Impacts of Hydrological Alteration in the Mekong to the Tonle Sap Ecosystem

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Research Highlights

- The Tonle Sap is the largest wetland and fishery in the Mekong but it is expected to be affected by hydropower and climate change
- Landscape-scale spatial distribution of habitats were found to be largely driven by flood duration patterns.
- The flood-pulse hydrology could explain most of the underlying variability in soil and vegetation field-scale characteristics.
- Hydropower could cause distinct seasonal changes, while climate change could increase inter-annual uncertainty.
- Fauna species richness was found to be greatest in natural habitats likely to experience the most significant disruptions

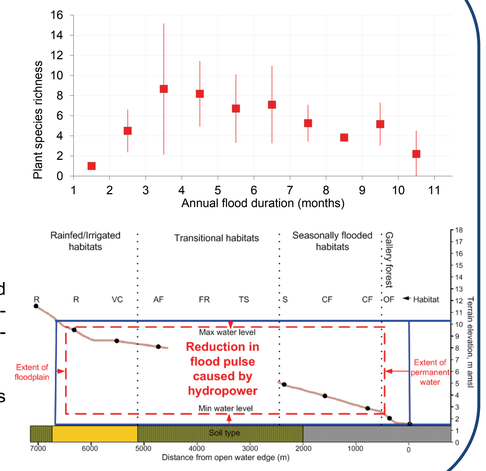
Component 2: Habitat Patterns

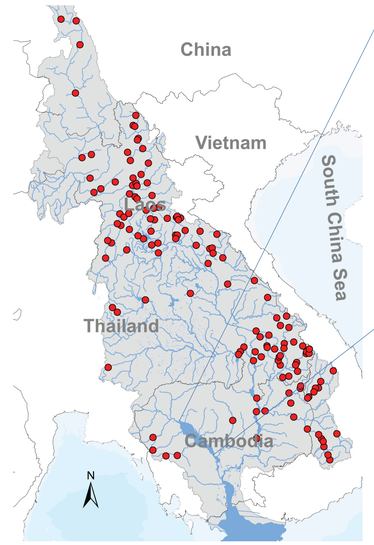
The flood-pulse drives habitat characteristics:

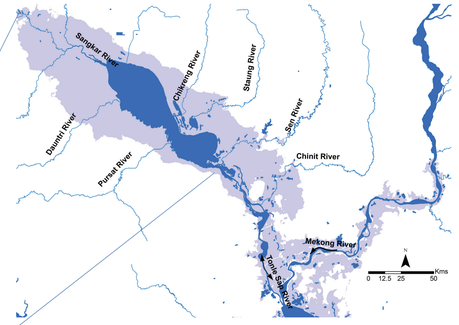
1. Determines inundation depth and duration;
2. Creates the main soils gradient;
3. Limits the area cleared for agriculture;
4. Influences vegetation structure and water quality;
5. Shapes the composition of plant species.

Expected alterations in the Mekong could increase the dry season water levels by 80-90 cm and reduce wet season levels by 40-50 cm.

Soil, vegetation, and water quality patterns expected to change in the long term.







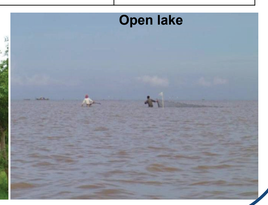
The Tonle Sap, the world's largest freshwater flow reversal system:

- flood area ~ 15,000 km^2.
- 50-80 km^3 of water flowing from the Mekong River during the wet monsoon season.
- Unique mosaic of natural and agricultural habitats.
- Declared a UNESCO Biosphere Reserve.
- Largest inland fishery in the world.
- Largest source of protein to Cambodians.

Component 1: Landscape Patterns

- Distinct relationship between inundation maps and land use/land cover.
- Habitats in the Tonle Sap divided into 5 groups based on annual flood duration.
- Large habitat shifts could occur as a result of hydropower development scenarios by the 2030's.
- Gallery forest extent could decrease by 82%.
- Rainfed habitats extent could increase by 10-13 %.

