Ecosystem modelling approach to Eflows assessment

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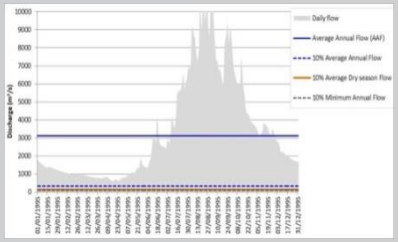
Cape Town

1970 — Evolution of EFlows discipline — 2020

Hydrological
$Q_{95;}$ 10% AAF

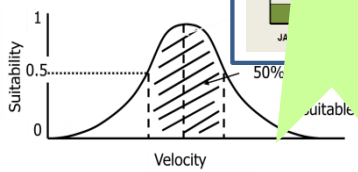


Hydraulic
Wetted perimeter

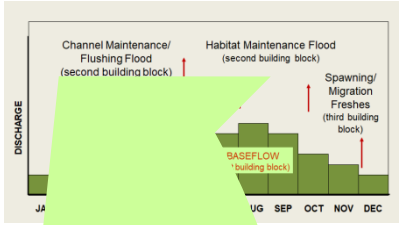
Left bank

Rig

Habitat ra
IFIM; PHAB



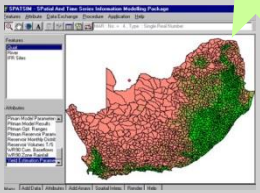
Holistic
BBM; Benchmarking



Ecosystem models
DRIFT; RANA-ICE

Forces pushing:
- Black box
- Ecosystems
- Social concerns
- Negotiations
- Capacity building
- Monitoring targets

Rapid Frameworks
Desktop; ELOHA, DRIFT
Equations

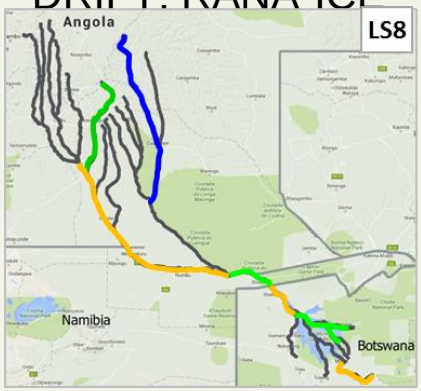


Remote sensing; Satellite imagery; Hydrodynamics

UN environment
United Nations Environment Programme

Ecosystem models

DRIFT: RANA-ICE



Nairobi Convention

gef

Ecosystem models for EFlows

Based on a combination of data, knowledge and experience, use scenarios to show how interventions in river basins resonate through to biodiversity, ecosystem services, and lives and livelihoods.

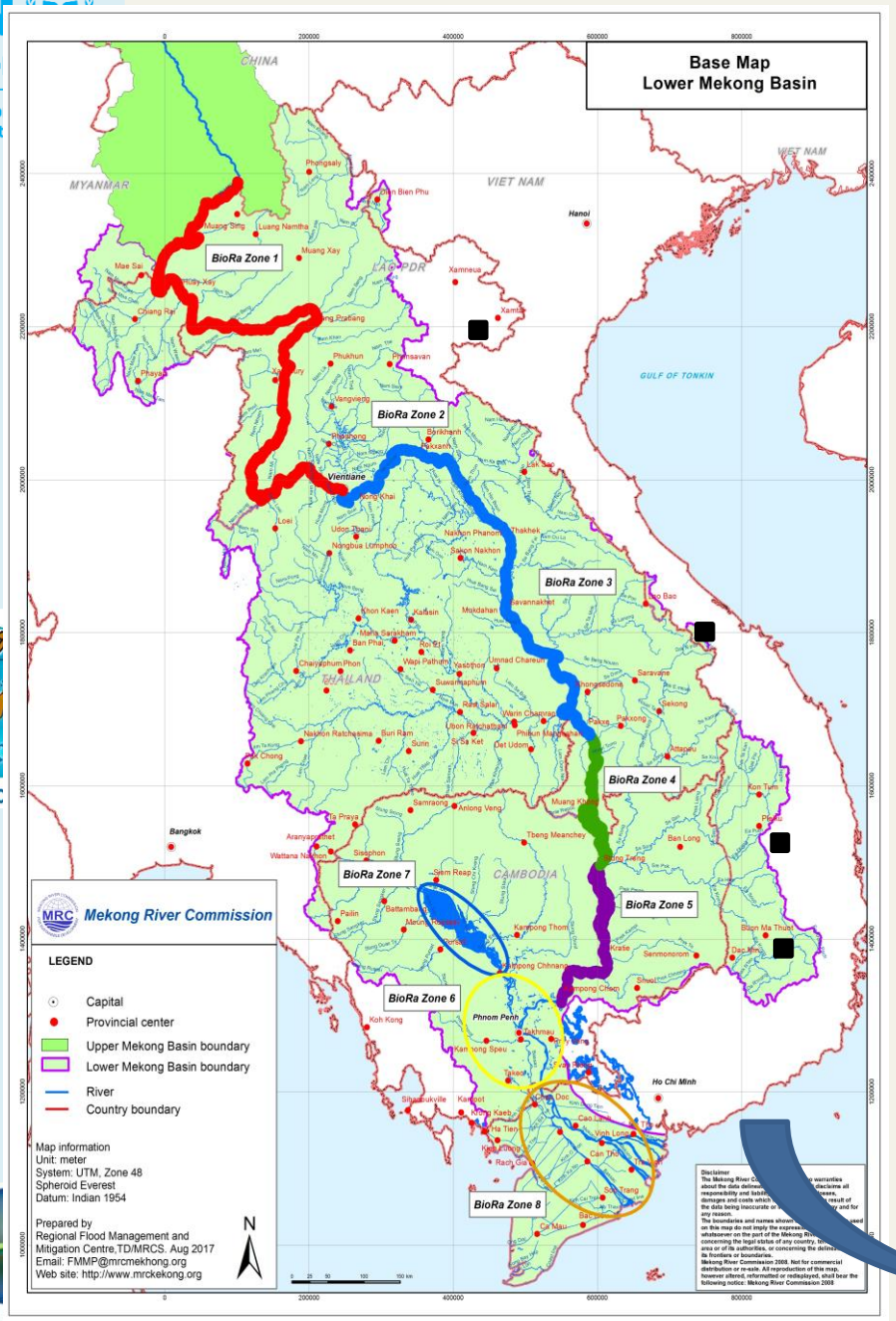
Interventions change the following drivers :

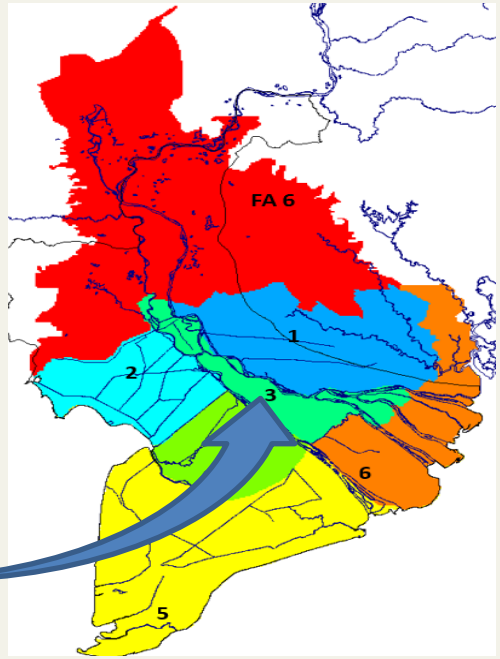
- Hydrology
- Hydraulics
- Sediments
- Water quality
- Barriers (connectivity)
- Harvesting pressure

