EFlows case studies and review

Cate Brown

Honorary Professor
Institute for Water Studies
University of the Western Cape

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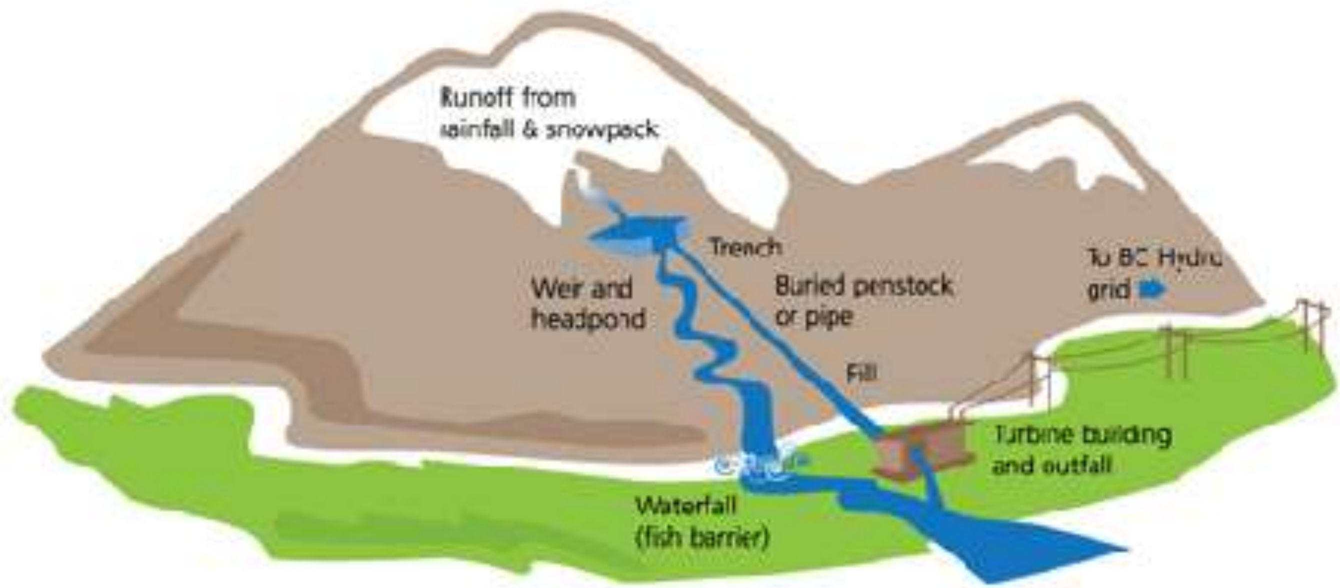
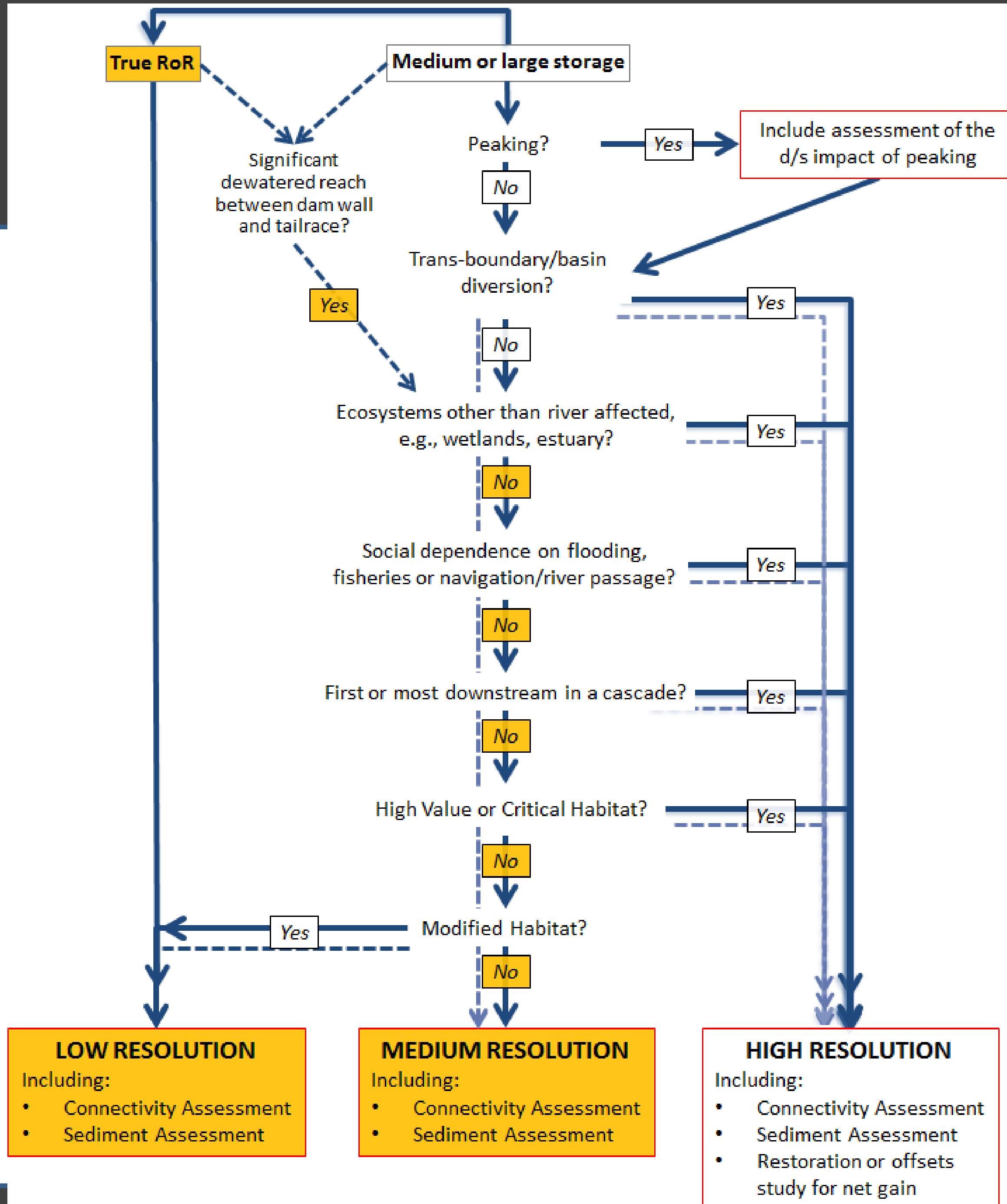
southern waters

USING DECISION TREE

Proposed design for Bute Inlet array (individual)

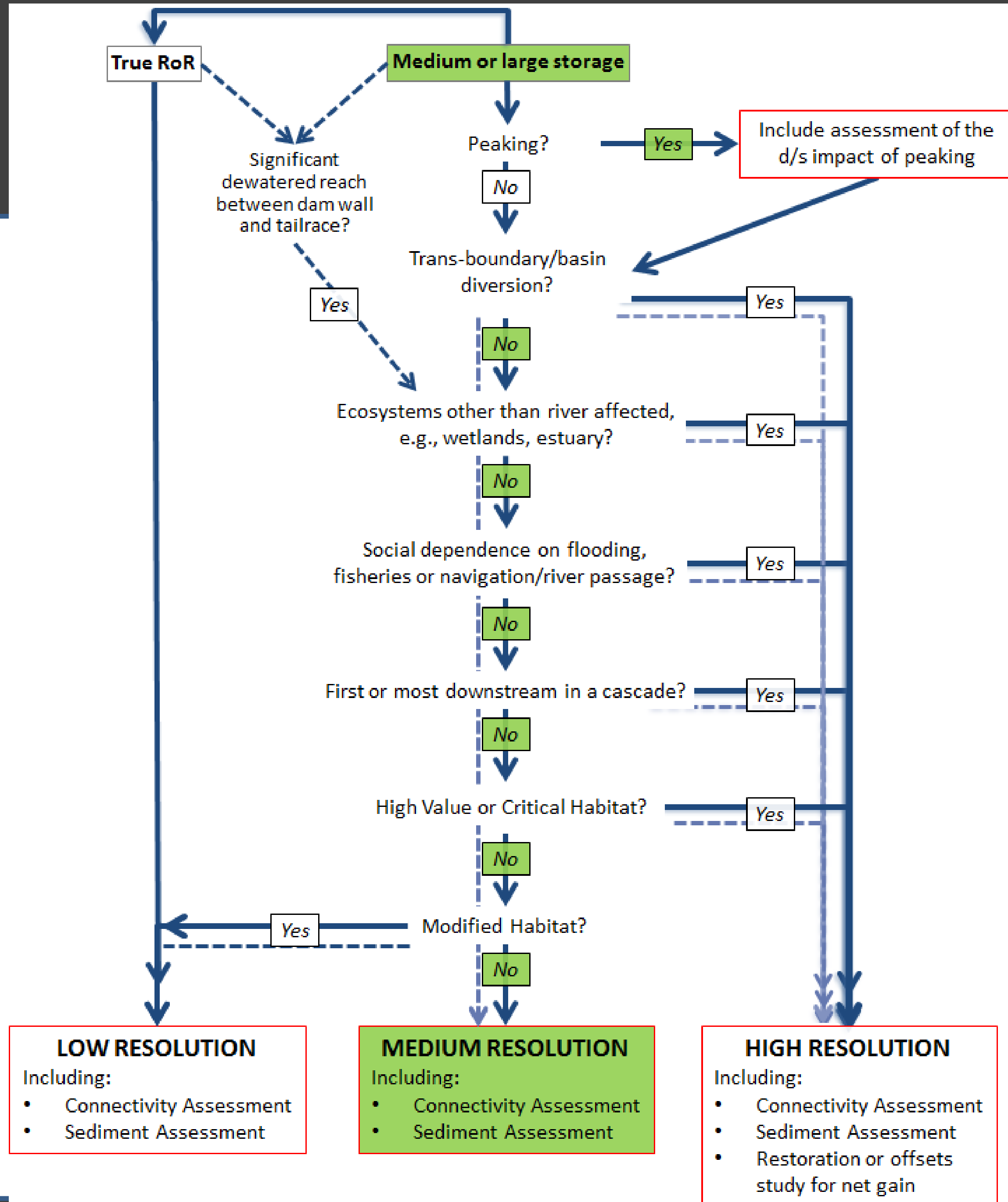


Proposed design for Bute Inlet array (individual)



Batoka Gorge HPP

Batoka HPP – retrospective



BATOKA EFlows assessment: Scope and costs (2014)

