BioRA Progress
RTWG Meeting 5

MRC Council Study:
BioRA Indicators, Links and Focus Areas

Prepared by
BioRA Team

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- Indicators
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- Focus Areas

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BioRA Indicators

Detail in Technical Progress Report 1: Indicators and Site Selection

BioRA Indicators

- Indicators are inputs to the DRIFT model
- Each indicator must have a describable relationship to the flow or sediment regime
- Indicators describe:
  - the flow regime of the river, e.g., duration of the dry season
  - ecosystem attributes; e.g.; abundance of white fish
  - river-linked social attributes, e.g., riverbank gardens
- BioRA will predict how each indicator will change from baseline

DRIFT Water Quality Indicators

- Water Quality indicators are external indicators
  - Apply to all Focus Areas
- Derived from DSF:
  - Temperature   - NO_{2+3}
  - pH   - NH_4^+
  - DO   - Si
  - Salinity/EC   - PO_4
  - COD   - TN and TP
- Calibration data set = MRC WQMN results
  - Summary information available (1985 – 2015)
  - 1985 – 2008 = Reference data set
- Additional water quality indicators identified as necessary
  - Herbicides
  - Insecticides

Examples of WQMN Results
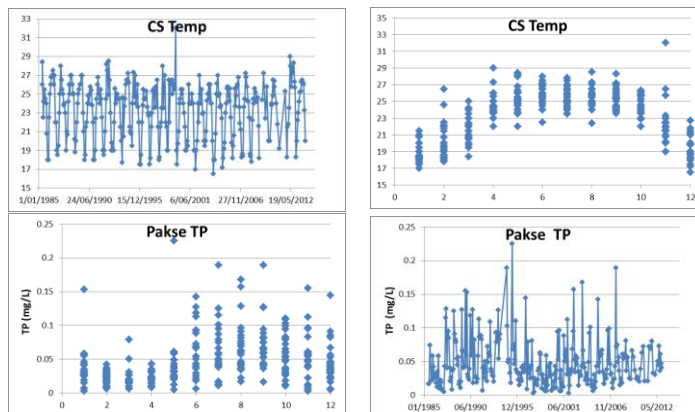
- Time series and monthly trends available for WQMN parameters for representative site in each FA
- WQMN results include temporal changes
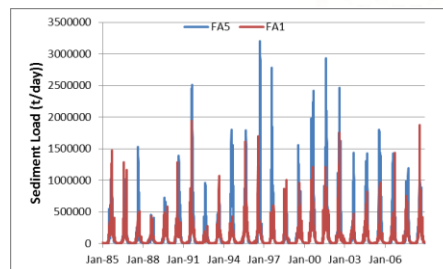
Sediment Indicators

- Sediment indicators are external & apply to all Focus Areas
- From DSF:
  - Sediment concentration (mg/L)
  - Sediment Load (t/day)
  - Sediment grain-size (D_{50})
  - Onset of sediment delivery (week number)
  - Duration of sediment delivery (week number)
- Initial - TSS & SSC monitoring data from MRC
  - Daily time series based on rating curves
  - 1985 – 2008 = Reference data set

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Geomorphology Indicators

- Linked to sediment indicators and hydraulics
- Reflect changes in habitats

Lois Koehnken, Toch Sophon and Bounheng Southichak provided input into the list for BioRA

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Geomorphology indicators

Erosion (bank / bed incision)
Average bed sediment size (DRY)
Average bed sediment size (WET)
Availability of exposed sandy habitats on bars and banks in the dry season
Availability of inundated sandy habitats on bars and banks in the dry season
Availability of exposed rocky habitats in the dry season
Availability of inundated rocky habitats in the dry season
Depth of bedrock pools
Water clarity

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Geomorphology indicators, e.g.: Availability of Sandy Habitat (2)

- Includes exposed and inundated sand bars, banks and sandy insets
- Important habitat for:
  - Vegetation
  - Macroinvertebrates
  - Fish
  - Herpetofauna
  - Birds