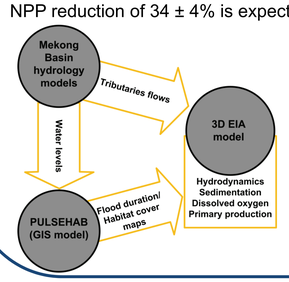
Habitat group	Average flood duration (months)
Rainfed habitats	0-1
Transitional habitats	1-5
Seasonally flooded habitats	5-8
Gallery forest	9
Open lake	10-12

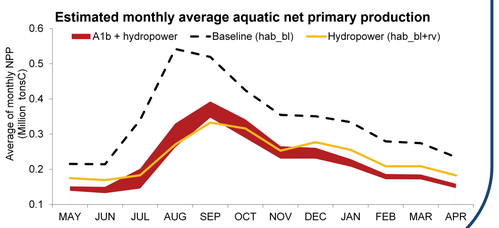


How will hydrological alterations affect the Tonle Sap Ecosystem?

Component 3: Ecosystem Function

- A 3D hydrodynamic model used to evaluate 11 scenarios of hydropower development and climate change.
- Hydropower development would cause the most distinct changes in seasonality by reducing wet season water levels and increasing dry season water levels.
- Estimated annual net sedimentation was projected to decrease by 56 ± 3% from baseline (3.28 ± 0.93 million tons).
- Annual net primary production (NPP) in the open water and in the floodplain was1.07 ± 0.06 and 3.67 ± 0.61 million tons C, respectively
- NPP reduction of 34 ± 4% is expected.





Problematic

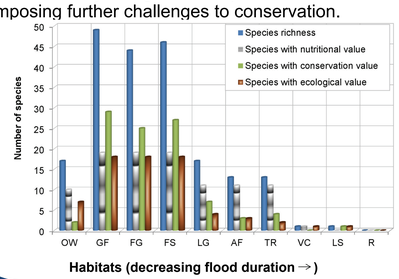
Hydropower development in the Mekong has accelerated exponentially in the past decade. Once the proposed regional scheme is completed, the number of large hydropower projects could triple while the active storage could increase ten-fold.

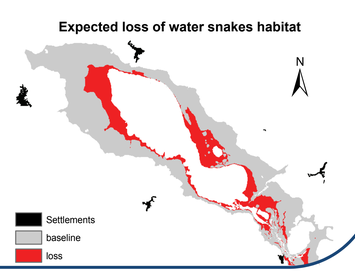
The Tonle Sap is facing a two-fold problem:

1. The link between its hydrology and ecosystem properties is not well understood.
2. Potential ecological changes caused by future hydrological disruptions related to hydropower and climate change are unknown.

Component 4: Impacts on Fauna

- A spatial modelling framework was developed to simulate the impact of potential scenarios of change using relationships between fauna and biophysical characteristics.
- Potential impacts on 61 animal species were estimated using documented nutritional, conservation or ecological values.
- A large number of species rely on gallery forest. This area is likely to be highly impacted by permanent inundation.
- Strong synchronicity between life histories and the flood pulse.
- Continued hydrological disruptions will have a significant impact on ecosystem dynamics, imposing further challenges to conservation.





Conclusions

The flood-pulse is the major driver of ecological structure and function in the Tonle Sap

- Forms groups of natural, transitional and agricultural habitats delimited by inundation.
- Highly influential in habitat field characteristics.
- Responsible for sedimentation and aquatic primary production.
- Drives life histories of most aquatic and terrestrial fauna species.

Modifications to the Mekong's hydrology could bring significant disruptions to the Tonle Sap

- Escalating impacts (small water alterations ► large productivity reduction
- Hydropower is a more immediate threat than climate change.
- Primary production changes may disrupt ecosystem services to the Lower Mekong

Recommendations

Future research

- Regional climate change modeling
- Environmental change monitoring
- Sedimentology
- Ecohydrology
- Foodweb and fish ecology

Ecosystem Management

- Minimize hydropower disruptions
- Establish environmental change monitoring and social adaptation programs
- Conservation of natural habitats in areas that are likely to remain hydrologically undisturbed
- Restoration of natural habitats where optimal growth conditions could occur
- Control and optimization of agricultural practices

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