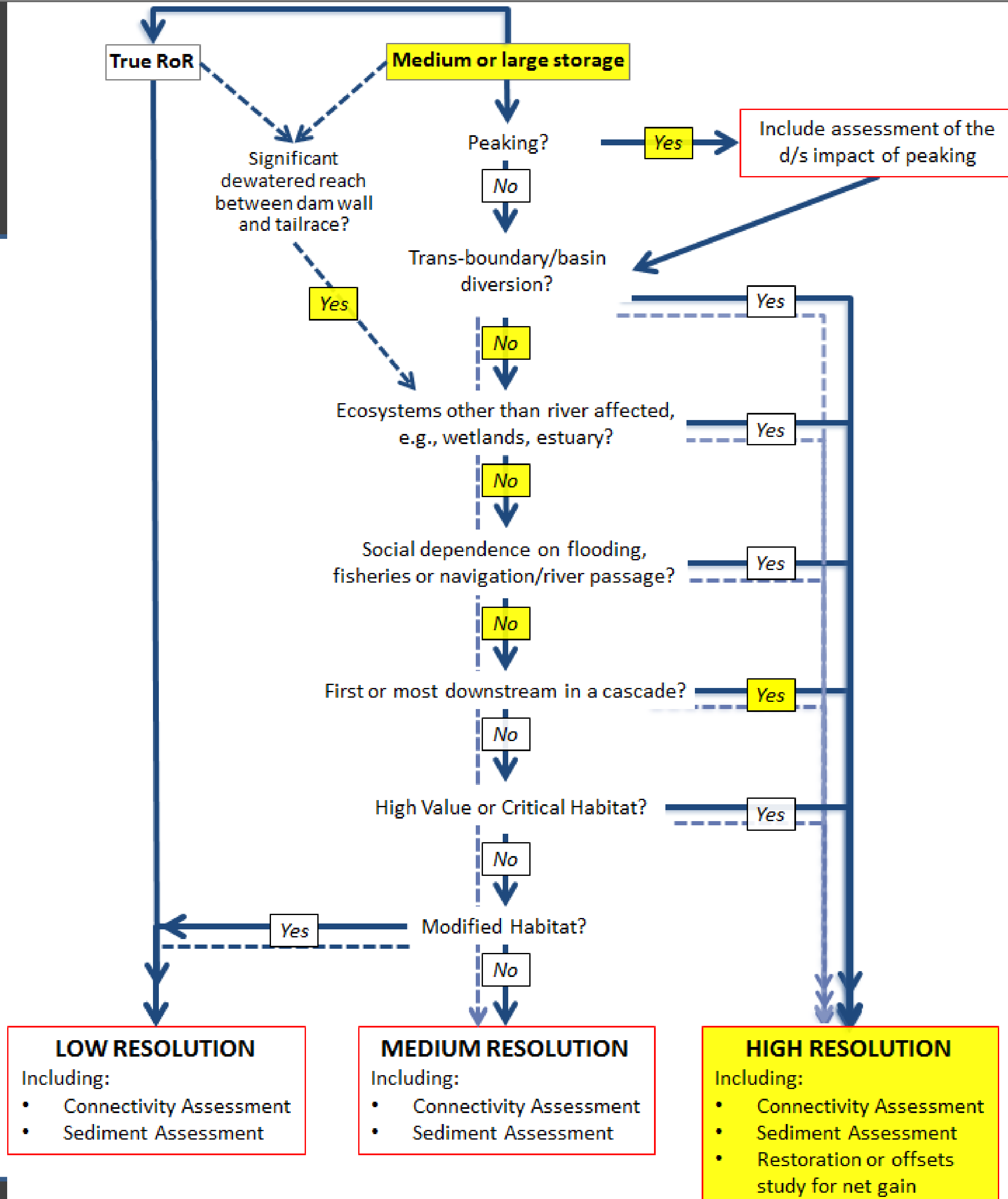
- Two sites downstream of the tailrace to Kariba Dam.
- The EFlows scenarios incorporated considerations of:
  - changes to pattern and volume of downstream flows
  - the downstream effects of sediment trapping and/or flushing
  - changes in connectivity assessment for key migratory fish (Victoria Falls)
- The team = 6 international consultants with EFlows experience
- Duration = 2 months
- Cost to client: ± US$ 110 000.00 *inclusive of disbursements*.

Poonch River Mahaseer National Park

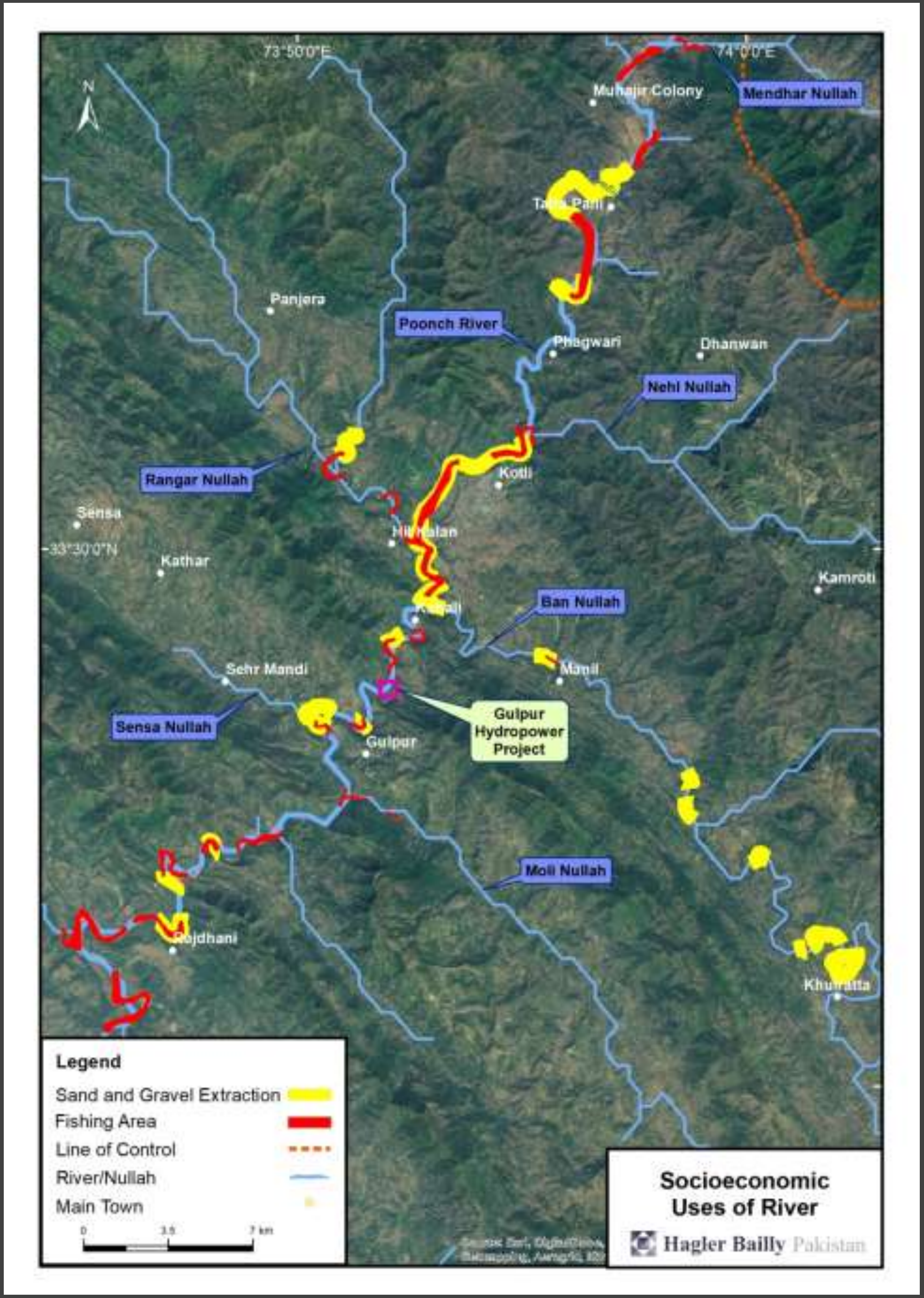
Kashmir Catfish

Golden Mahaseer

Gulpur HPP – retrospective

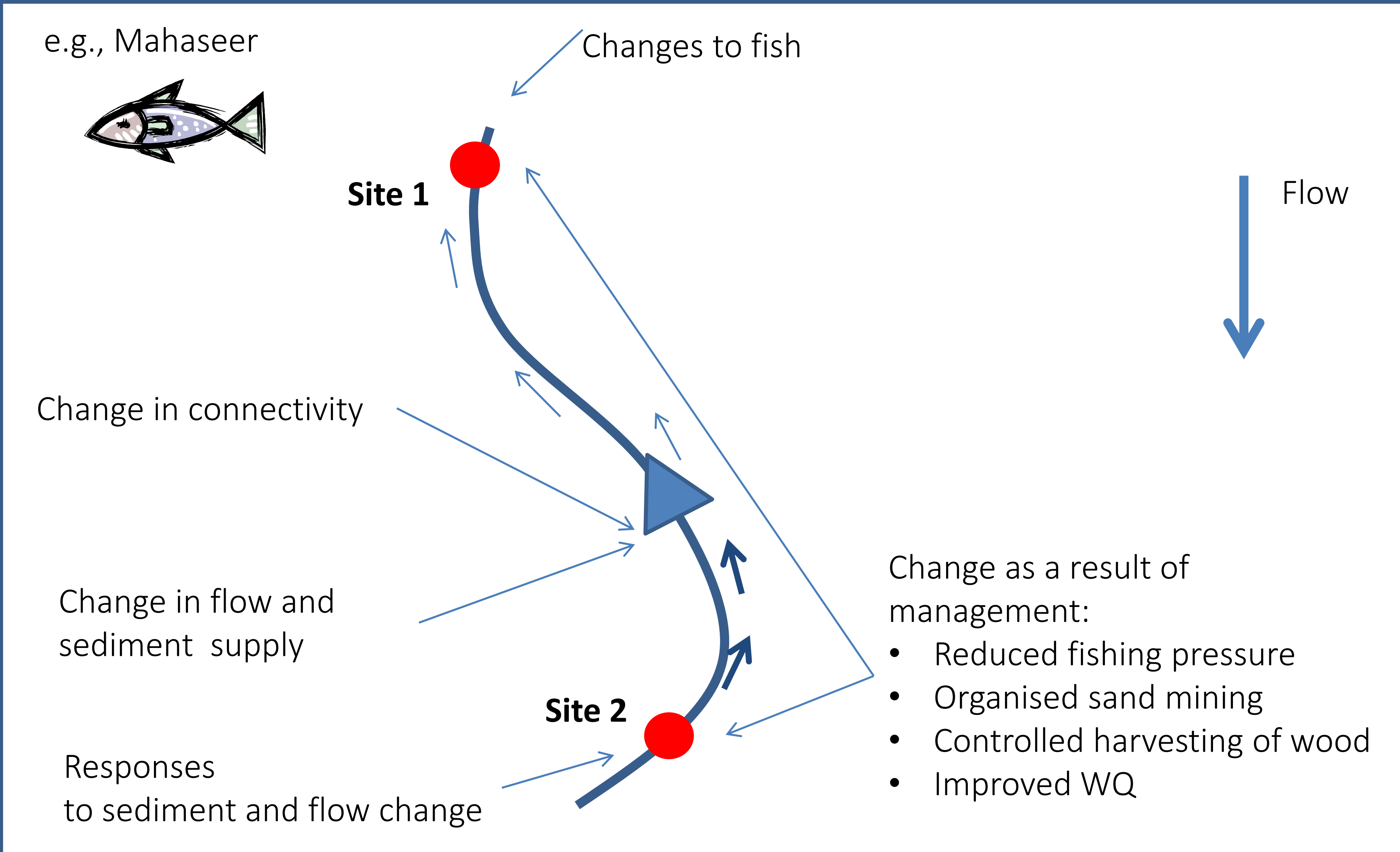


POONCH RIVER (NEELUM-JHELUM)



