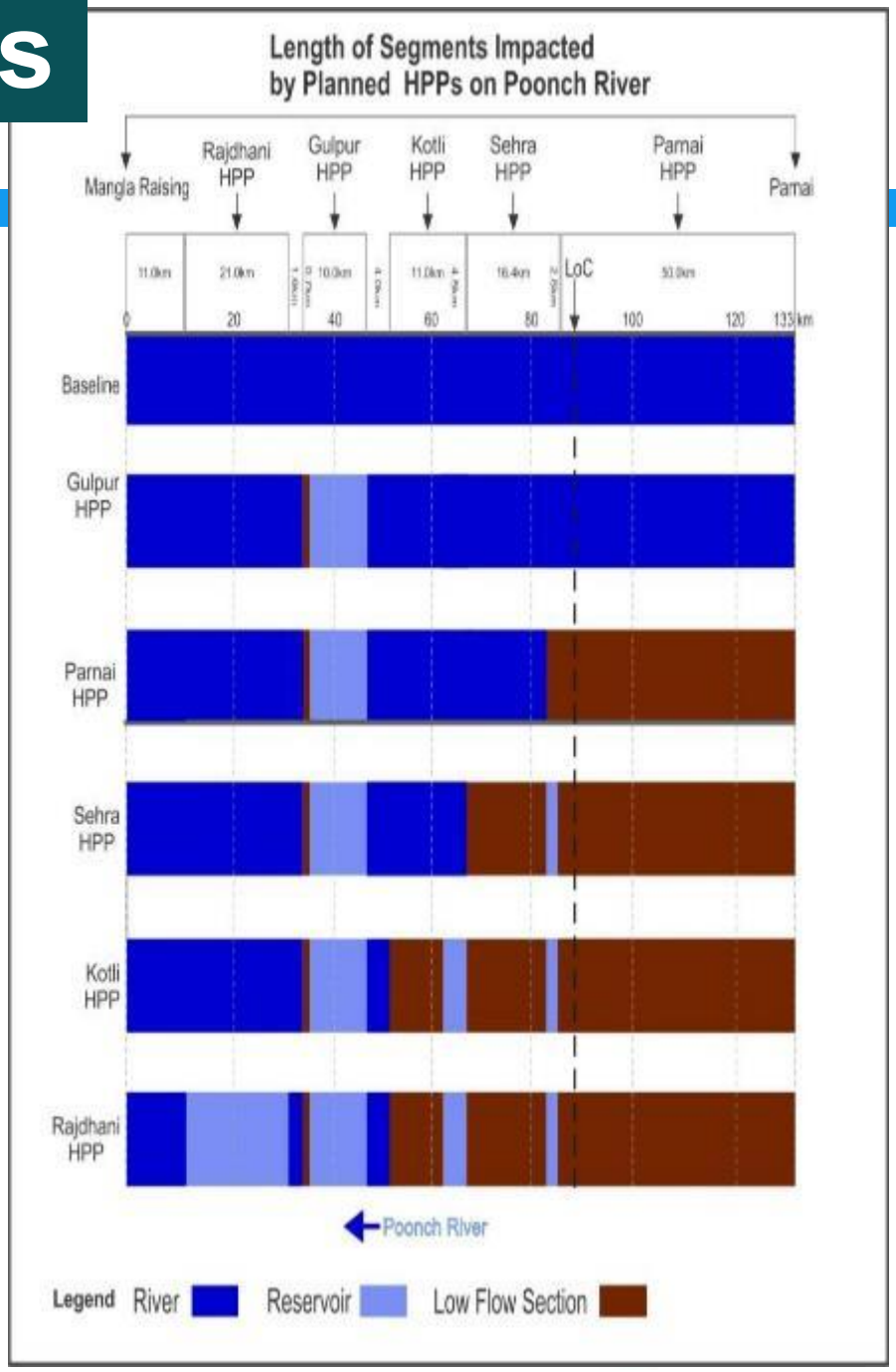


Exhibit 6.5: Estimated Cumulative Impact of Planned HPPs on the Population of Mahaseer

