Potential Impacts of Climate Change on Fisheries in LMB

Ngor Peng Bun, So Nam and Peter Degen
MRC Fisheries Programme, Phnom Penh, Cambodia

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Adaptation to Climate Change in the Transboundary Context
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Outline

1. Fisheries in the LMB
2. Climate change in the LMB
3. Potential impacts of climate change in fisheries in LMB countries
4. CC vulnerability of people’s livelihoods and food security
5. Fisheries adaptation to climate change
6. Conclusion
Fishes of the Mekong River Basin
Fishes of the Mekong River Basin

**Mekong basin countries** - highest freshwater fish species diversity per square kilometer.

Only French Guyana and Suriname - similar fish species diversity.
Fishes of the Mekong River Basin (con’t)

- Mekong River has world’s highest fish diversity after the Amazon.
- **850** freshwater fish species recorded from the River Basin
- About **1,200 fish species** including coastal or marine visitors.
- A significant proportion of endemic fish species, approx. **20%**
Thailand and Viet Nam are among top 10 countries in the world having the largest number of freshwater fish species, followed by Lao PDR and Cambodia.
Fish species richness of the top ten lakes in the world

- **Malawi**: 438
- **Tanganyika**: 316
- **Tonle Sap**: 296
- **Victoria**: 226
- **Chad/Chari**: 172
- **Biwa**: 69
- **Baikal**: 64
- **Taal**: 63
- **Turkana**: 60
- **Rukwa**: 59
Size of LMB fisheries

The Annual LMB fish production is approximately 4 million tonnes.
Comparison with other regions

<table>
<thead>
<tr>
<th>Region</th>
<th>Fishing Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>2%</td>
</tr>
<tr>
<td>Africa</td>
<td>43%</td>
</tr>
<tr>
<td>America</td>
<td>19%</td>
</tr>
<tr>
<td>Asia</td>
<td>4%</td>
</tr>
<tr>
<td>SE Asia</td>
<td>12%</td>
</tr>
<tr>
<td>Europe</td>
<td>24%</td>
</tr>
</tbody>
</table>

LMB fish production =

* LMB fish production represents about **20%** of the world inland fish production.

* This inland capture fish production is higher than anywhere else in the world.
Economic Value of the LMB fisheries

- Total first-sale value: estimated up to **US$7.0 billion** / year.
- Mostly fish is consumed directly by households, as part of rural subsistence economy – not recorded in official statistics.
- Inland fisheries make significant contributions to the monetized economies of all four riparian countries.
- Fisheries accounts for nearly **12%** of Cambodia’s GDP, and fisheries value in Lao PDR is equivalent to **7%** of the country’s GDP.
• > 60 million people live in the LM watershed (100 million by 2025)
• Regional average of per capita fish consumption 46 kg/person/year
• Significantly higher than world rate of 24 kg/person/year.

In LMB, much more freshwater fish harvested than cattle produced.
In Cambodia and Laos, fish production is twice the combined production of pork and chicken” (ICEM, 2010).
Contribution to nutrition

- In Average, >50% of the total animal protein intake of the people in the Lower Mekong Basin come from fish,
- World protein intake from fish is 16%.
Is climate change occurring in the LMB countries?

Yes
By 2050, largest increase in temperature will occur in 3-S river basins – increase of 4°C.
Wet season, average maximum daily temperature from 1.7 to 5.3°C.
Dry season, temperatures will increase from 1.5 to 3.5°C.

Source: ICEM, 2013
Average maximum daily precipitation in wet season, LMB

- Annual precipitation increase by 3-18% (35 – 365 mm).
- Increase of magnitude and frequency of extreme events such as storms, floods, and drought
- Increased seasonal variability in rainfall with wetter wet seasons and drier dry seasons.

Source: ICEM, 2013
Projections for severe drought are centered on NE Khorat Plateau in Thailand, but the largest increases in drought will occur in the Mekong floodplain in Cambodia & Southern Lao PDR. Mekong River Delta, during the dry season, maximum salinity is projected to increase by > 50% as compared to the reference period of 4 g/l.
Potential impacts of climate change on fisheries
Climate change impacting fisheries via different pathways

Changes in:
- Sea level rise
- Rainfalls/floods
- River flows
- Lake levels
- Thermal structure
- Storm/drought severity
- Acidification

Effects on:
- Production Ecology
  - Fish species composition
  - Fish production & yield
  - Fish distribution
  - Diseases

- Fishing & aquaculture operations
  - Fishing safety & efficiency
  - Fishing infrastructure
  - Aquaculture installations

Impacts on:
- Communities
  - Damage to livelihood assets
  - Risk to health and life
  - Displacement, conflict