- Fishing:
  - Selective
  - Non-selective
- Sediment mining:
  - Cobbles and sand
- Harvesting of woody plants
- Sewage disposal

Issues covered in EFlows assessment



Gulpur HPP: Poonch River

- Detailed EFlows assessment
- DRIFT Method
- Zoneing of river - Four sites, one upstream, one between the dam wall and the tailrace and two in the river downstream of the tailrace and Mangla Dam.
- The EFlows scenarios incorporated considerations of:
  - changes to pattern and volume of downstream flows
  - the downstream effects of sediment trapping and/or flushing
  - changes in connectivity assessment for key migratory fish
  - options for turbine selection
  - options for management protection (i.e., offsets).
- The team = 4 international consultants with EFlows experience, who guided a team of Pakistan specialists through the assessment.
- Duration = 1 year
- Cost to client: ± US$ 300 000.00 *inclusive of disbursements* (2014)

Gulpur HPP: Poonch River

- The results of the EFlows Assessment underpinned the following decisions:
  - Design:
    - reduce the dewatered section from 6 km to 1 km;
    - select different turbines that would allow greater operating flexibility under low-flow conditions
  - Operation
    - release an EFlows of 4 $m^3 s^{-1}$ for the dewatered section;
    - forgo peaking power generation
    - Changes to PPA to accommodate offset costs
  - Offset
    - implement a management and finance structure for protection in the Poonch River National Park;
    - establish a Mahaseer fish hatchery;
    - relocate and regulate sediment mining

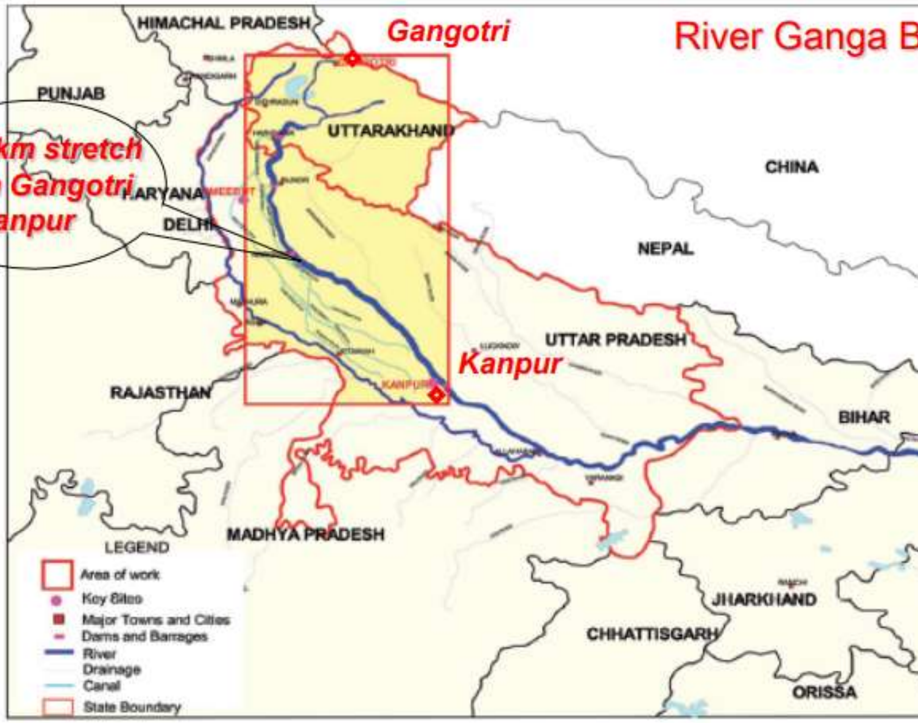
GANGA RIVER

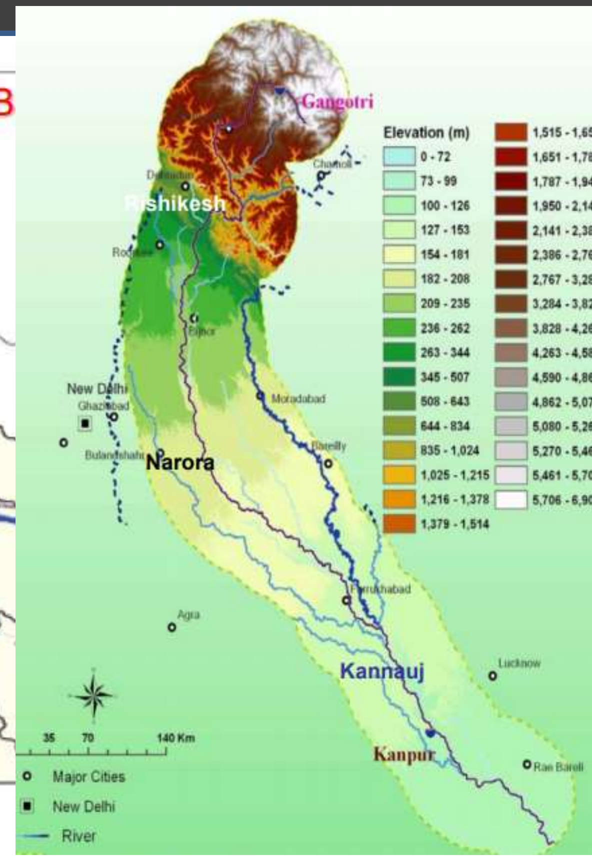
Ganges River

BBM EFlows assessment

- River revered by millions of Indians - Social, cultural and emotional values needed to be accounted for in the EFlows assessment
- Detailed assessment
- Building Block Methodology:
  - Multidisciplinary Team
    - Hydrologist
    - Hydraulician
    - Geomorphologist
    - Vegetation specialist
    - Invertebrate specialist
    - Fish
    - Livelihoods specialist
    - Spiritual/cultural specialist
- Ganga from Gangotri to Kanpur (Test section)
- Large capacity building component (3 year project)

Step 1: Zone the river





- four homogenous zones – similar physical river features (such as geology, slope, climate, shape and size of channel, landuse)

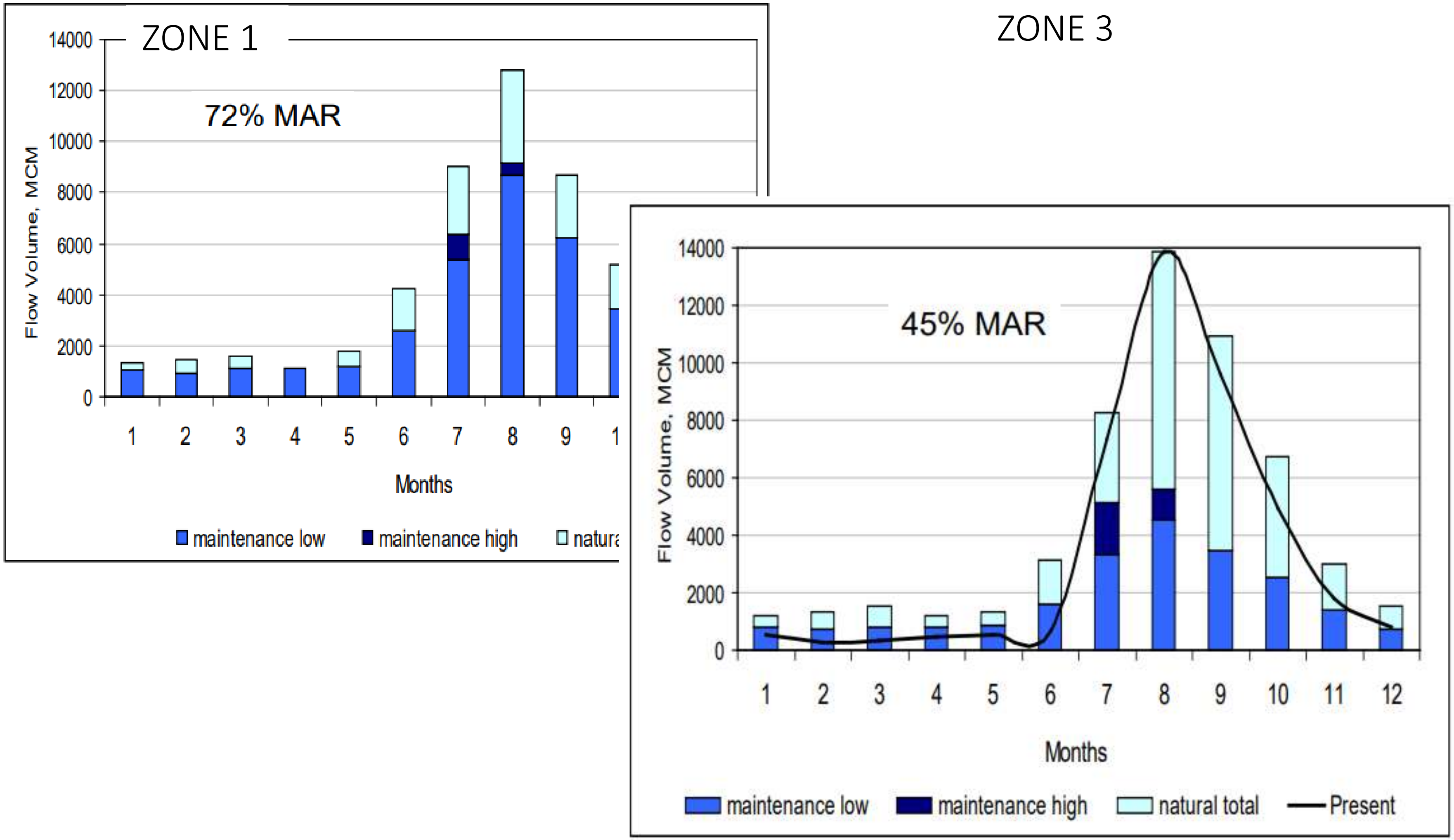
Step 2: Decide on desired future state

- Livelihood group: depth, width and other requirements (such as physical appearance of water) to maintain activities such as ferrying or rafting.
- Spiritual/cultural group: river depth and water quality for religious and cultural activities such as ritual bathing.
- Biodiversity group: habitat characteristics (depth, velocity, width and substrate) for important flow-dependent species such as the river dolphin, fish, macro-invertebrates and floodplain vegetation.
- Fluvial geomorphology group: river velocities and depths to move, sort and deposit different sizes of sediment, to maintain required habitat complexity and restore channel shape, e.g., multiple channels and bars.