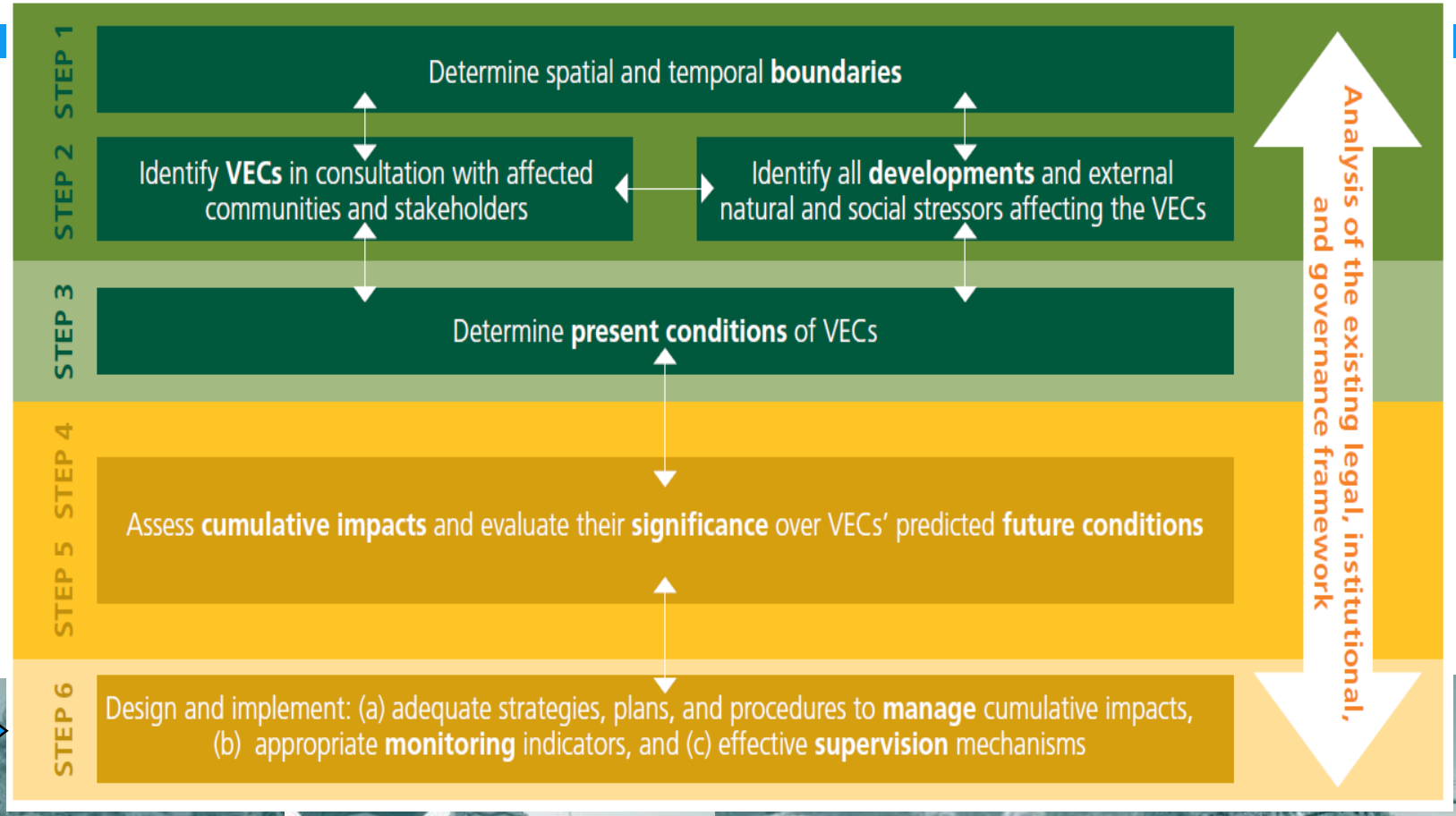
Blue and green are major changes that represent a move towards natural: green = 40-70%; blue = >70%.
Orange and red are major changes that represent a move away natural: orange = 40-70%; red = >70%.
Baseline, by definition, equals 100%. Italicised scenarios are repeats

River reach		*2013*	*Sequential implementation of:*				
			Gulpur HPP	*Parnai HPP*	*Sehra HPP*	*Kotli HPP*	*Rajdhani HPP*
Poonch River Upstream of LoC	Parnai dam to LoC	–	40	-20	-40	-40	-40
Poonch River Downstream of LoC	LoC - 5 km	–	80	-20	-40	-40	-40
	10	–	80	60	-40	-40	-40
	15	–	80	60	-90	-90	-90
	20	–	80	60	-90	-90	-90
	25	–	80	60	-90	-90	-90
	30	–	80	60	60	-90	-90
	35	–	80	60	60	-90	-90
	40	–	80	60	60	-90	-90
	45	–	80	60	60	0	0
	50	–	80	60	60	0	0
	55	–	-90	-90	-90	-90	-90
	60	–	-8	-8	-8	-60	-90
	65	–	-8	-8	-8	-60	-90
	70	–	-8	-8	-8	-60	-90
	75	–	-8	-8	-8	-60	-100
	80	–	-8	-8	-8	-60	-100