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Vegetation indicators

Channel	Extent of upper bank vegetation cover	
	Extent of lower bank vegetation cover	
	Extent of herbaceous marsh vegetation	
	Biomass of riparian vegetation	
	Biomass of algae (planktonic and benthic)	
Floodplain	Extent of flooded forest cover	
	Extent of herbaceous marsh vegetation	
	Extent of grassland vegetation	
	Biomass of riparian/aquatic cover	
	Biomass of cyanobacteria	
	Biomass of algae (planktonic and benthic)	
	Extent of Invasive riparian plant cover	
	Extent of floating and submerged invasive plant cover	

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Macroinvertebrate indicators

- Identified from MRC bioassessment studies (2003-8). Taxa selected because of :
  - specificity to habitats likely to be influenced by changes in flow regime
  - importance to people
  - conservation significance
  - existing data and known indicator value
- Dr Bounnam Pathoumthong (NUL) who conducted the early littoral invertebrate surveys suggested many of the indicators
- Dr Ian Campbell added to and revised the list for BioRA

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Macroinvertebrate indicators

| Insects on stones |
| Insects on sand |
| Dry season emergence |
| Burrowing mayflies |
| Snail abundance |
| Diversity of snails |
| Neotricula aperta |
| Bivalves abundance |
| Polychaet worms |
| Shrimps and crabs |
| Littoral invertebrate diversity |
| Benthic invertebrate diversity |
| Zooplankton abundance |

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Macroinvertebrate indicators, e.g.:
Neotricula aperta = host of Schistosomaisis
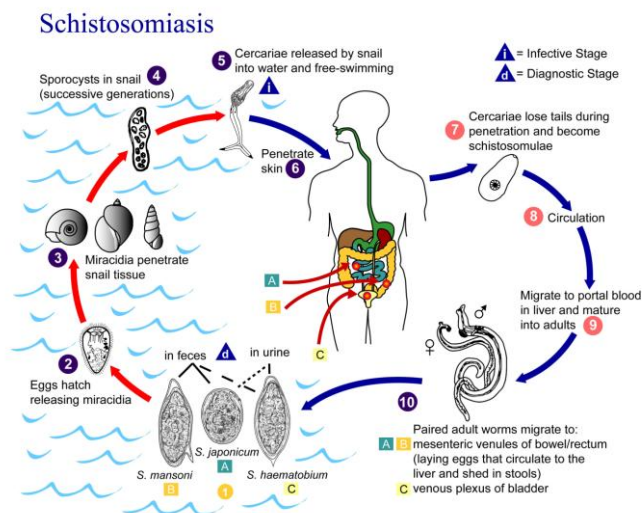
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Fish indicators

- Need to account for diversity of species – 800+ species
- Need to account for spatial and temporal distribution
- Need groupings that are responsive to pressures
- Adopted fisheries guild structure commonly used in in this type of analysis

Ian Cowx, Kenzo Utsugi, So Nam, Kaviphone Phouthavong, Chaiwut Grudpun, Chea Tharith, Vu Vi An, Chavalit Vidthayanon, and others provided input into the list for BioRA

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Fish indicators

| Rithron resident species |
| Main channel resident (long distant white) species |
| Main channel spawner (short distance white) species |
| Floodplain spawner (grey) species |
| Eurytopic (generalist) species |
| Floodplain resident (black fish) |
| Estuarine resident species |
| Anadromous species |
| Catadromous species |
| Marine visitor species |
| Non-native species |

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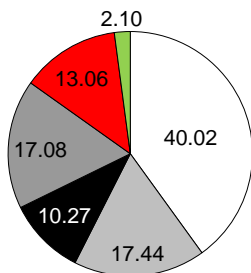
Fish indicators, e.g.: white fishes (2)