Steps 3/4: Derive and finalise EFlows

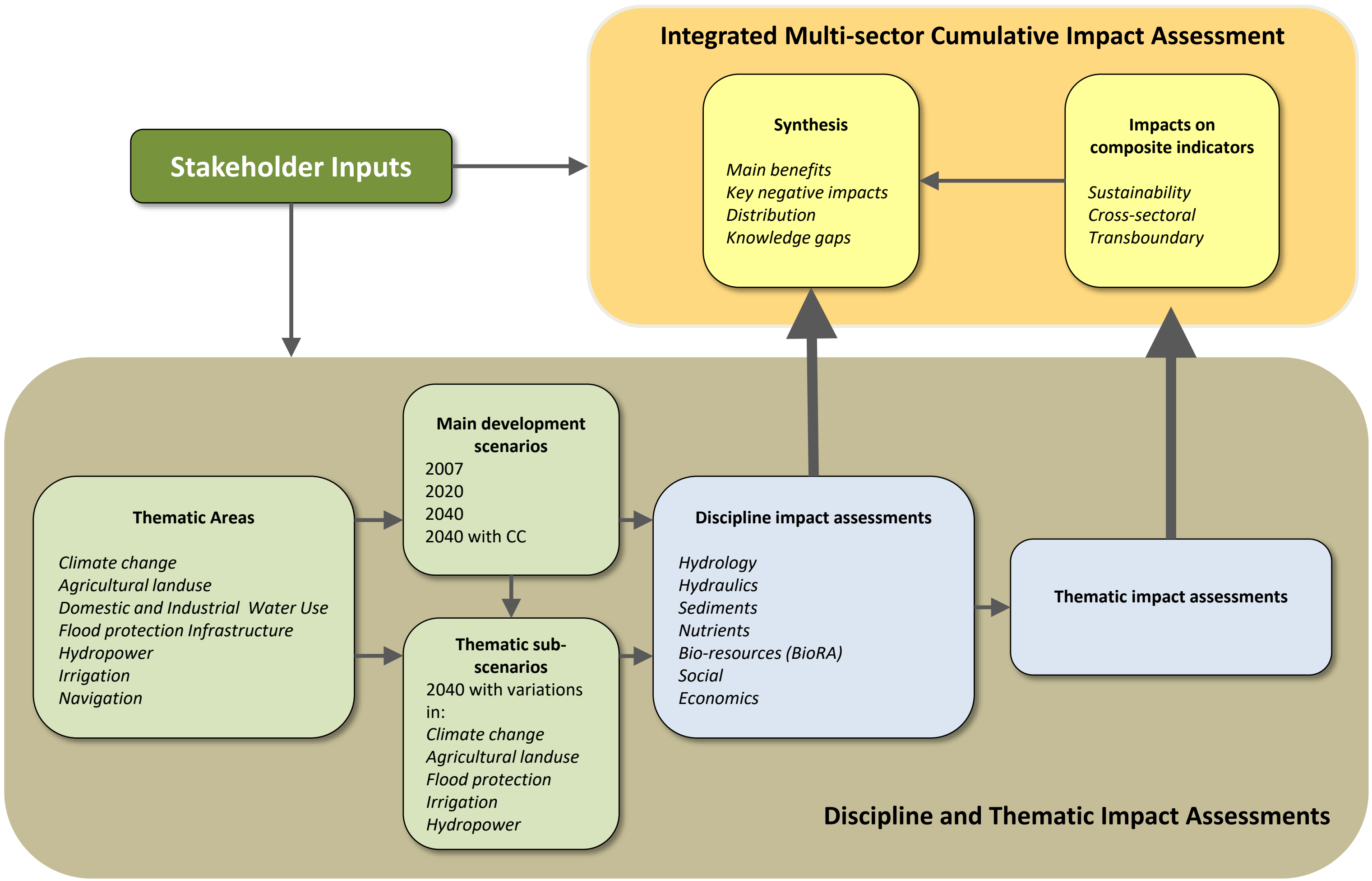
- Individual groups define flows to meet desired future state in driest month and wettest month
- Hydraulician translated depth, width, velocity requirements into discharge
- Individual groups motivate for flows
- “EFlows setting workshop” to discuss and agree on the critical flows for maintenance (normal) and drought conditions that would satisfy the requirements of all groups