DRIFT Model

www.drift-eflows.com

Sites to represent river reaches or whole areas for floodplains/deltas/ lakes/estuaries





Indicators to represent ecosystem and social use

A network of indicators is used to describe the river ecosystem and its human users. These include:

- a range of aspects of the flow, sediment and WQ regime of the river
- a range of ecosystem attributes
- a range of river-linked social attributes

Change described as a % change from baseline for each indicator

Selection of driving indicators for one site

Discipline	DRIVING Indicators
Hydrology (sub-set)	Dry season onset
	Dry season min 5-day discharge
	Dry season duration
	Dry season average daily volume
	Wet season onset
	Wet season duration
	Wet season maximum discharge
	Wet season duration
	Wet season flood volume
	Within-day range in discharge
Hydraulics	Width/wetted perimeter
	Depth
	Mean velocity
	Mean shear stress
Suspended sediments	Dry: min/max/mean Coarse suspended sediment
	Dry: min/max/mean Fine suspended sediment
	Wet: min/max/mean Coarse suspended sediment
	Wet: min/max/mean Fine suspended sediment
Water quality	Nutrient concentrations
	Temperature

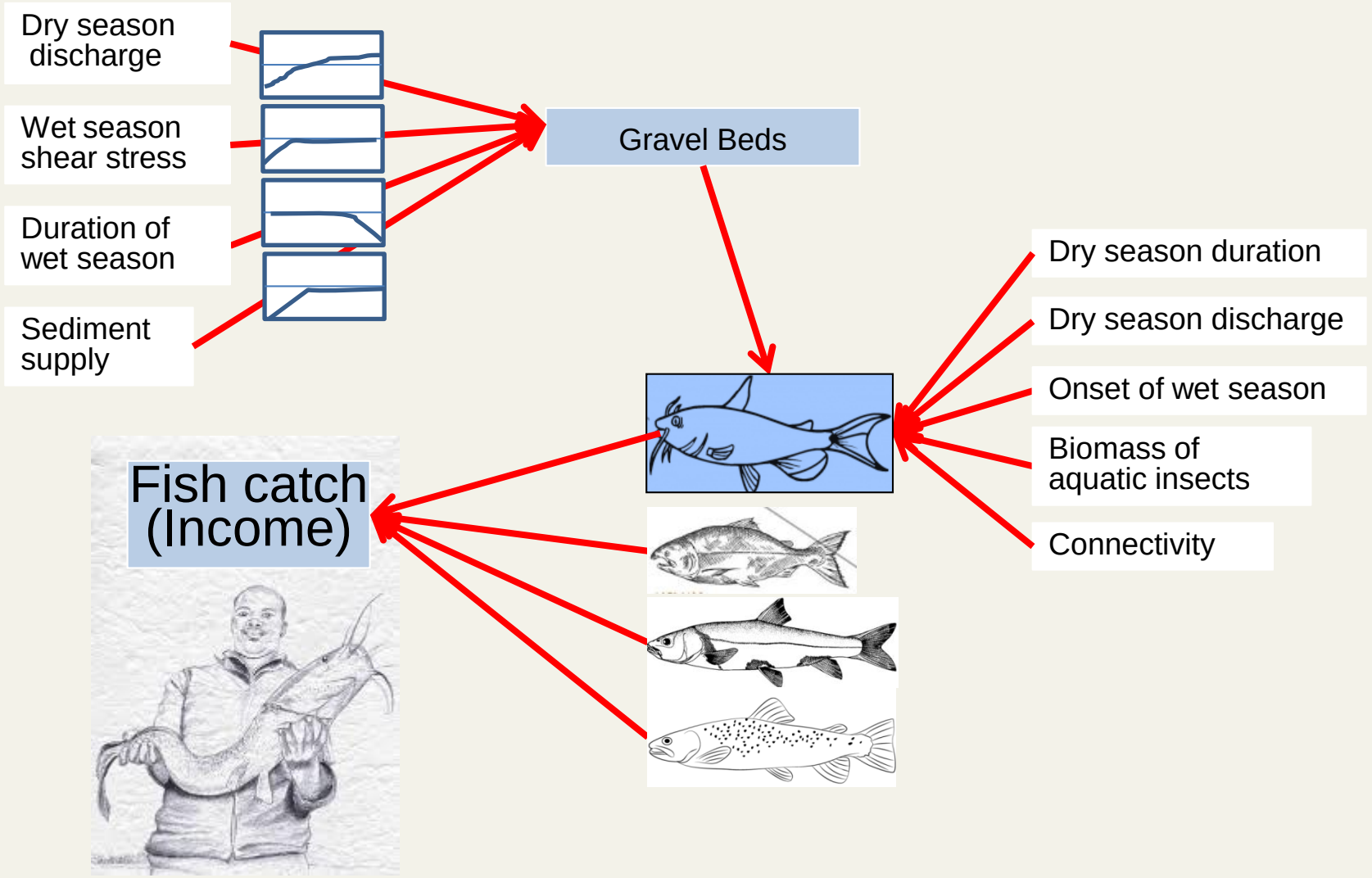
Selection of responding indicators for one site

Discipline	RESPONDING Indicators
Geomorphology (habitat)	Lengths of cut banks
	Bed sediment size (fine to coarse)

