Using River Ecosystem Service Framework to identify sweet-spots and hotspots for protection and management in rivers of South East Asia

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Headline

- Land use changes show that **25 % of PAs in the Greater Mekong** are disturbed by human pressures – Moderate to Very Low Degree of Naturalness
- The **River Ecosystem Service Framework** can be used to identify:
  - **Sweet spots** of important ecosystem services
  - **Hot spots** of human pressure
- RESF is being developed as part of a research programme at the University of Edinburgh, UK
Introducing the RESF for rivers of Greater Mekong Region

- Uses open access geospatial data for river ecology and ecosystem services in GMR
- Uses river reach networks and sub-basins defined by HydroAtlas and river reach classifications e.g. GLoRiC
- Maps and measures indicators of river ecosystem services, and assesses their relative importance by river reach
- Useful for river basin planning, EIAs, monitoring baselines and environmental trends

Source: GMR river reach classification, Lehner and Dallaire 2014
Western Tonle Sap river basins to be used as examples – Pursat, Sangker, Dauntri rivers
Components of the RESF

- Open access datasets grouped by river basin or sub-basins (HydroBasins) to indicate the relative strength of the parameter
- By river reach using the HydroAtlas networks of rivers classified by size
- Appropriate parameters chosen to indicate river ecosystem services – Provisioning, Regulating, Supporting and Cultural
- Relative strength in each hydrobasin assessed and scored on 5 point scale from Very Low to Very High according to significance criteria
- These are mapped to indicate:
  - “sweet spot” areas or river reaches, that are ecologically important and
  - “hotspot” areas that are at risk or threatened by development pressures

Significance criteria

<table>
<thead>
<tr>
<th>Rarity</th>
<th>Productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diversity</td>
<td>Regulating capacity</td>
</tr>
<tr>
<td>Connectivity</td>
<td>Integrity</td>
</tr>
</tbody>
</table>
Identifying ecologically important river reaches –

**Indicator**: River reach rarity

Different reach classes are likely to have different ecologies – rare reach classes have more unique features

**Dataset**: GMR River reach classification, Lehner and Dallaire (2014)

- **River reach rarity** calculated by taking % of length of each reach size class divided by the total length within the GMR
- Scored according to % scale
  - For example:
    - Highlights the river reaches around the Tonle Sap as being **Very Rare**
    - Large, Medium and Small rivers in **Flooded Forest and Grassland with and without Floodplains**
Identifying ecologically important river reaches within Protected Areas in GMR

- **Indicator:** River reaches within Protected Areas are more important
  a) because the areas have been selected for their natural significance – Cultural and Biodiversity ecosystem service
  b) they have some sort of protection already.

- **Dataset:** Protected Planet data base of protected areas from UNEP/WCMC/IUCN
Identifying ecologically important river sub-basins

Indicator: Distribution of **WWF Ecoregions in Greater Mekong** – ecoregions have different ecological features in rivers and sub-basins

**Ecoregion Rarity** and **Ecoregion Diversity**

Data: WWF Terrestrial Ecoregions of the World
Scoring Ecoregion Rarity by HydroBasin level 12

- **Ecoregion rarity** is a measure of the proportion of each Ecoregion within the overall area of the Greater Mekong
- The **lower** this proportion, the **more rare** the ecoregion and therefore the more likely to have **unique aquatic biodiversity** in each HydroBasin
- Cardamom mountains and Tonle Sap ecoregions are Rare
- Ecoregions to the north of the Tonle sap are more common
Ecoregion Diversity of tributaries in the Greater Mekong and in Tonle Sap