Environmental Flows in Ganga

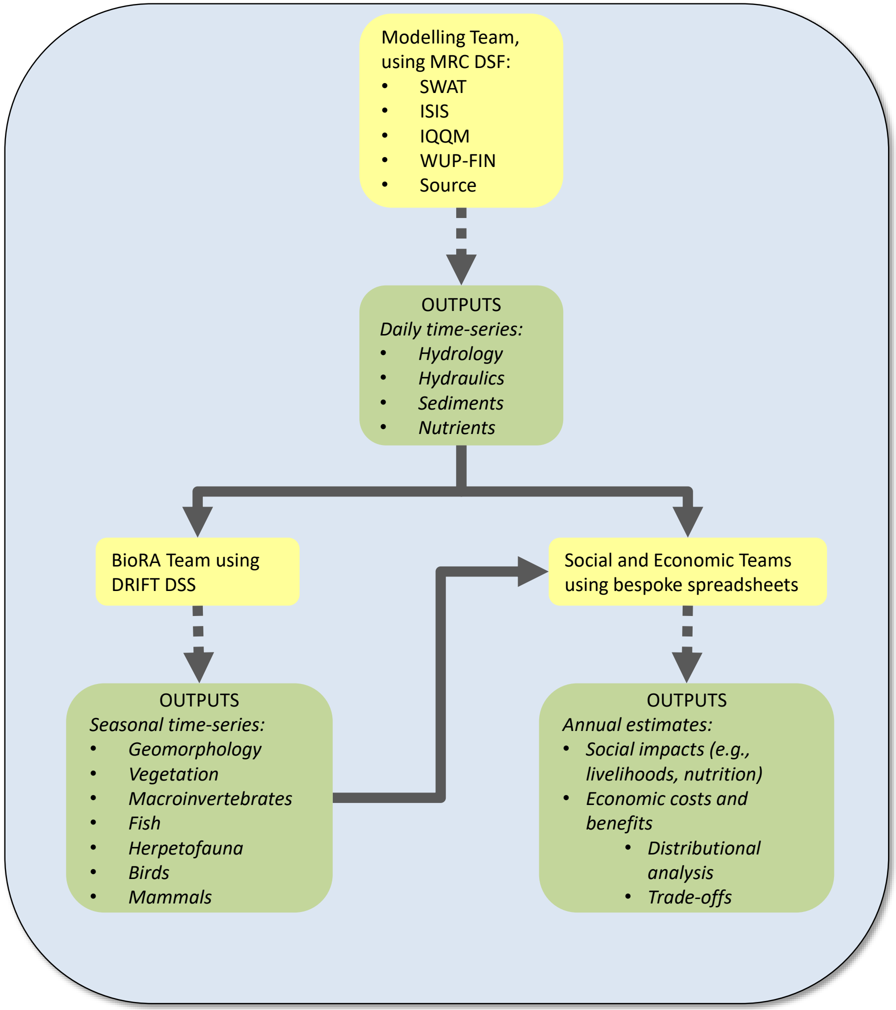


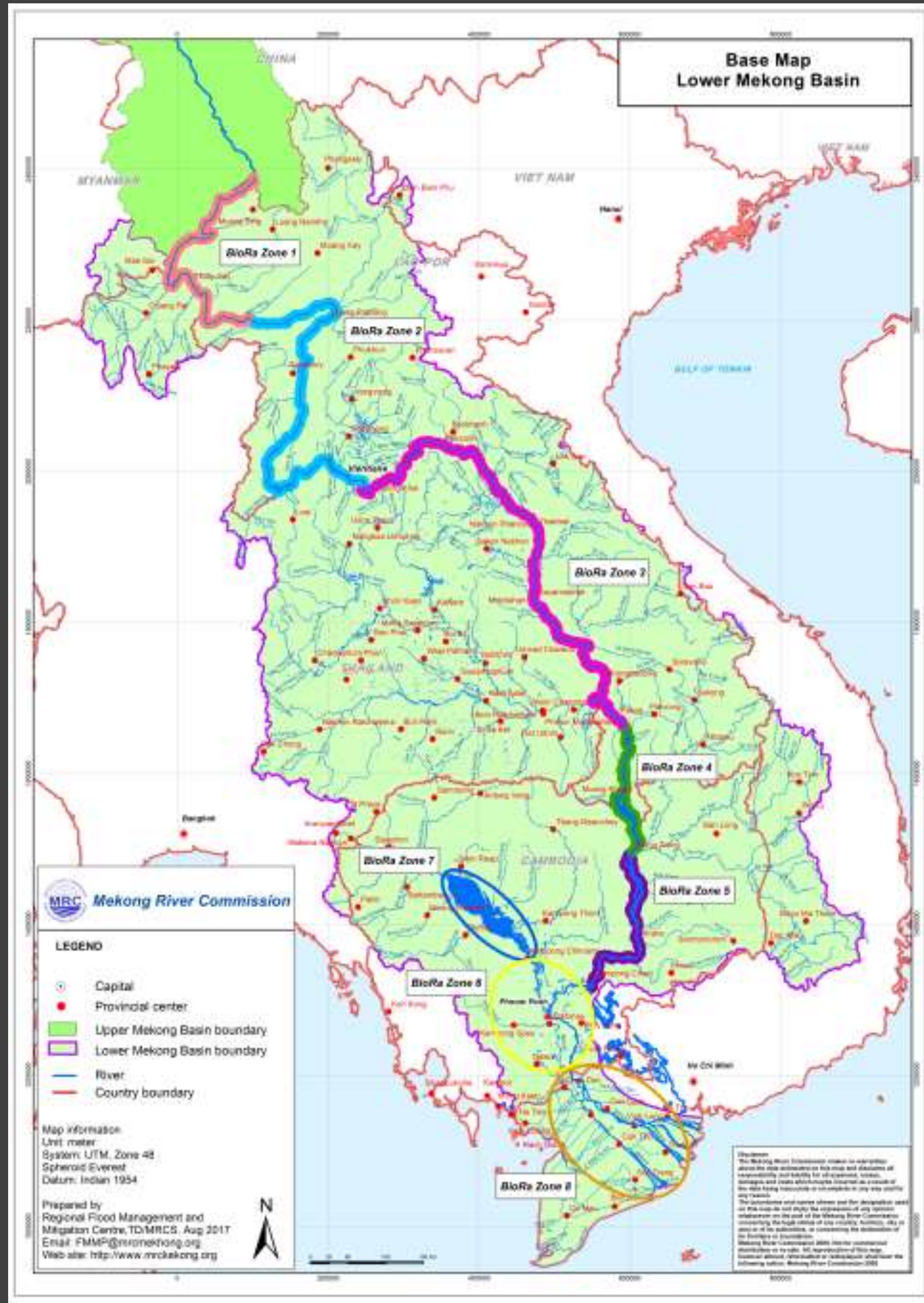
LOWER MEKONG RIVER

MRC Council Study



EFlows assessment

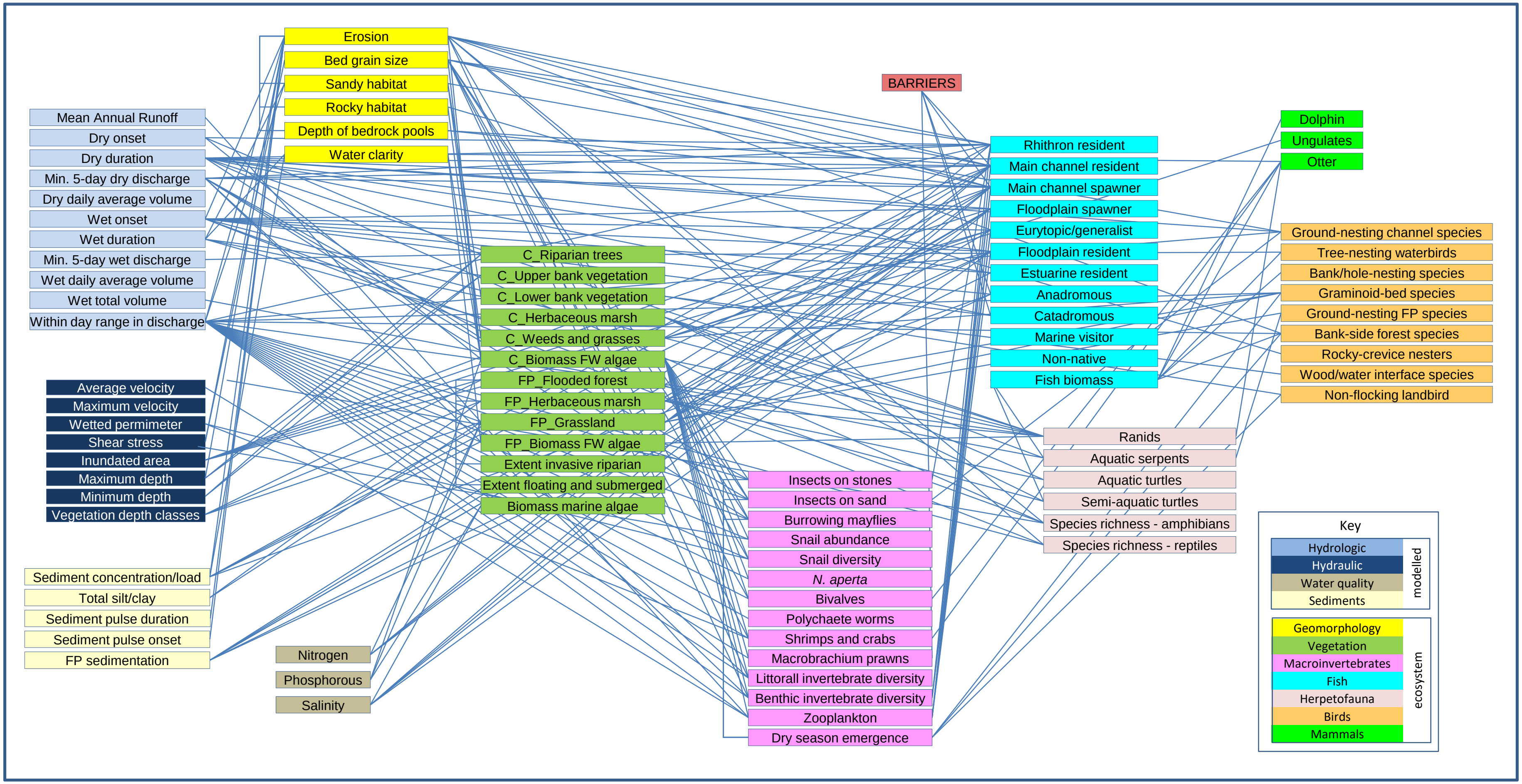



Base Map
Lower Mekong Basin
MYANMAR
VIET NAM
CAMBODIA
BioRs Zone 1
BioRs Zone 2
BioRs Zone 3
BioRs Zone 4
BioRs Zone 5
BioRs Zone 6
BioRs Zone 7
BioRs Zone 8
Mekong River Commission
LEGEND
Capital
Provincial center
Upper Mekong Basin boundary
Lower Mekong Basin boundary
River
Country boundary
Map information
Unit: meter
System: UTM, Zone 48
Spheroid Everest
Datum: Indian 1954
Prepared by
Regional Flood Management and
Mitigation Centre,TD/MRCS, Aug 2017
Email: FMMP@mrcmekhong.org
Web site: http://www.mrcmekong.org
N

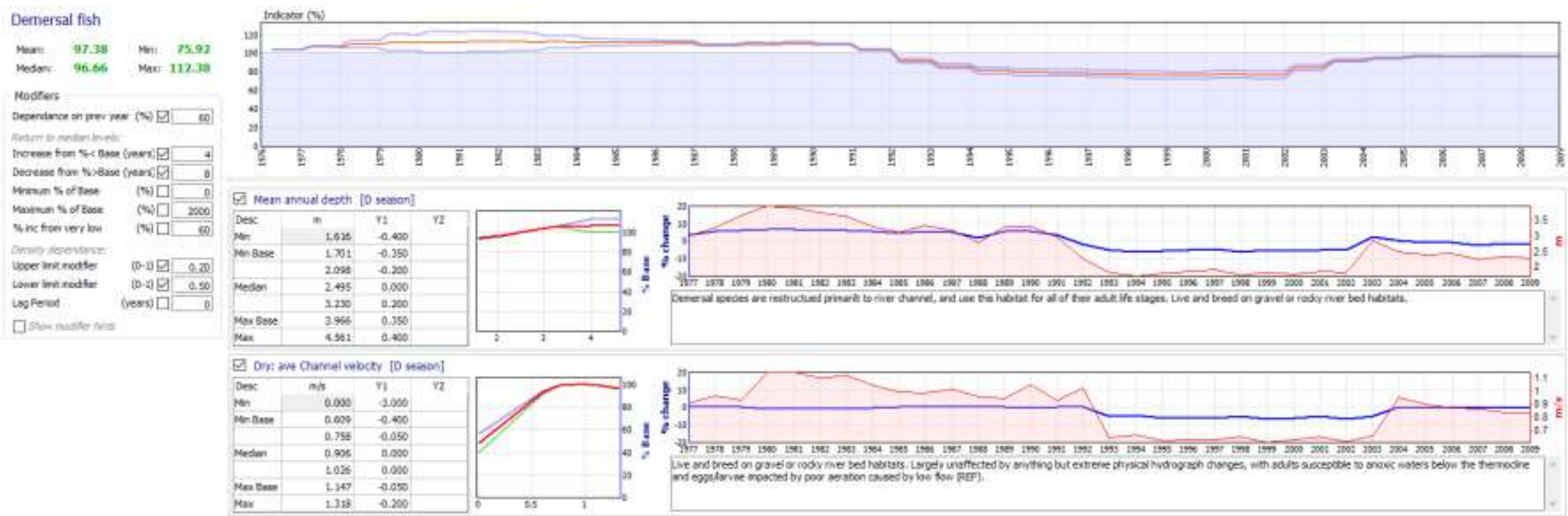
BioRA EFlows DSS

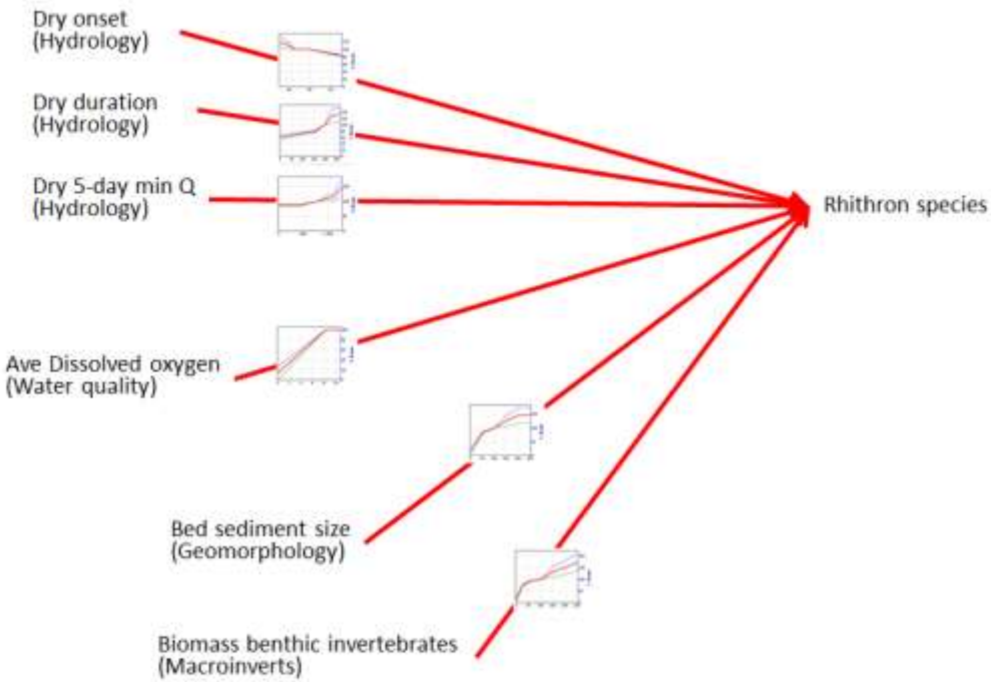
- Erosion
- Habitat availability
- Wetland and riparian vegetation
- Insects, snails, mussels, prawns, crabs
- Fish
- Frogs, snakes and turtles
- Birds
- Aquatic and semi-aquatic mammals