CUMULATIVE IMPACT ON ECOLOGICAL INTEGRITY

B = blue, B/C and C = green, C/D = white, D = orange, No river remaining = red

River Reach		2013	Sequential implementation of:				
			Gulpur HPP	Parnai HPP	Sehra HPP	Kotli HPP	Rajdhani HPP
Poonch River upstream of LoC	Parnai weir to LoC	B	B	C/D	C/D	C/D	C/D
Poonch River downstream of LoC	LoC - 5 km	B/C	B/C	C/D	D	D	D
	10	B/C	B/C	C	No river remaining	No river remaining	No river remaining
	15	B/C	B/C	C	D	D	D
	20	B/C	B/C	C	D	D	D
	25	B/C	B/C	C	D	D	D
	30	B/C	B/C	C	C	No river remaining	No river remaining
	35	B/C	B/C	C	C	D	D
	40	B/C	B/C	C	C	D	D
	45	B/C	No river remaining	No river remaining	No river remaining	No river remaining	No river remaining
	50	B/C	No river remaining	No river remaining	No river remaining	No river remaining	No river remaining
	55	B/C	D	D	D	D	No river remaining
	60	B/C	B/C	B/C	C	C/D	No river remaining
	65	B/C	B/C	B/C	C	C/D	No river remaining
	70	B/C	B/C	B/C	C	C/D	No river remaining
	75	B/C	B/C	B/C	C	C/D	D
	80	B/C	B/C	B/C	C	C/D	D
	85	B/C	B/C	B/C	C	C/D	D
	90	B/C	B/C	B/C	C	C/D	D
Mendhar Nullah		B	B	D	D	D	D



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PROJECT LEVEL PROPOSED APPROACH

- Given the state of protection in the Poonch River, there will not be much of environmental resource left to protect if the present trends continue.
- Implement a Biodiversity Action Plan (BAP) to address basin level protection of wildlife which is in jurisdiction of AJK Fisheries and Wildlife Department.
- Implementation of the BAP requires commitment from the government. Additional resources for the BAP will be provided by the Project.
- The government and Project owner signed an agreement to implement the BAP

BIODIVERSITY ACTION PLAN (BAP)

BAP includes:

- Ecological Flow Management Plan and continued monitoring;
- Support AJKFWD in the construction and maintenance of a hatchery for Mahaseer on the Poonch River;
- Help the AJKFWD development of a strong management plan for the Mahaser National Park;
- Effective watch and ward system to reduce illegal and indiscriminate hunting and killing of wildlife (both aquatic and terrestrial) and removal of vegetation that is important for supporting biodiversity;
- Bans on non-selective fishing, fishing in tributary breeding grounds, and fishing during breeding season;
- Specific conservation measures such as increased park staff, patrols and mining inspectors;
- Limitations on and designated areas for sediment mining, and banning sediment mining in ecologically sensitive areas;
- Banning of livestock grazing and wood collection in sensitive areas;
- Environmental awareness events / training for local communities;
- Protection of tributaries for Golden Mahaseer breeding; and
- Enhance sand/gravel riffle habitat for the Kashmir catfish.

BASIN LEVEL: PROPOSED APPROACH

- Written commitment from AJK EPA to request “net gain and betterment of the Mahaseer-Poonch River National Park” as a requirement for any new HPP development.
- Detailed downstream flow management plan (DRIFT)
- Extensive Biodiversity Action Plan (BAP)
- IFC working in a “Landscape” approach at the Jhelum-Poonch watershed using donor funding via Hydro Advisory program.
  - Biodiversity Strategy developed FY2015-16
  - Implementation 2017-2021
  - Elevating to broader E&S issues

BIODIVERSITY STRATEGY

- **DRIFT modeling** for the complete system – commit all developers to avoid peaking.
- **Putting in place a protection system** for the Mahaseer National Park partly financed by the Project and implemented with support from an independent Implementation Organization, and protect other areas of the basin – potentially to be Mahaseer and Kashimir Catfish sanctuaries.
- **Commitment by the Wildlife Departments of the three affected provinces** to make staff available for protection, and coordination with other government line departments and developers.
- Commitment by Wildlife Department to provide **legal authority to the Independent Organization** for exercising powers under wildlife legislation (e.g. Himalayan Wildlife Foundation)
- **Construction of a Mahaseer / Kashmir catfish hatchery** for stocking of fish in affected areas and avoid inbreeding / formation of subpopulations.
- Basin-wide **Mining Plan** to ensure a balance between meeting community needs for sand and gravel and integrity of aquatic habitats
- **Monitoring by an Independent Third Party** on a long term basis and
- Long term **Capacity Building and Oversight and monitoring by the Provincial EPA/Wildlife Management Departments**

HOW TWO FISH ARE CHANGING HYDROPOWER IN PAKISTAN

Jhelum-Poonch river watershed. © Leeanne Alonso / IFC

In project finance, environmental and social risks traditionally have been managed one project at a time. IFC is changing the game, by considering and addressing the impact of projects on an entire region, interconnected ecosystems, and communities. We bring together the private and public sectors, civil society, and local communities to achieve that. In Pakistan, it all started with two fish.