White fish, undertaking long distance migrations, in particularly between lower floodplains and the Mekong mainstream and its major tributaries.
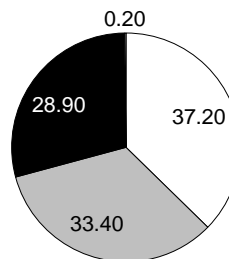
37% of species richness
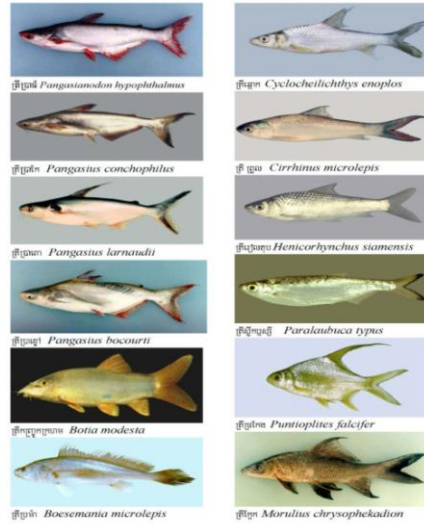
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Contribution of fish guilds to catches

Vietnam

- whitefish
- grey fish
- black fish
- marine/estuarine
- exotics
- OAAs

2.10
13.06
17.08
10.27
17.44
40.02

Cambodia

- whitefish
- grey fish
- black fish
- marine/estuarine

0.20
28.90
33.40
37.20

White fish – highly vulnerable to loss of connectivity:
40 % catch [33 species] in Vietnam and 37% [37 species] in Cambodia

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Herpetofauna indicators

- Based on current knowledge of herpetofauna in the LMB and potential impacts of human activities in the basin
- Literature
- Consultation with regional specialists
- Taxa selected because of :
  - specificity to habitats likely to be influenced by changes in flow;
  - importance to people;
  - some knowledge of life histories.

Hoang Minh Duc and Sereywath Pich compiled the list for BioRA

What are Herpetofauna

- Amphibians

- Reptiles

Herpetofauna indicators

Ranid amphibians (frogs)	*Rana nigrovittata*
	Hoplobatrachus rugulosus
Aquatic serpents	*Enhydris bocourti*
	Cylindrophis ruffus
Semi-aquatic serpents	*Coelognathus radiatus*
Aquatic turtles	*Amyda cartilaginea*
	Malayemys subtrijuga
Semi-aquatic turtles	*Cuora amboinensis*
Amphibians for human use	N/A
Aquatic/semi-aquatic reptiles for human use	N/A
Species richness of riparian/floodplain amphibians	N/A
Species richness of riparian/floodplain reptiles	N/A

Herpetofauna indicators, e.g.:

Indicator	Description	Species
Ranid amphibians	These species are associated with water bodies for whole or part of their life-cycle.	*Hylarana nigrovittata* *Hoplobatrachus rugulosus*

Bird and mammal indicators

- Based on current knowledge of ecology in the LMB and potential impacts of human activities in the basin
  - Reference to literature
  - Discussion / consultation with regional experts (national counterparts, NGO representatives, academics, authors of specialist papers on taxa):
    - Will Duckworth, Sarah Brook, Andrea Claasen, Hoang Minh Duc, Frederic Goes, Tom Gray, Simon Mahood, Philip Round, Robert Steinmetz and
- Tony Stones, Phaivanh Phiapalath and Luu Hong Truong compiled the list for BioRA

Bird indicators

Medium ground-nesting channel species	River tern
	Lapwing
Large tree-nesting waterbirds	White-shouldered ibis
Bank-/hole-nesting species	Pied kingfisher
Flocking non-aerial passerine of tall graminoids	Baya weaver
Large ground-nesting species of floodplain wetlands	Sarus crane
	Bengal florican
Large species using bank-side forest	Lesser Fish Eagle
	Grey-headed Fish Eagle
Rocky-crevice nester in channels	Wire-tailed swallow
Dense woody vegetation / water interface	Masked finfoot
Small non-flocking land bird of seasonally-flooded vegetation	Jerdon's bushchat
	Mekong wagtail
	Manchurian reed warbler

Bird indicators, e.g.: Medium ground-nesting channel species - River Tern: (*Sterna aurantia*)

Inhabits rivers and freshwater lakes, also occurring rarely on estuaries, and breeds on sandy islands (del Hoyo *et al.* 1996), as a solitary or loosely colonial sandbar nester. It feeds predominantly on fish, small crustaceans and insects. River terns formerly associated with a group of Mekong Irrawaddy Dolphins in Ban Hangkhone, Siphandone wetland (I. Baird *pers. com*. 1996).