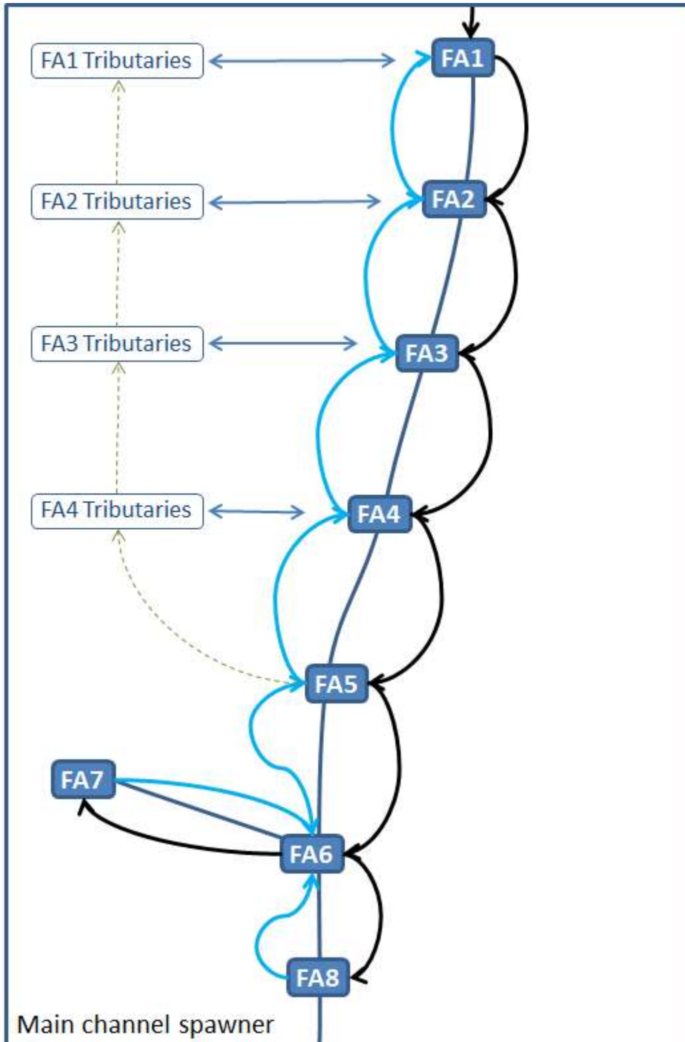
BioRA (DRIFT) DSS



Response curves

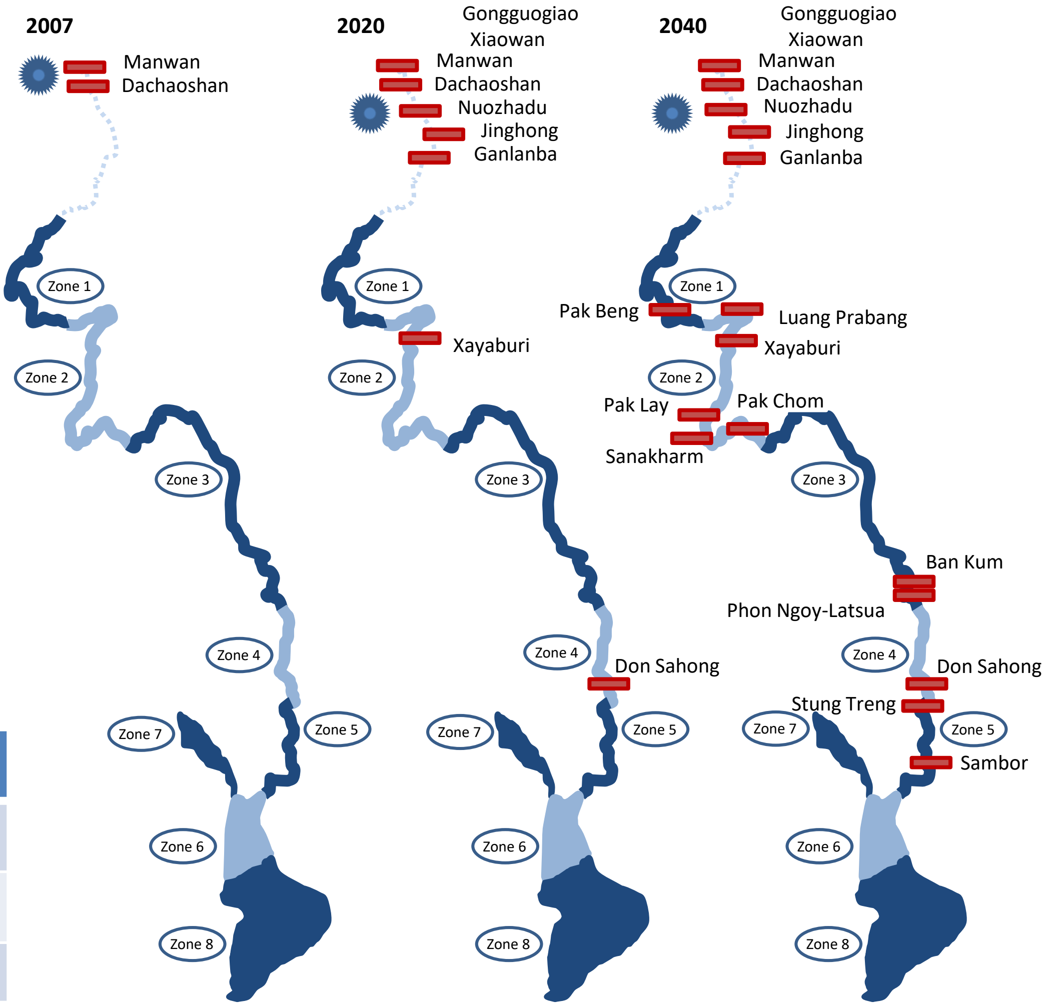



Dry onset
(Hydrology)
Dry duration
(Hydrology)
Dry 5-day min Q
(Hydrology)
Ave Dissolved oxygen
(Water quality)
Bed sediment size
(Geomorphology)
Biomass benthic invertebrates
(Macroinverts)
Rhithron species


FA1 Tributaries
FA2 Tributaries
FA3 Tributaries
FA4 Tributaries
FA1
FA2
FA3
FA4
FA5
FA6
FA7
FA8
Main channel spawner