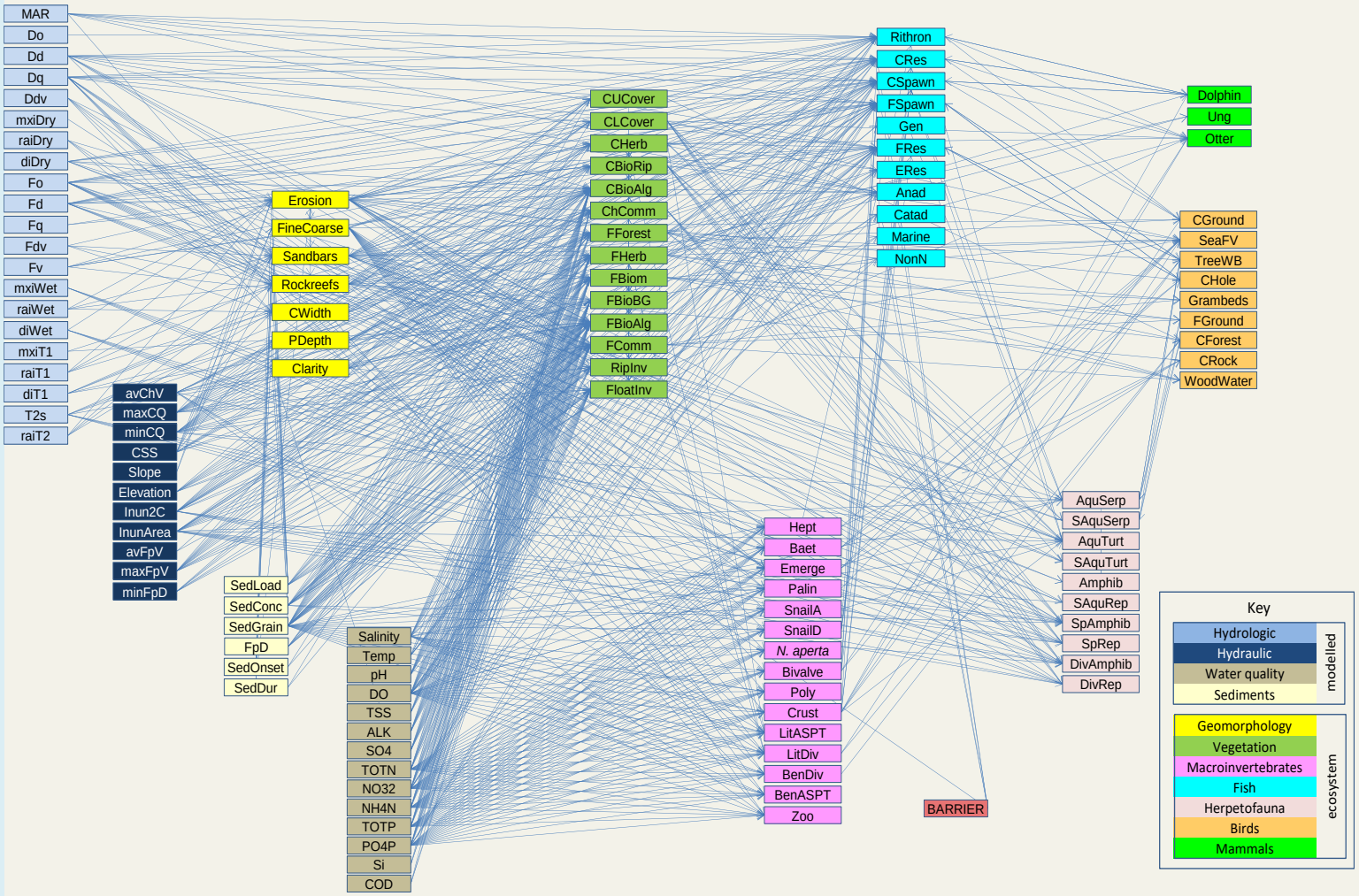
Discipline	RESPONDING Indicators
Macroinvertebrates	Ephemeroptera
	Midges
	Pest species
	Shrimps/prawns
Vegetation	
Fish (sub-set)	Hydrocynus vittatus
	Mormyrops anguilloides
	Labeo cylindricus
	Cichlids
	Distichodus spp
	Labeo altivelis
Crocodiles	

Discipline	RESPONDING Indicators
Social	Availability of fish
	Availability of fruits (figs, etc.)
	Extent of grazing for livestock
	Availability of reeds and grasses
	Extent of flood irrigated commercial agriculture

Captures relationships of driving and responding indicators



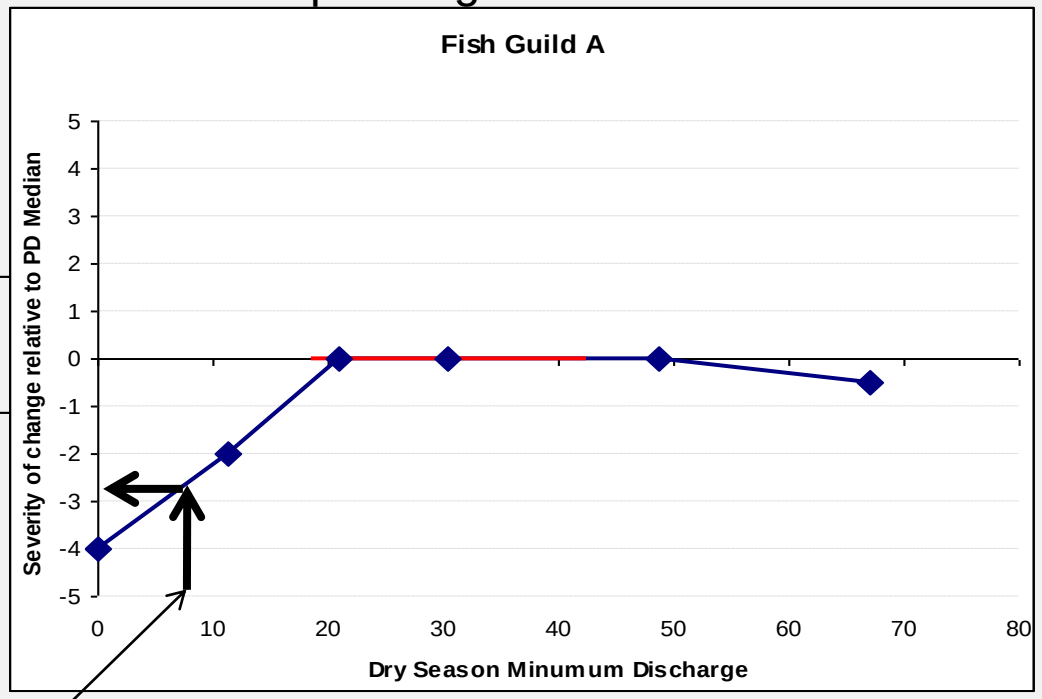
A simplified eco-social model that is true to the complexity of river ecosystems and social uses



External modelled time series

Transformed into time series of driving indicators

Each responding indicator



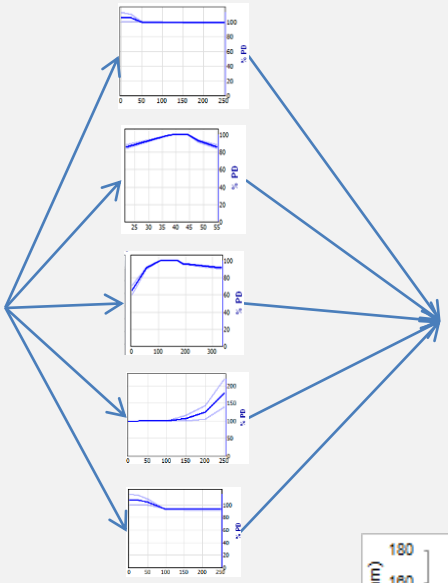
Curves combined using multi-criteria decision analysis procedures