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Mammal indicators

| Irrawaddy dolphin |
| Otters |
| Wetland ungulates |

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Relation to proposed MRC framework

|	MRC indicator	BioRA indicator
Wetland area	Flooded forest area	• Extent of flooded forest
	Flooded marshes	• Extent of herbaceous marsh vegetation
	Inundated grasslands	• Extent of grassland vegetation
	Inundated rice fields	-
	Disconnected wetlands	• Extent of floodplain pools
River channel condition and habitats	Availability of sandbars	• Availability of exposed sandy habitats on bars and banks in the dry season
	Availability of rocky habitat including rapids	• Availability of inundated rocky habitats in the dry season
	Number of deep pools	• Depth of bedrock pools
	Percentage cover of riparian vegetation within river channels	• Extent of upper bank vegetation cover • Extent of lower bank vegetation cover
	Total sediment extraction	NA: Included in CS scenarios

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Links in BioRA
(BioRA Assessment Framework)

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Links in BioRA
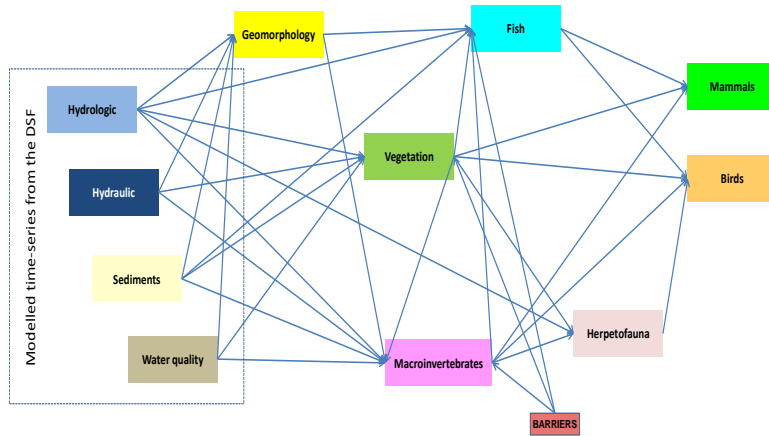
Example of links:
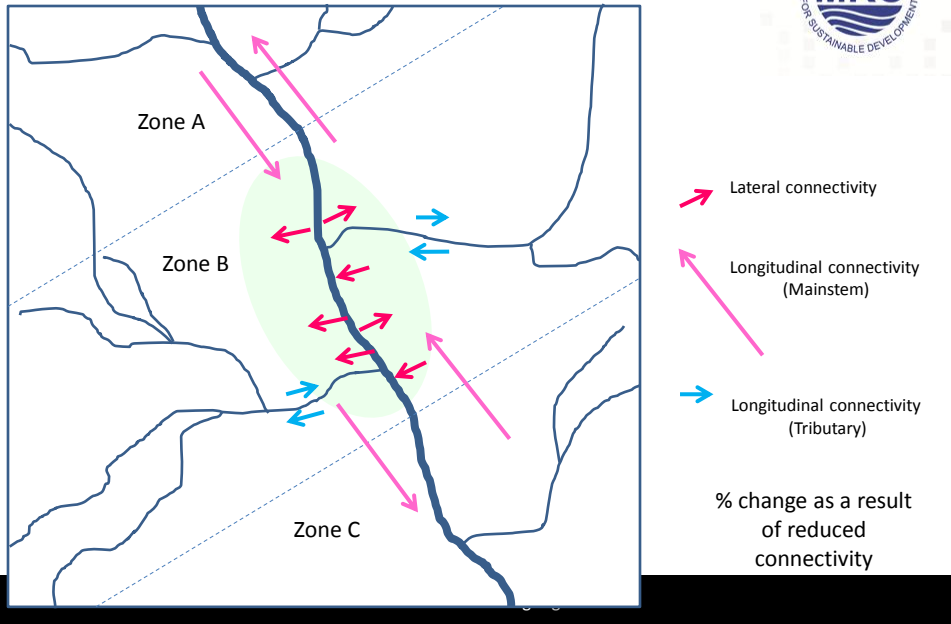# Geomorphology - erosion