- Ecoregion Diversity of Hydrobasins 6 calculated by Shannon Diversity Index of areas of different ecoregions occurring in each hydrobasin
- Ecoregion Diversity Index is a measure of the ecological diversity of the different tributaries –
  - **Low index** - river runs through one ecoregion, and may have a more unique aquatic biodiversity, representative of the ecoregion
  - **High index** - river runs through multiple ecoregions and is more likely to have higher aquatic biodiversity
- Tonle Sap Great Lake and tributaries within Cardamom mountains have very high ecoregion diversity
- Small basin has very low ecoregion diversity index and may have unique river ecosystem representative of the south facing slopes of the Cardamom mountains
- Mekong Delta has high ecoregion diversity
Identifying proportions of Ecoregions lying within Protected Areas

- Protected areas - indicator that basins and river reaches in them are ecologically important
- When combined with ecoregions, indicates proportion of ecoregion under protection
- Use the Protected Planet data base of protected areas from UNEP/WCMC/IUCN
- IUCN Class of PA may indicate different levels of protection/management
### Distribution, rarity and protection of GMR Ecoregions

Scoring on scale of 1 to 5 for rarity and proportion of ecoregion areas lying within PAs

**Rarest ecoregions in GMR often have the least coverage of Protected Areas**

- Chao Phraya Lowland moist deciduous forests
- Chin Arakan Yoma
- tane rain forests
- Myanmar Coast mangroves
- Northeast India-Myanmar pine forests
- Northern Khorat Plateau moist deciduous forests
- Northern Triangle temperate forests
- Red River freshwater swamp forests

#### Table: Ecoregion Data

<table>
<thead>
<tr>
<th>Ecoregion</th>
<th>Total area</th>
<th>Area in GMR</th>
<th>% within GMR</th>
<th>Ecoregion rarity in GMR</th>
<th>Rarity score</th>
<th>Area in PA</th>
<th>% inside PA</th>
<th>% outside PA</th>
<th>Protected score</th>
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<tbody>
<tr>
<td>Ceylonish mountain rain forests</td>
<td>44,035</td>
<td>44,035</td>
<td>100</td>
<td>3</td>
<td>45,638</td>
<td>59,267</td>
<td>33,277</td>
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<td>Central Indo-Burma dry forests</td>
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<td>302,740</td>
<td>95.6</td>
<td>14.44</td>
<td>45,143</td>
<td>34.17</td>
<td>65.83</td>
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<tr>
<td>Chao Phraya swamp forests</td>
<td>36,839</td>
<td>36,839</td>
<td>100</td>
<td>1.75</td>
<td>68.30</td>
<td>39.95</td>
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<td>44.73</td>
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<tr>
<td>Chao Phraya Floodplain deciduous</td>
<td>20,347</td>
<td>20,347</td>
<td>100</td>
<td>0.52</td>
<td>2,651</td>
<td>12.99</td>
<td>87.01</td>
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<td>Chao Phraya montane deciduous</td>
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<td>20,614</td>
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<td>0.75</td>
<td>1,376</td>
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<td>92.91</td>
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<td>Eastern Himalayan alpine shrubland</td>
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<td>22,034</td>
<td>100</td>
<td>0.64</td>
<td>4,872</td>
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<td>46.19</td>
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<td>2,416</td>
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<td>51.33</td>
<td>46.19</td>
<td>3.52</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Eastern Himalayan sub-alpine conifer forests</td>
<td>9,261</td>
<td>9,261</td>
<td>100</td>
<td>0.00</td>
<td>51.33</td>
<td>46.19</td>
<td>3.52</td>
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</tbody>
</table>

#### Table: Rarity and Protection Scores

<table>
<thead>
<tr>
<th>% range</th>
<th>Protected score</th>
<th>Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2</td>
<td>Very low</td>
<td></td>
</tr>
<tr>
<td>2-4</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>4-6</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>6-8</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>8-10</td>
<td>Very high</td>
<td></td>
</tr>
</tbody>
</table>

- % range: The percentage range of the area within GMR.
- Protected score: The protected score based on the rarity and protection of the ecoregion.