Scenario: Dry season minimum discharge for each year

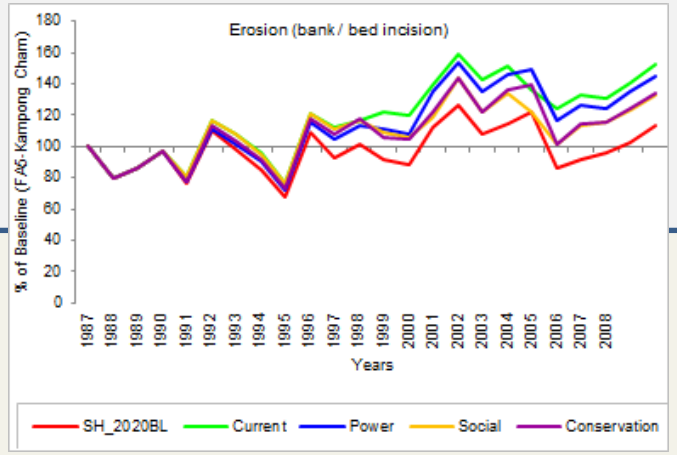
External modelled time series

Transformed into time series of driving indicators

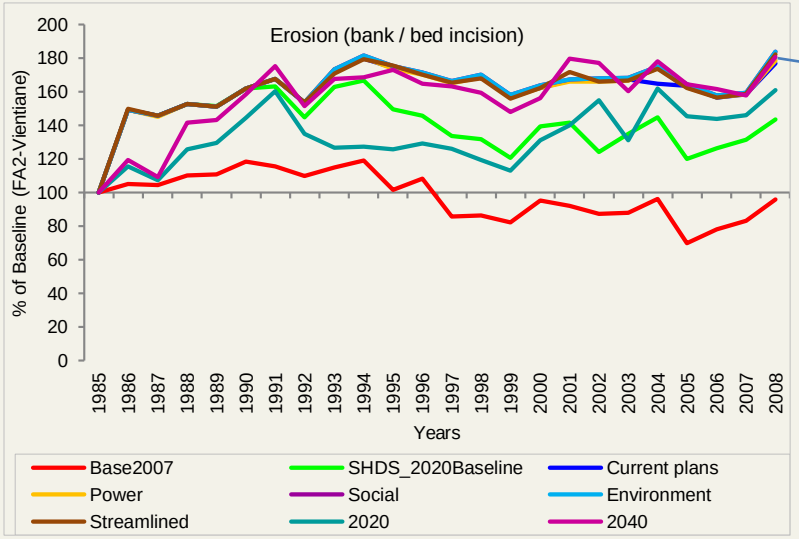
Each responding indicator



DRIFT prediction of change for each year
30 years of record = 30 values



Basic output is time series of relative change per indicator

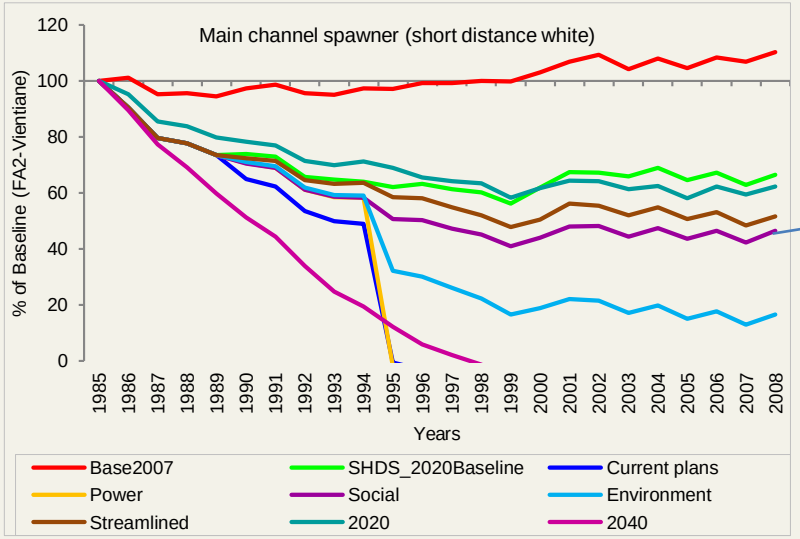


80% increase in erosion

B

‘Health’ of overall Habitat

D



50% reduction in white fish

C

Health of fish community

E

A Natural

B

C Moderately modified

D

E Considerably modified

- Basin-scale, time-series based
- Capture the functioning of river ecosystems
- Assess multi-dimensional scenarios
  - flow of water
  - sediments
  - water quality
  - management issues (channelisation/over-harvesting/sand mining)
- Provide reasons for predictions
- Build capacity and understanding
- Use available information
- Asset for ongoing management, teaching …
- Updated/expanded over time
- Tried and tested

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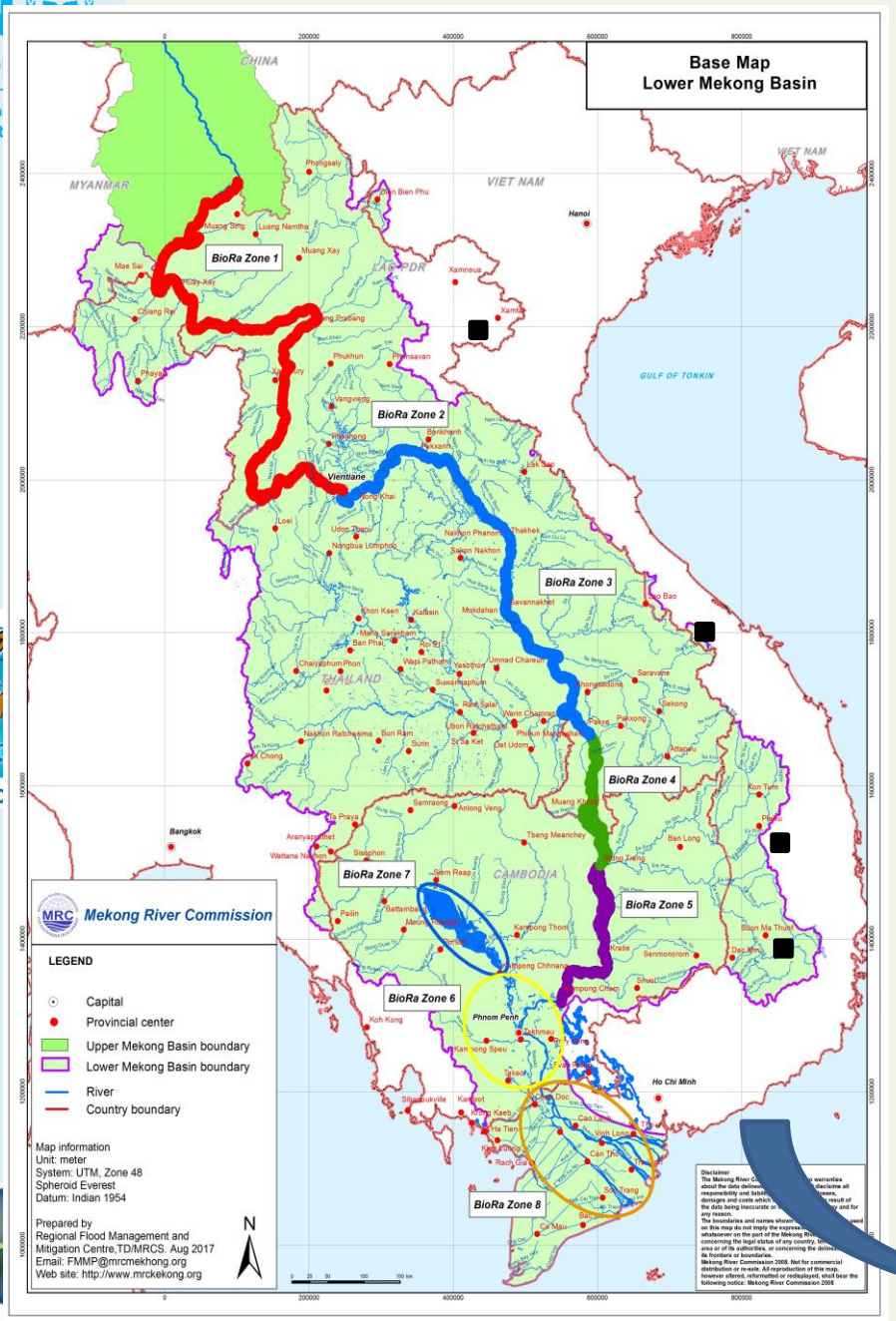
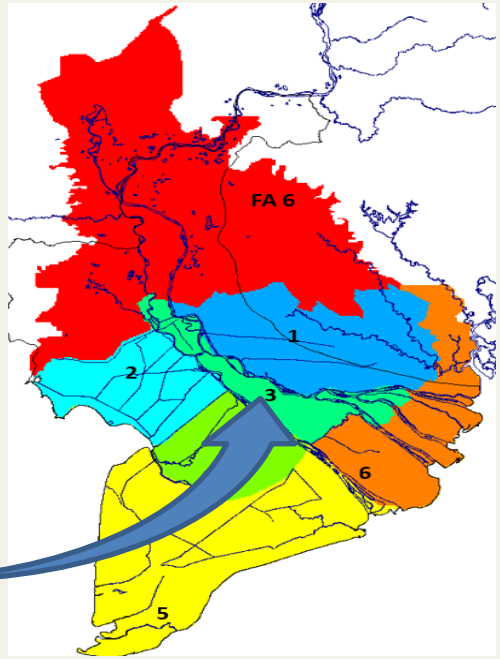
United Nations Environment Programme