- Includes changes to banks and river bed
- Negative erosion is deposition
- Linked to:
  - Shear stress
  - Duration of wet
  - Sediment load
  - Sediment concentration
  - Onset sediment delivery
  - Duration sediment delivery
  - Sediment grain-size
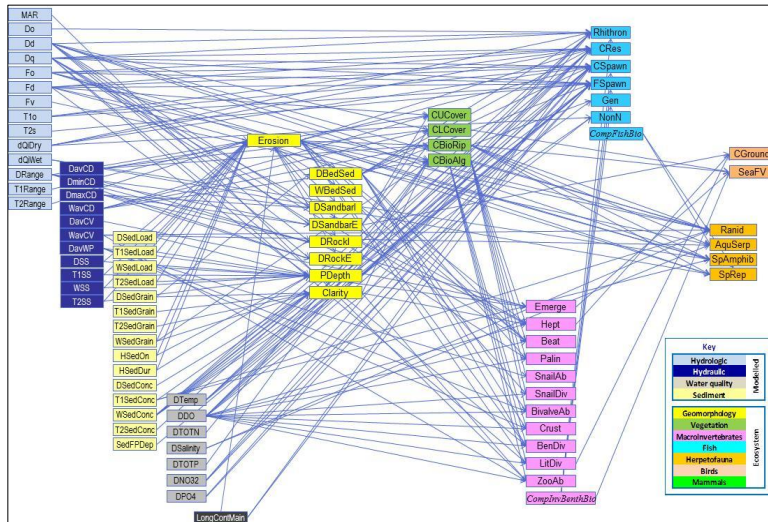 - Within day range of discharge
  - Biomass on bank

Connectivity (mainly fish)

Indicators and Linked Indicators

BioRA Focus Areas

# Establish nodes

Tier	Criteria	Description
1	International borders	Add node at each international border
2	Hydrological zones	Add node at downstream end of each Hydrological Zone
3	Geomorphological zones	Add node at downstream end of each Geomorphological Zone
4	Tributaries	Add node upstream of each major tributary
5	Conservation hotspots	Add node upstream and downstream of conservation hotspots
6	Mainstem fish migration pathways	Add node in mid-point of fish migratory pathways.
7	Inundation bands	Add node to represent the lowest extent of each inundation band in Tonle Sap Great Lake
8	Salinity	Add nodes at extent of flood and drought salinity intrusion
9	Existing water-resource developments	Add node upstream and downstream of locations of major existing water resource developments, plus navigation and sand mining
10	Planned water-resource developments	Add a node at the upstream limit of major dam infrastructure, mines, towns, agricultural areas, etc.
11	Socio-economic zones	Add node at downstream end of each Socio-economic Zone
12	Rationalisation	1. Remove nodes that <10 km (river length) apart. 2. Remove nodes at tributaries unimportant for sediment and fish.

Characterise nodes (biophysical) and delineate BioRA zones

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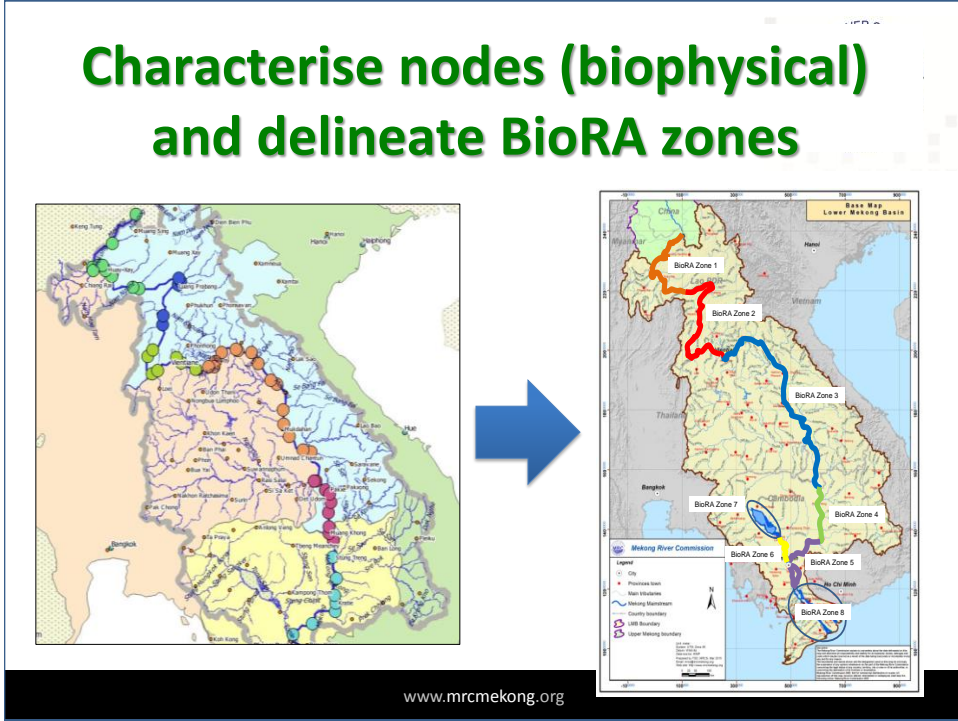
BioRA Focus areas (FAs)