Scenarios

- Climate change
- Landuse
- Navigation
- River works
- Hydropower

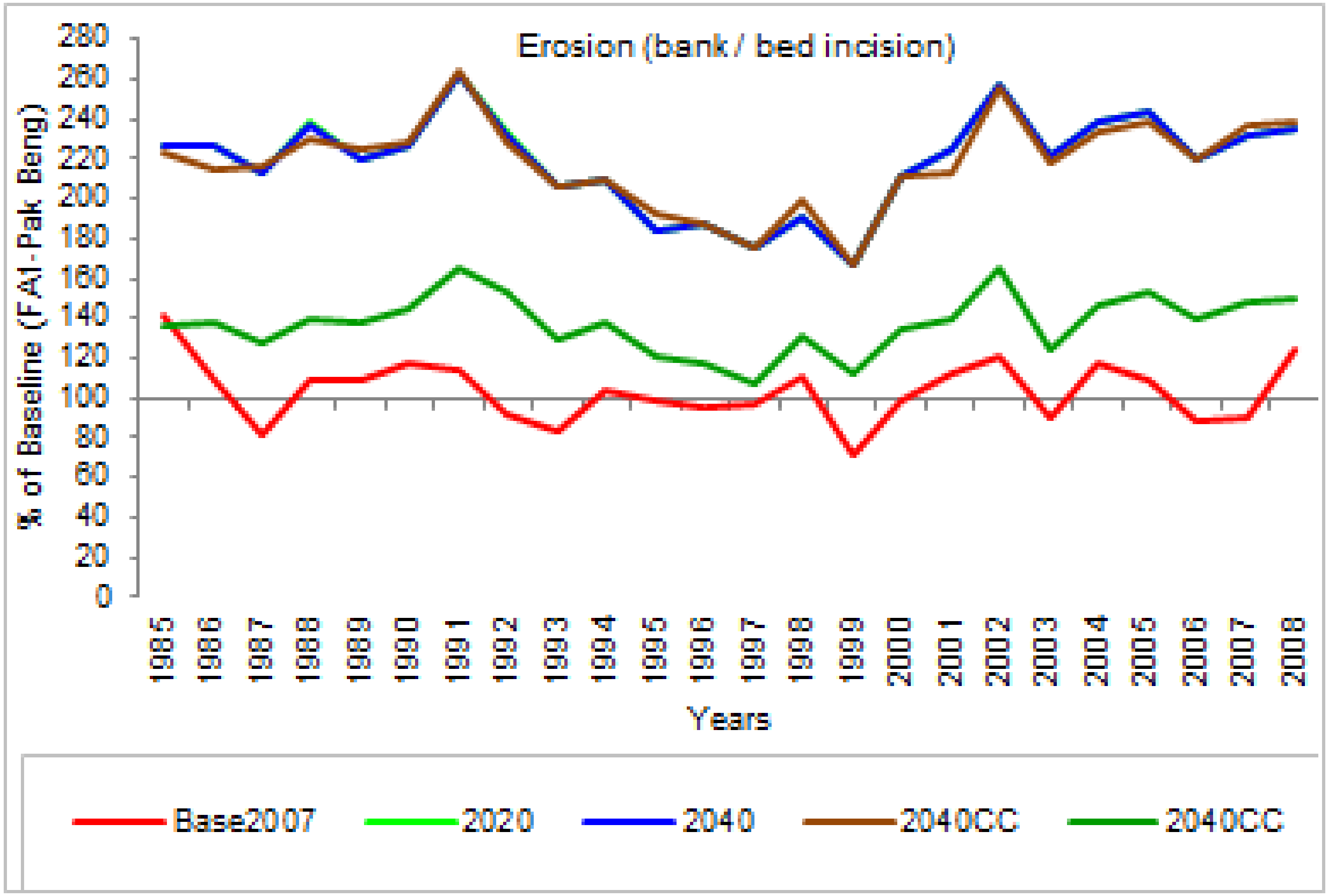


Scenario	Dams in tributaries
2007, 2020 and 2040	14
2020 and 2040	49
2040	57

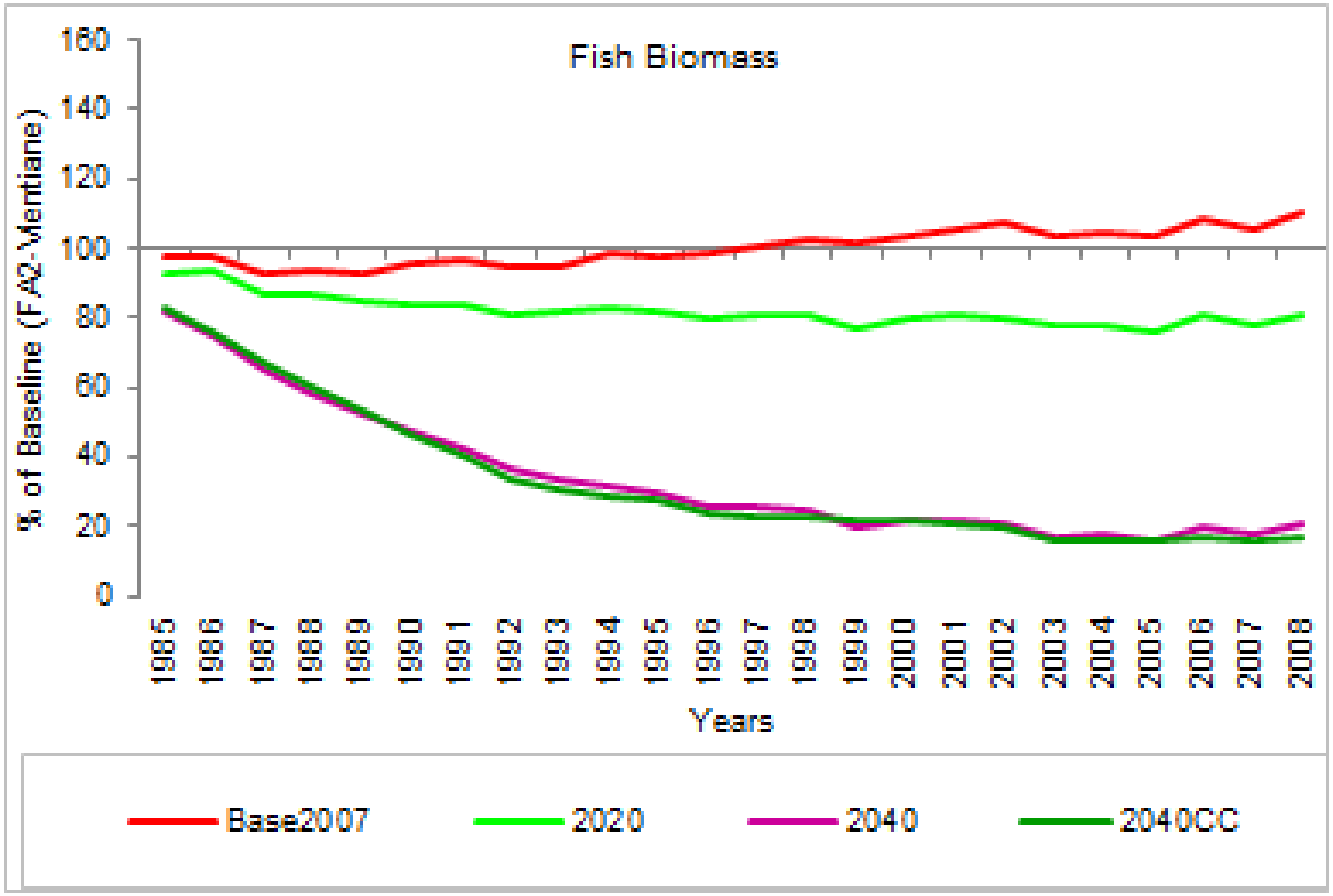
Tables for all indicators

Scenario	Indicators	Zone 1	2	3	4	5	6	7	8a	8b	8c
Scenario 2020	D: Average sediment load	-99	-45	25	-83	-79	-58				
	T1: Average sediment load	-100	-65	-41	-75	-45	-60				
	W: Average sediment load	-91	-73	-47	-60	-66	-58				
	T2: Average sediment load	-98	-73	-23	-68	-92	-71				
	W: Average sediment onset	7	-2	0	3	-5	11				
	W: Average sediment duration	-41	5	9	-11	-7	-4				
	D: Average Total Phosphorous	-51	-42	-28	-9	-18	-7		-33	-29	-26
	W: Average Total Phosphorous	-19	-20	-14	-11	-28	-35		-29	-32	-15
	D: Average Total Nitrogen	-23	-29	-21	-17	-17	-6		-15	-29	-30
	W: Average Total Nitrogen	-17	-19	-19	-22	-53	-35		-32	-35	-18
	W: FP TOT SiltClay			-9		-66	-63		-68	-65	-74
	FP Sedimentation						-65	-24	-68	-65	-73
	Average salinity								28		
Scenario 2040	D: Average sediment load	-99	-77	23	-85	-93	-91				
	T1: Average sediment load	-100	-82	-41	-79	-98	-98				
	W: Average sediment load	-91	-87	-56	-60	-97	-95				
	T2: Average sediment load	-98	-88	-31	-69	-97	-94				
	W: Average sediment onset	7	0	0	3	-3	-18				
	W: Average sediment duration	-41	-3	12	-13	8	13				
	D: Average Total Phosphorous	-51	-67	-42	-9	-60	-58		-69	-68	-70
	W: Average Total Phosphorous	-19	-9	-11	-11	-66	-69		-66	-68	-53
	D: Average Total Nitrogen	-23	-44	-27	-17	-20	-17		-39	-42	-52
	W: Average Total Nitrogen	-17	14	10	-22	-52	-61		-59	-58	-25
	W: FP TOT SiltClay			-9		-97	-97		-97	-97	-94
	FP Sedimentation						-97	-56	-97	-97	-94
	Average salinity								20		
Scenario 2040CC	D: Average sediment load	-99	-54	9	-85	-96	-93				
	T1: Average sediment load	-100	-61	-38	-73	-98	-98				
	W: Average sediment load	-93	-75	-48	-59	-96	-95				
	T2: Average sediment load	-98	-71	-20	-70	-92	-97				
	W: Average sediment onset	10	2	3	7	3	2				
	W: Average sediment duration	-40	11	18	-11	1	37				
	D: Average Total Phosphorous	-51	-70	-46	-10	-61	-40		-15	27	-61
	W: Average Total Phosphorous	-19	-16	-14	-11	-67	-65		-57	-48	-3
	D: Average Total Nitrogen	-23	-55	-40	-17	-20	8		73	136	-31
	W: Average Total Nitrogen	-17	-21	-25	-20	-62	-49		-43	-28	42
	W: FP TOT SiltClay			-13		-97	-96		-96	-96	-91
	FP Sedimentation						-96	-54	-96	-96	-91
	Average salinity								36		

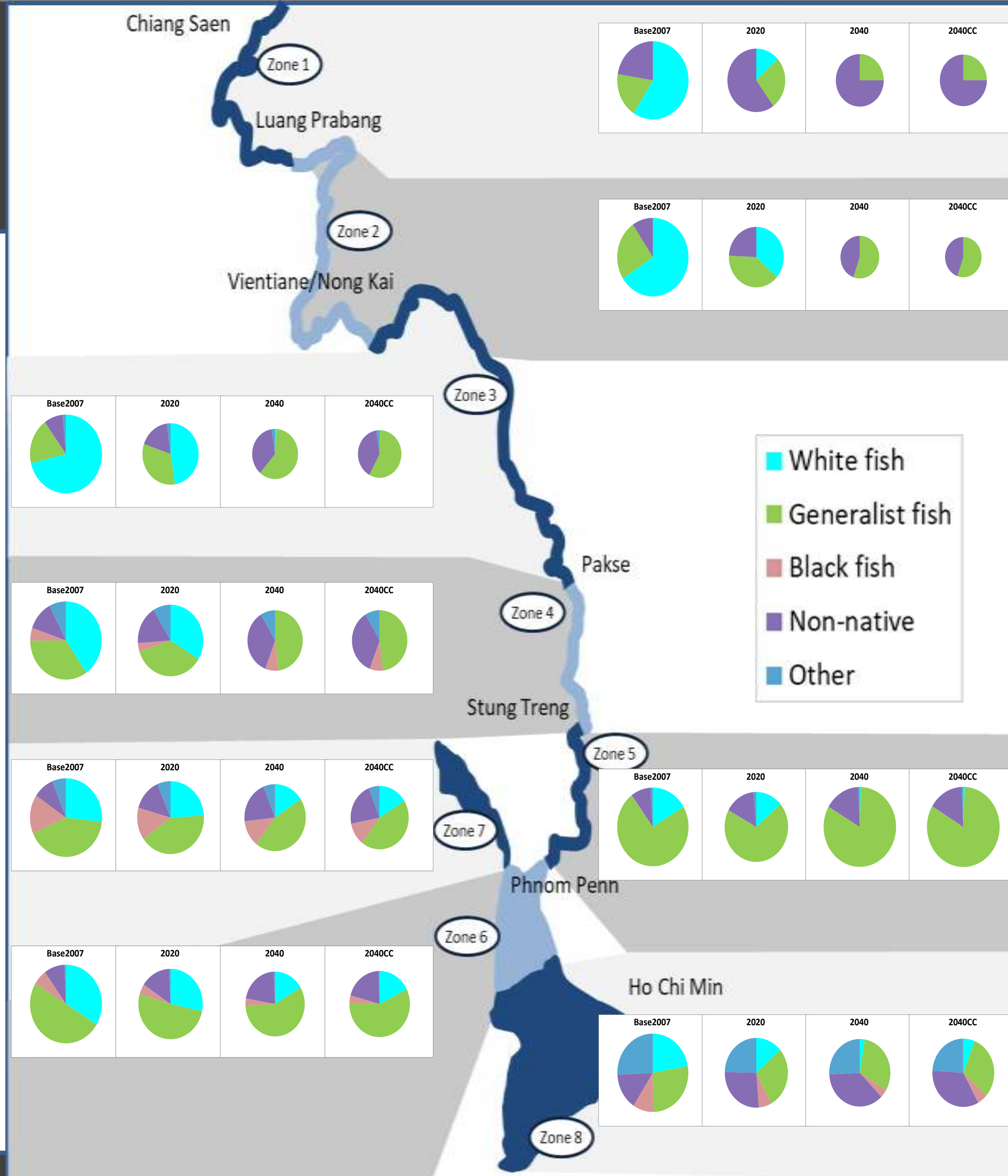
Time-series (Erosion: Zone 1)



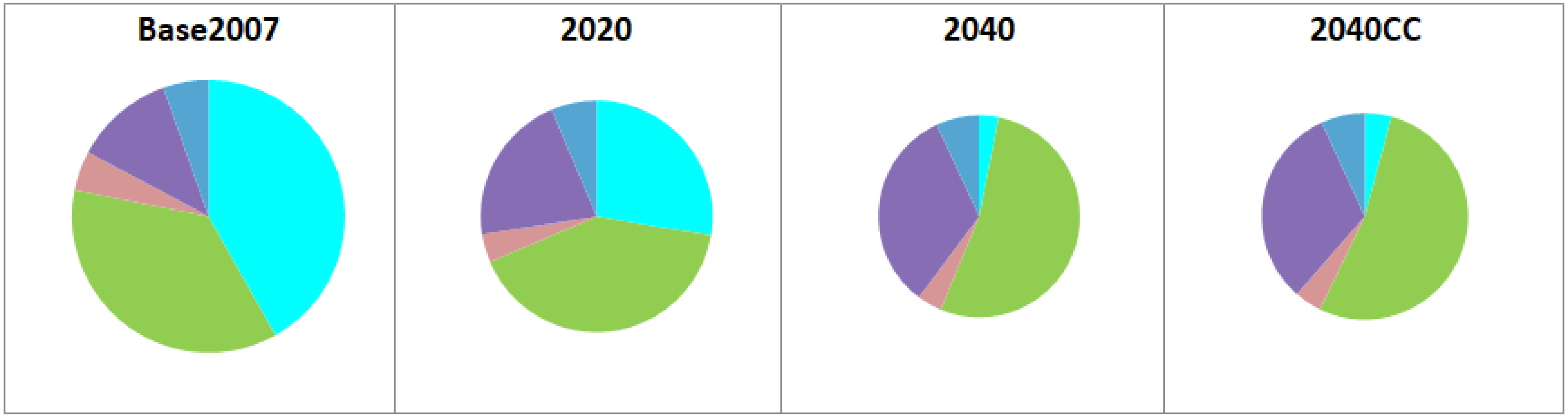
Time-series (Fish biomass: Zone 2)