EXAMPLE OF APPLICATIONS

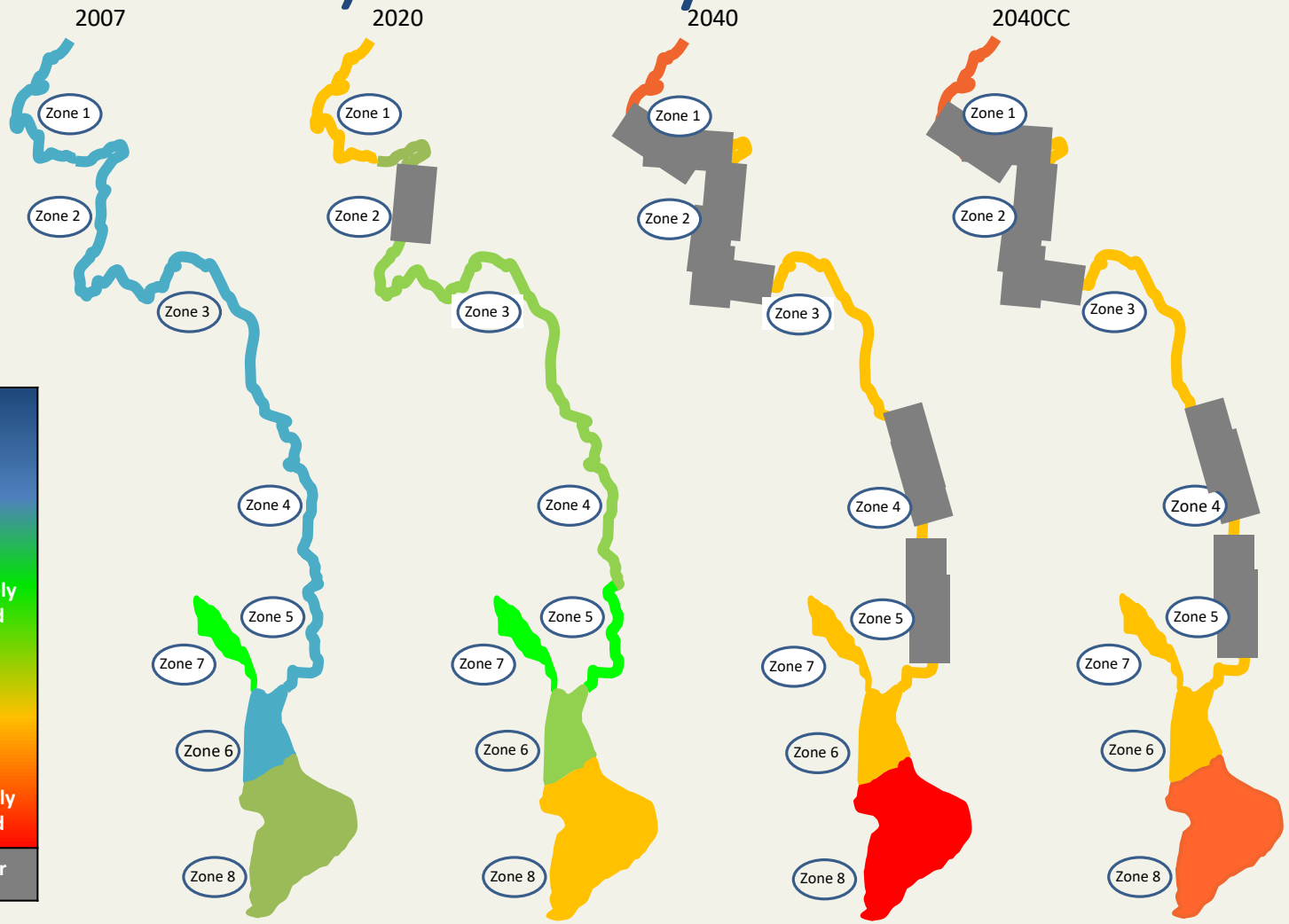


The Lower Mekong Basin:

- Mekong River
- Tonle sap River
- Tonle Sap Lake
- Mekong Delta



Predict impacts of development (*or restoration*) on ecosystem condition



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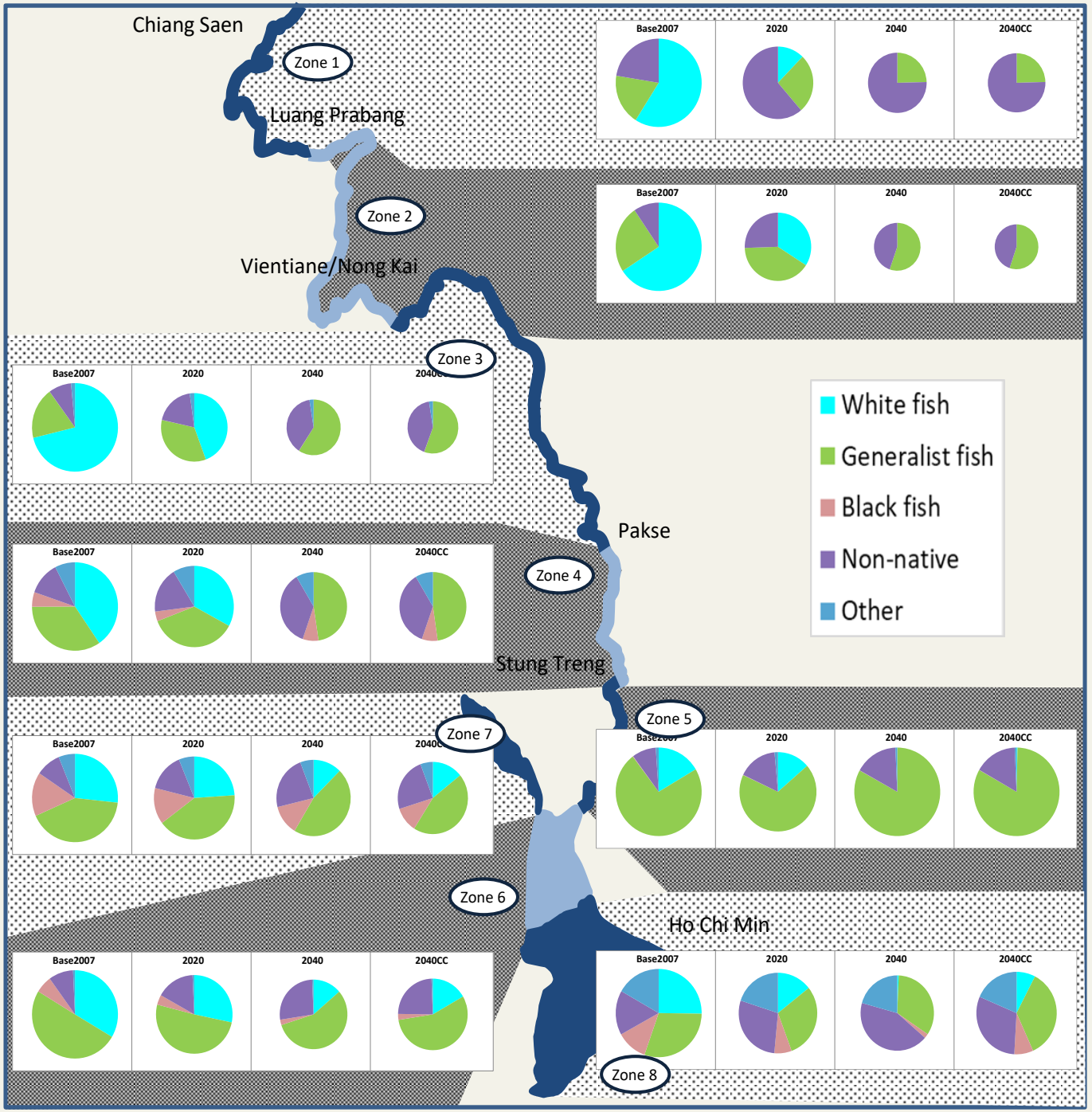
... and on individual resources