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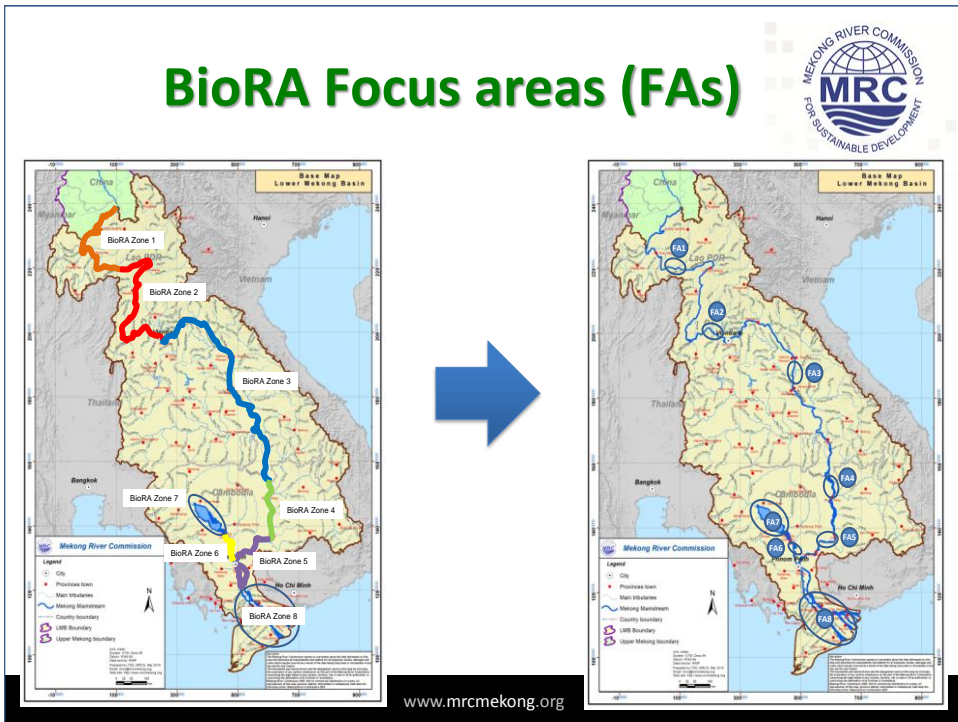
Focus areas

- 8 focus areas
- Based on IBFM zones

BioRA zones	
1	Mekong River from the border with China to Pak Beng
2	Mekong River from downstream of the Nam Beng to upstream of Vientiane
3	Mekong River from Vientiane to Nam Kam
4	Mekong River from Nam Kam to Stung Treng
5	Mekong River from Stung Treng to Phnom Penh
6	Tonle Sap River from Phnom Penh to the Tonle Sap Great Lake
7	Tonle Sap Great Lake
8	Mekong Delta from the Cambodian/Viet Nam border to the sea

The RTWG is specifically requested to:

– Take note of the progress of the work on BioRA indicators, links and focus areas
– Provide feedback and guidance on indicators
– Provide feedback and guidance on the focus areas

Thank you

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