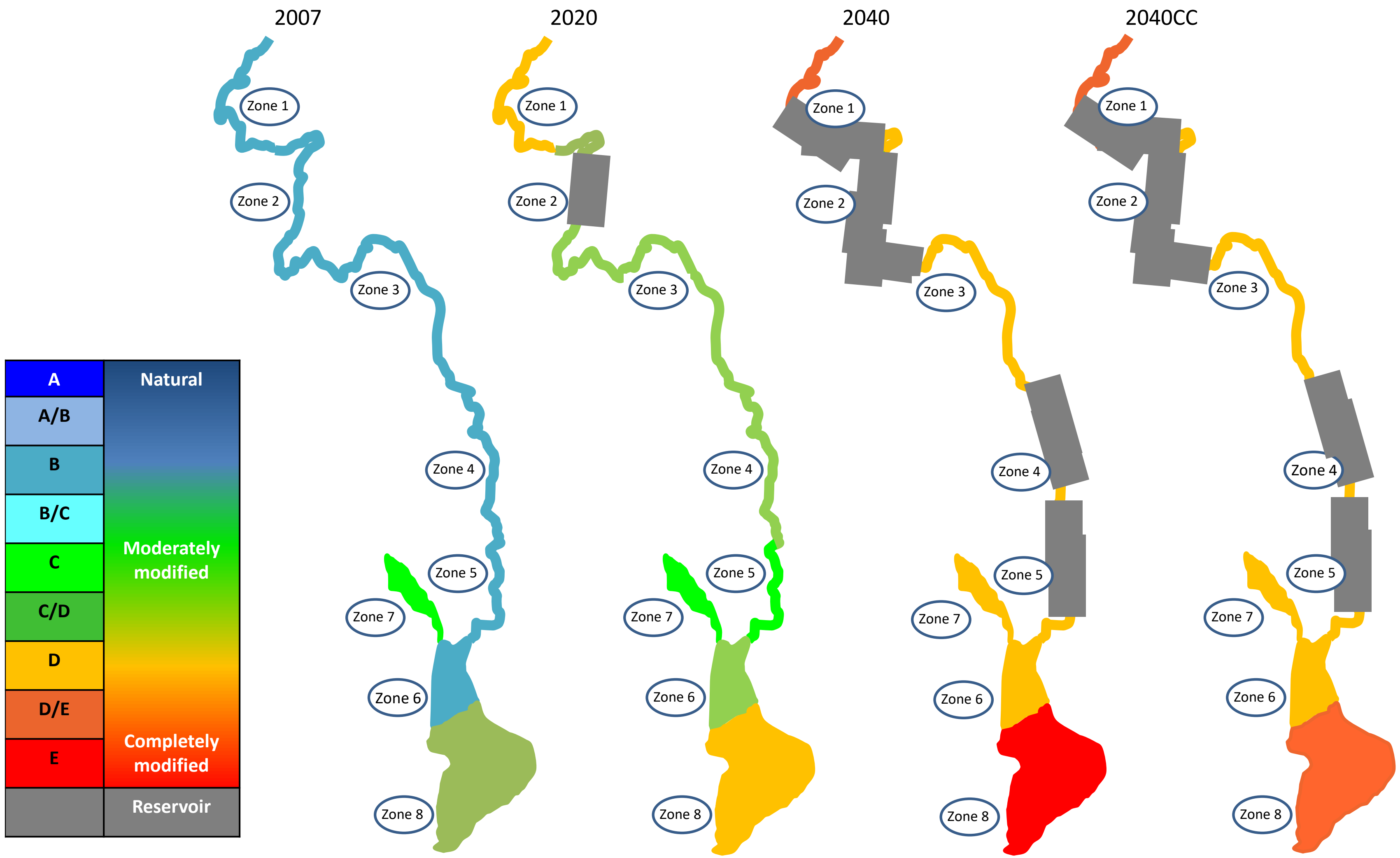
Fish biomass and proportional representation



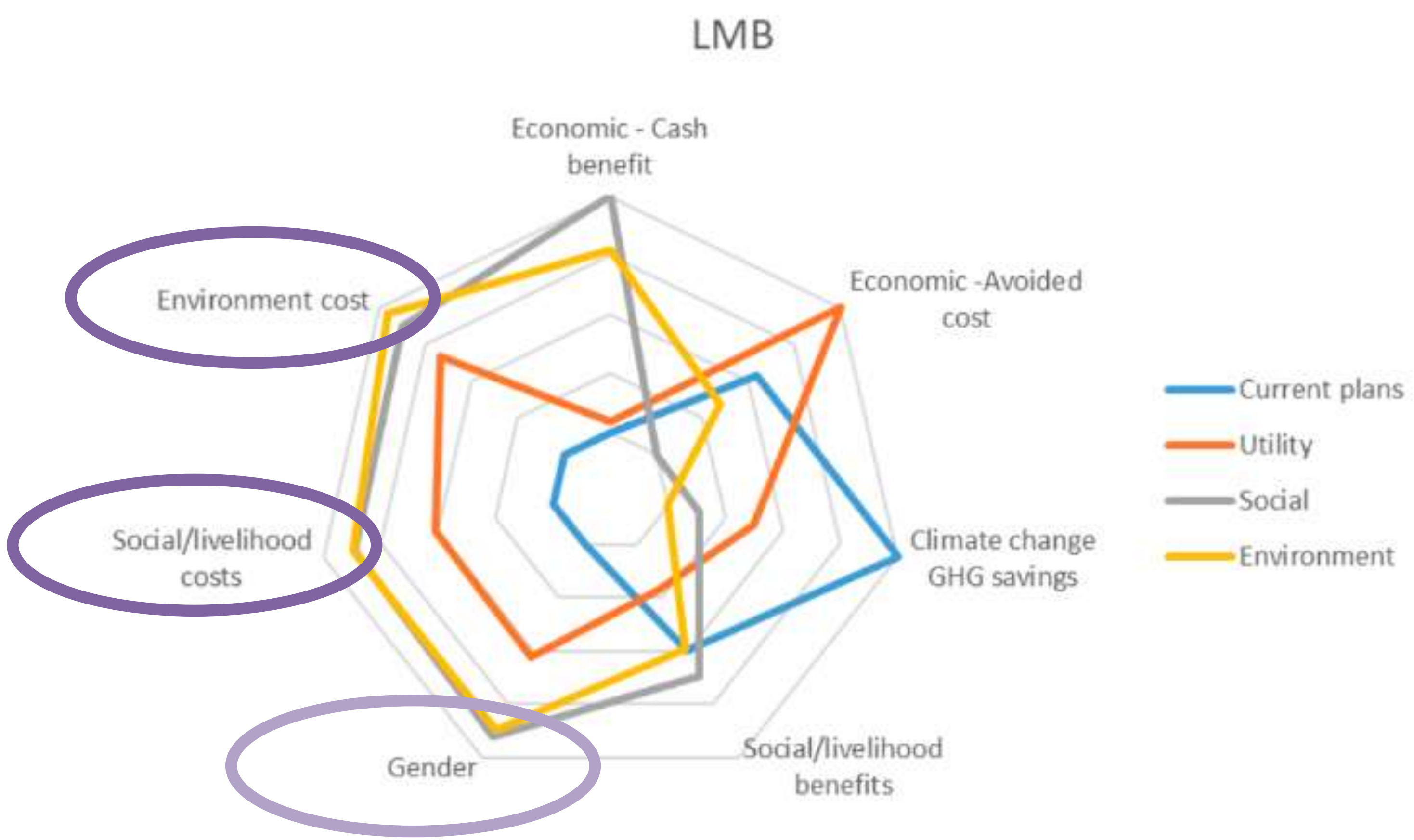
Fish biomass – whole LMB



Example of outputs



In-depth analysis of options



Environment normalised indices (5=lowest cost)

Secondary indicator	% Cost	Current plans pathway	Utility pathway	Social pathway	Environment pathway
1. Flooding of environmental hotspots	5%	1.00	3.43	4.35	5.00
2. Fish diversity	5%	1.00	4.37	4.13	5.00
3. Downstream impacts	10%	1.00	4.63	4.10	4.91
4. Flooding of protected areas	10%	1.00	3.45	2.63	5.00
5. Lost land	15%	1.00	4.01	4.33	4.34
6. Erosion	5%	1.08	1.00	5.00	4.06
7. Overall System Integrity	50%	1.00	3.66	5.00	4.98
Summary		**1.00**	**3.68**	**4.50**	**4.84**

- ✓ Stark pattern of **highest costs being imposed by the Current Plans** and **lowest costs by the Social and Environment** pathways.
- ✓ The **weighting has been biased to overall system integrity**, because this indicator gives an overall environmental score for each pathway.
- ✓ Social and Environment pathways have almost the same level of hydropower development by 2040, so it is the **different combination of dams, together with the chosen weighting structure, which explains the difference**.

REVIEW

#	Criteria	Y	N
1	Were Stakeholders adequately engaged at all points in the process?		
2	Is there a review of existing knowledge about the host river system? - hydrological characteristics - ecological attributes and key features of sensitivity - ecological condition - social uses and level of dependence on aquatic ecosystem services.		
3	Is there a desktop delineation of the basin/sub-basin affected by the HPP? - Are there any floodplains likely to be affected? - Are there any ecosystems other than rivers likely to be affected by the HPP?		
4	Does the level of assessment undertaken correspond with that recommended through using the Decision Tree? - If not, are compelling reasons provided for not implementing the recommended level of assessment?		
5	Is the level of resolution of the EFlows Assessment justified?		
6	Is the EFlows Assessment method correctly applied and referenced? - Are the dewatered section and the river downstream of the tailrace assessed separately? - Are the calculations shown? - Are the calculations done correctly? - Are the EFlows contextualised within the hydrological regime of the river? - Are the limitations of the EFlows assessment made clear?		
7	Are the potential effects of changes in the longitudinal movement of sediments, fish and other organic and inorganic materials adequately described and addressed?		
8	Does the EFlows Assessment consider: 1. a site upstream of the HPP reservoir; 2. a site between the HPP weir and the tailrace outlet (if relevant); 3. at least one site (and preferably more) downstream of the tailrace outlet?		
9	Is peaking-power generation planned? If so, were the potential impacts of peaking-power releases assessed at an appropriate time-step?		
10	Is an EFMP in place for the construction and operation phases?		

Thank you