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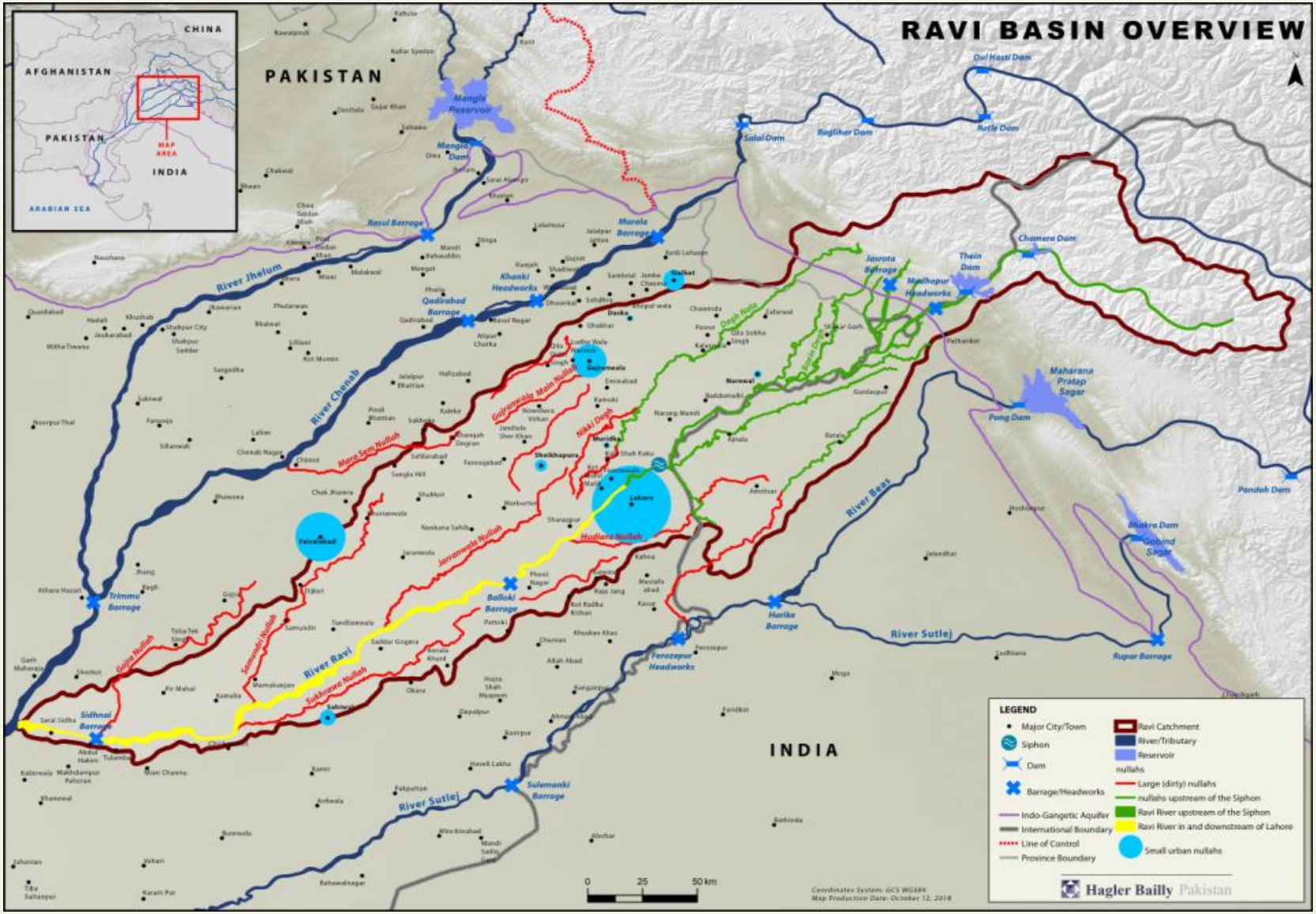