The Jhelum-Poonch Watershed, in South Asia, is home to critically endangered species of fish such as the Golden Mahaseer and the Kashmir Catfish. The basin is also a vast source of hydropower in Pakistan.

http://www.ifc.org/wps/wcm/connect/news_ext_content/ifc_external_corporate_site/news+and+events/news/how+two+fish+are+changing+hydropower+in+pakistan

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SUPERVISION VISIT JAN 2017 – BAP IN ACTION!

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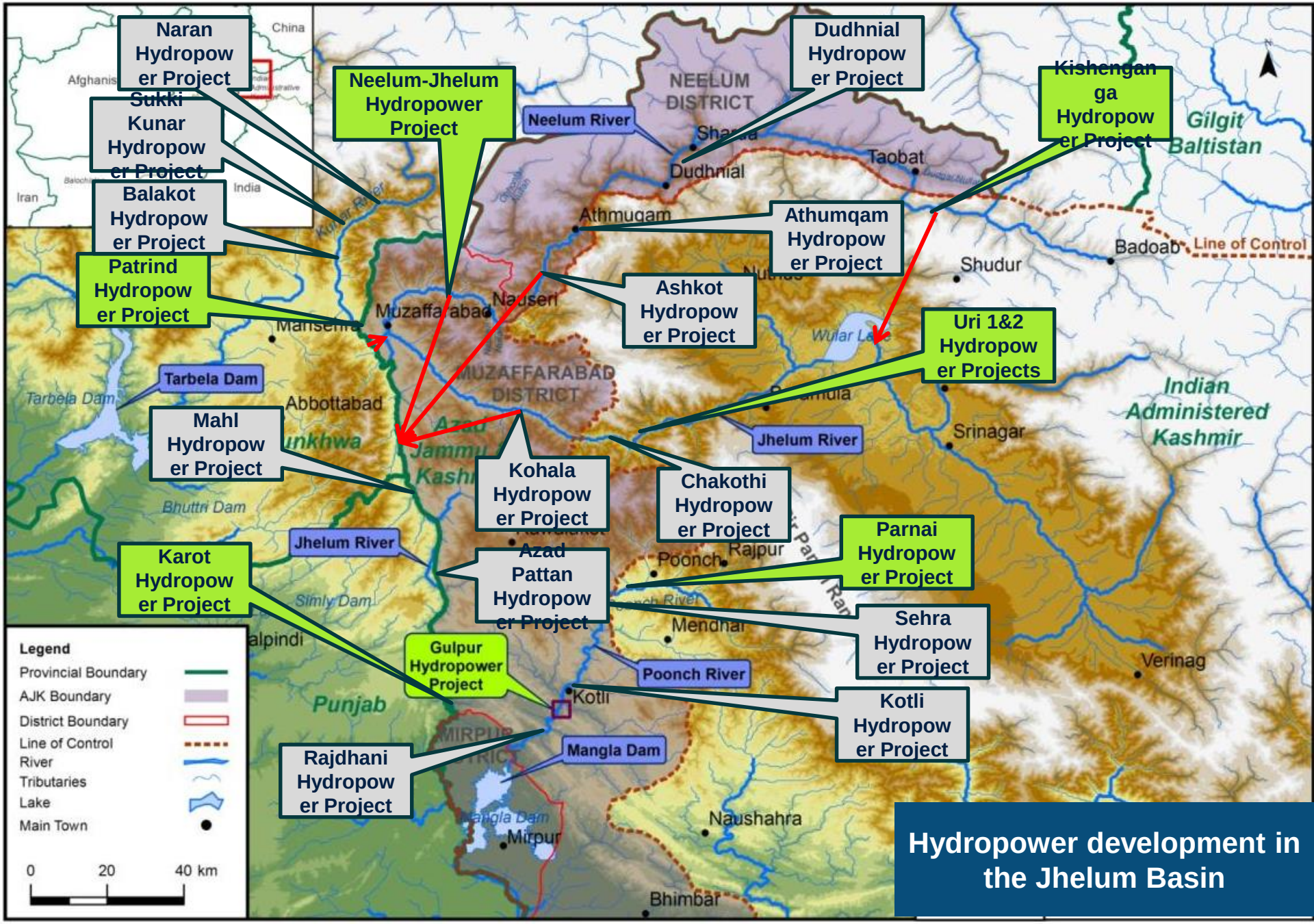

Hydropower development in the Jhelum Basin

Hydropower Developers' Working Group

THANK YOU

https://www.youtube.com/watch?v=70woqAm4oYg

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