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**Legend:**

- **Very Low**
- **Low**
- **Moderate**
- **High**
- **Very High**
Protected Area coverage of Ecoregions around the Tonle Sap

- Central Indochina dry forests are very common - very low protection
- Tonle Sap freshwater swamp forests and peat forests are moderately rare, with very low protection
- Southeastern Indochina dry evergreen forests are common with low protection
- Cardamom mountain rainforests are moderately rare and moderately protected
Using landcover data – Degree of Naturalness by sub-basin in GMR

<table>
<thead>
<tr>
<th>Landcover type</th>
<th>Naturalness Weighting %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown</td>
<td>70</td>
</tr>
<tr>
<td>Surface Water</td>
<td>70</td>
</tr>
<tr>
<td>Mangroves</td>
<td>100</td>
</tr>
<tr>
<td>Flooded Forest</td>
<td>100</td>
</tr>
<tr>
<td>Forest</td>
<td>100</td>
</tr>
<tr>
<td>Orchard or Plantation Forest</td>
<td>100</td>
</tr>
<tr>
<td>Evergreen Broadleaf</td>
<td>100</td>
</tr>
<tr>
<td>Mixed Forest</td>
<td>100</td>
</tr>
<tr>
<td>Urban and Built Up</td>
<td>10</td>
</tr>
<tr>
<td>Cropland</td>
<td>40</td>
</tr>
<tr>
<td>Rice</td>
<td>30</td>
</tr>
<tr>
<td>Mining</td>
<td>10</td>
</tr>
<tr>
<td>Barren</td>
<td>10</td>
</tr>
<tr>
<td>Wetlands</td>
<td>100</td>
</tr>
<tr>
<td>Grassland</td>
<td>70</td>
</tr>
<tr>
<td>Shrubland</td>
<td>70</td>
</tr>
<tr>
<td>Aquaculture</td>
<td>10</td>
</tr>
</tbody>
</table>

- **Indicator:** Weighted area of different landcover units within each HydroBasin level 12
- **Naturalness Weighting %** multiplied by area of landcover units in each HydroBasin
- **Dataset:** Servir Mekong Landcover 2019 (Myanmar, Thailand, Cambodia, Laos, Vietnam)
Degree of Naturalness by sub-basin around Tonle Sap

- **Very Low** Degree of Naturalness in Thailand north-west of Tonle Sap
- Populated and cultivated land area around Tonle Sap shows bands of **low and very low degree of naturalness**
- Cardamom mountains show **high and very high degrees of naturalness**
- Follows patterns of Protected area coverage of ecoregions
Degree of Naturalness within Protected Areas

- Sub-basins within PAs encroached or damaged by change of landuse or deforestation
- Hotspots of low degree of naturalness within sweet spots of PAs
Human Pressure Index

Index developed from composite of indicators, analysed by HydroBasin 12:

- **Connectivity** – locations of hydropower, irrigation dams and weirs
- **Linear infrastructure** – roads, canals, transmission lines
- **Urban infrastructure**
- **Agriculture intensity**
- **Population density**

**Western Tonle Sap basins**

- Urban areas of Battambang and Pursat show up as very high pressure
- Central belt of lowland paddy agriculture is also high pressure
- Some PAs e.g. Samlaut and Phnom Somkos and Central Cardamoms also show increasing disturbance
Human Pressure Index on river network of Western Tonle Sap river basins

Identifying hotspots in river network

Threats and pressures to river ecosystems includes terrestrial pressures plus
- Hydropower
- Irrigation weirs
- Urban pollution
Conclusions

- The RESF provides an approach for identifying:
  - **Sweet-spots** of ecosystem service importance for rivers and river basins and
  - **Hotspots** of human pressure on rivers and river basins

- Can highlight the sweet-spots under the most pressure

- Uses open access global or regional datasets

- Express these as five-point scale on maps or in geo-referenced tables of different hydrobasins or river reaches

- Used in **impact assessment process** showing both baselines or projected impacts e.g. land use change or infrastructure for specific areas within the Greater Mekong
Thank You

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