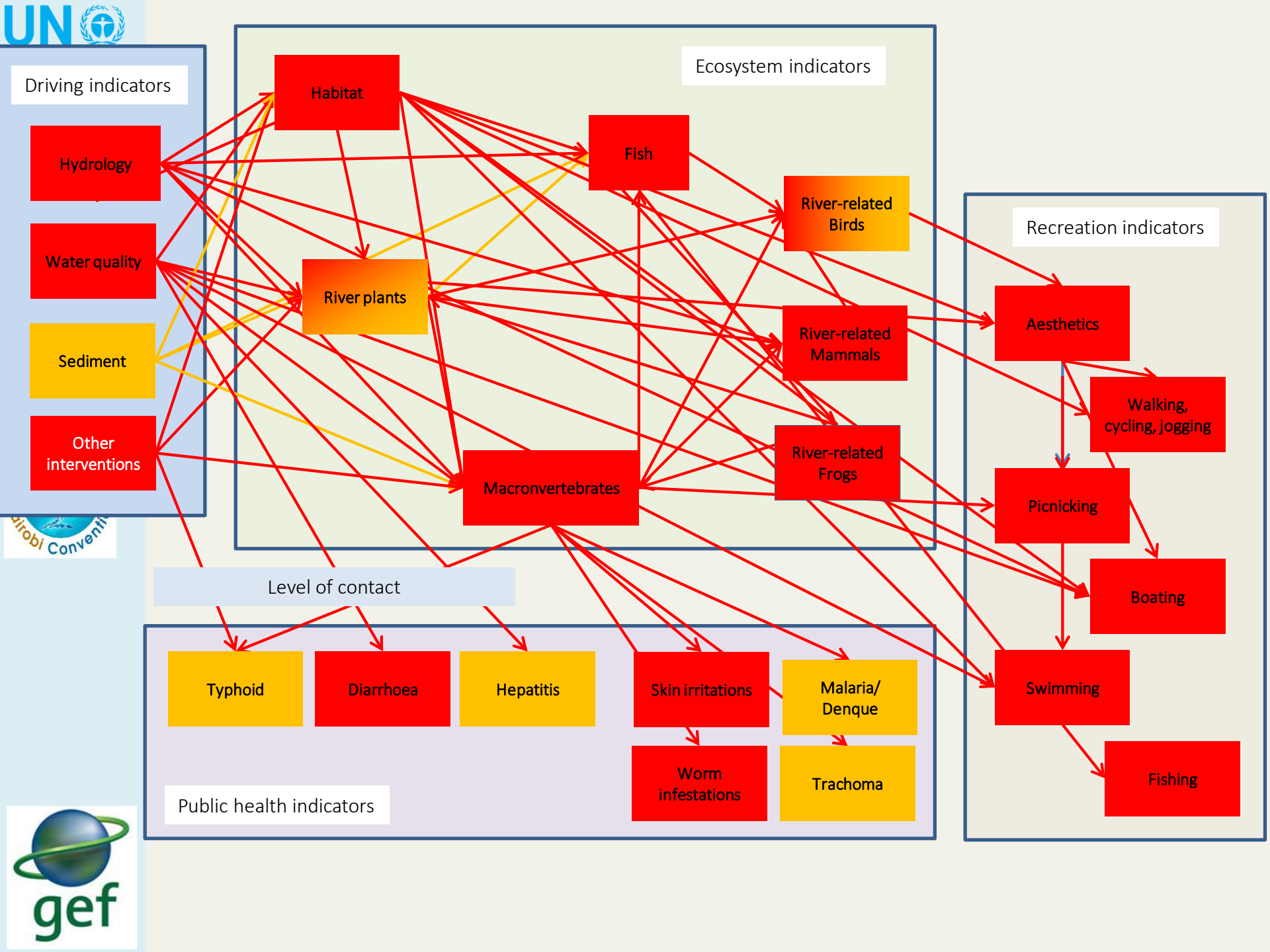
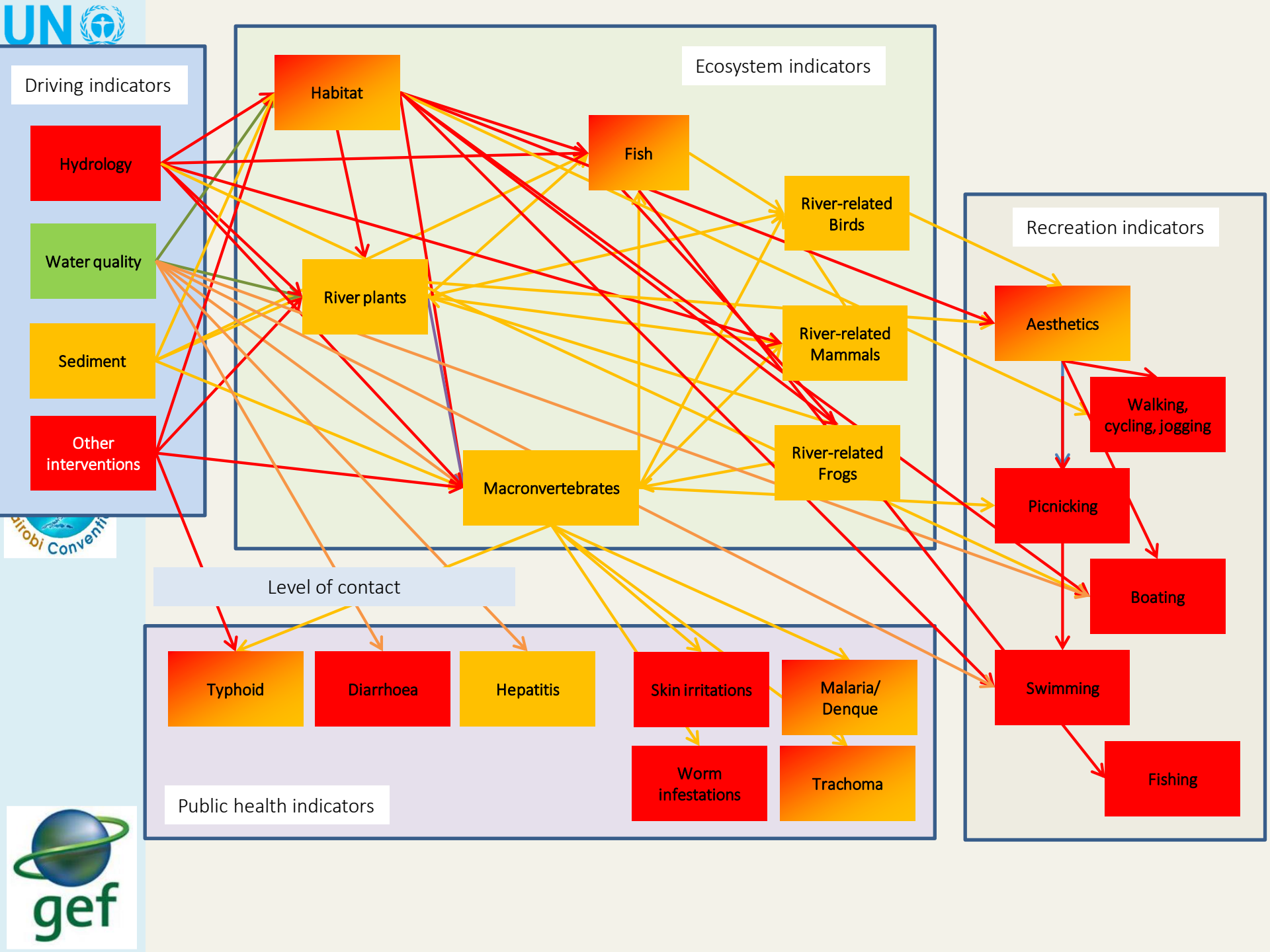
Ravi Basin, Punjab, Pakistan




Driving indicators
Hydrology
Water quality
Sediment
Other interventions
Ecosystem indicators
Habitat
Fish
River-related Birds
River plants
River-related Mammals
River-related Frogs
Macronvertebrates
Recreation indicators
Aesthetics
Walking, cycling, jogging
Picnicking
Boating
Swimming
Fishing
Level of contact
Typhoid
Diarrhoea
Hepatitis
Skin irritations
Malaria/ Denque
Worm infestations
Trachoma
Public health indicators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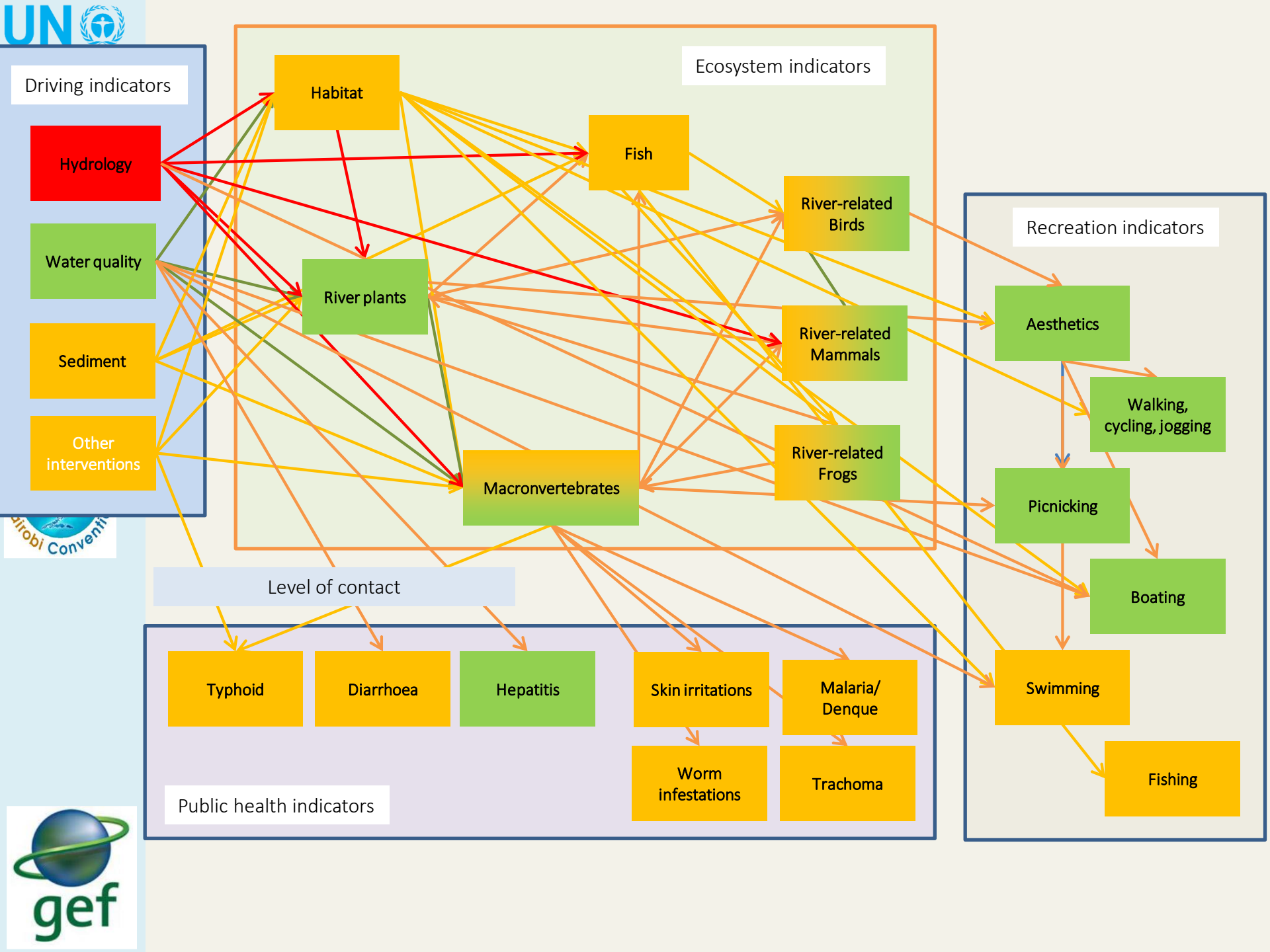
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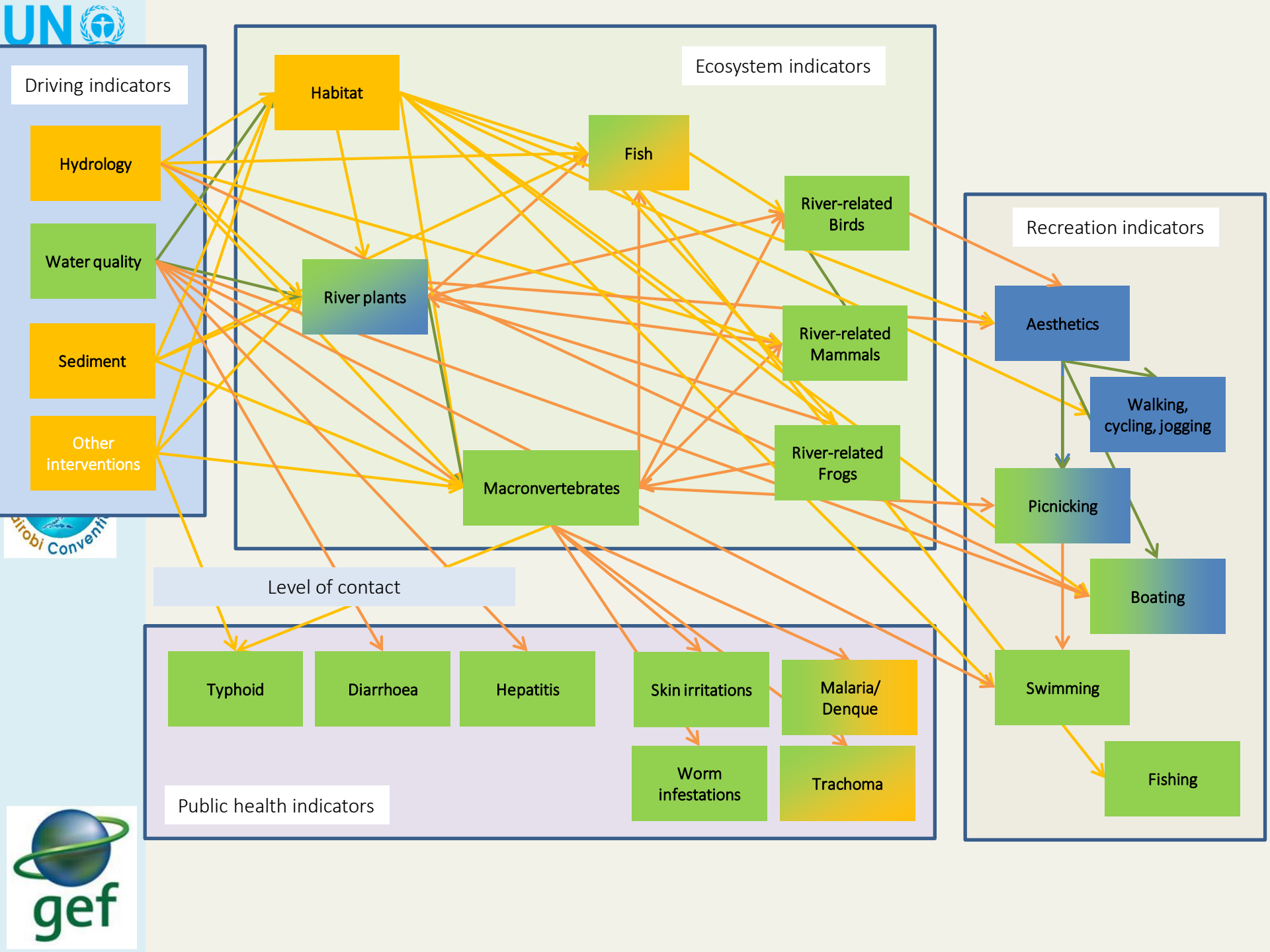
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Public health indicators

Some other applications

- Zambezi Basin
- Pangani Basin
- Breede Basin
- Kafue Flats and Lower River
- Elephant Marsh on Shire
- Lilongwe Basin

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Thank you