- Wider society & economy
  - Adaptation costs
  - Market impacts
  - Water allocation
  - Floodplain & coastal defense

Source: Badjeck et al. 2010
Potential impacts of climate change on fisheries

- **Expected Higher Temperature (1)**
  - Reduce oxygen solubility in water
  - Increase metabolic rates of fish
    - In food limited environments, this potentially reduces fish growth and survival rates.
  - As temperature tolerance ranges of fish are species-specific. Resulting in:
    - **Stenothermal** species may be displaced to regions where water temperature more closely match their thermal optima, and be replaced by **Eurythermal** species such as common carp.
    - Limited reproduction success – less abundant
    - Loss of species and alteration of species composition for capture fisheries.
Potential impacts of climate change on fisheries

- **Expected Higher Temperature (2)**
  - Thermal stratification and wind-driven mixing of water column (in lakes and reservoirs):
    - Reduction of nutrients in surface layers.
    - Sudden overturn of cold anoxic deep waters can cause fish mortalities
    - Reduction in fish stocks and thus fish yield.

- **Aquaculture:**
  - Stimulate shifting location,
  - Culture of different species
  - Losses to disease (and higher operating costs)
  - Higher capital costs for aeration equipment or deeper ponds.
Potential impacts of climate change on fisheries

- **Precipitations/Rainfalls/Flows (1)**
  Change in spatial and temporal patterns of precipitation is expected to impact on flows. Change in flows affect habitat availability, system productivity and fish population processes: growth, survival and reproduction.

  - **WET SEASON:** expected higher precipitations/flows mean more extensive and prolonged floodplains are inundated

  - **GOOD NEWS** for fish as it potentially increases overall system productivity.

  - **BUT, NOT** all species can benefit as increased river flows may:
    - Hamper upstream spawning migrations
    - Erode spawning beds or sweep eggs and juveniles past downstream nursery and feeding habitats.
    - Rapid changes in water level diminish reproductive success of channel-margin spawning and nest-building fish.
    - Changed timing of flows also can disrupt spawning behaviour.
    - Implication for aquaculture that depends on capture fisheries - seed and feed supply.
Potential impacts of climate change on fisheries

- **Precipitations/Rainfalls/Flows (2)**
  - **DRY SEASON**: greater precipitation and water availability may create favorable conditions for fish to survive.
  - **But**, increased dry season water levels may diminish primary production and habitat diversity within the system by:
    - Permanently submerging fringing forests and vegetation causing permanent die-back and;
    - Effectively reducing the size of the flood margin or ATTZ
  - **Increasing hydrologic variability in river systems could favor generalist species at the expense of specialist species – locally adapted fish species.**
Potential impacts of climate change on fisheries

- **Extreme events (storms, severe drought)**
  - Large waves and storm surges; Inland flooding from intense precipitation; Salinity changes; Introduction of disease or predators into aquaculture facilities during flooding episodes can cause:
    - Loss of aquaculture stock and loss/damage to aquaculture facilities and fishing gear.
    - Impacts on wild fish recruitment.
    - Higher direct risk to fishers; and
    - Higher capital costs needed to design cage moorings, pond walls, jetties, etc. that can withstand storms/floods.
  - Lower water quality, availability and flows
    - Higher salinity
    - Loss of wild and cultured stocks;
    - Intensified competition for fishing areas
    - Migration by fisher-folks;
    - Increased production costs.

Photo: Thai DoF, 2011
Potential impacts of climate change on fisheries

- **Sea level rising/salinity**

  A combination of lower flow and sea level rise, may cause increase in saline intrusion into river deltas, leading to changes in estuary systems:
  
  ✓ Shift to brackish water: Displacing stenohaline species, whilst increasing downstream range and biomass of more tolerant euryhaline species – giant river prawn.
  
  ✓ Shift in species abundance: distribution and composition of fish stocks and aquaculture seed.
  
  ✓ Loss of land: reduced area available for aquaculture; and loss of freshwater fisheries.
  
  ✓ Salt water infusion into groundwater: reduced freshwater availability for aquaculture and species.
  
  ✓ Loss of coastal ecosystems (mangroves): reduced recruitment and stocks for capture fisheries and seed for aquaculture.
CC vulnerability of people’s livelihoods and food security
Vulnerability of people’s livelihoods

- Using the indices of exposure, sensitivity and adaptive capacity, compared vulnerability of 132 countries:
  - Cambodia and Viet Nam are amongst most vulnerable ranked 27 & 30, respectively:
  - Lao PDR ranked at 37 and Thailand ranked at 82

Allison et al. (2009)
### Vulnerability – capture fisheries

<table>
<thead>
<tr>
<th>Species</th>
<th>Threat</th>
<th>Vulnerability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Increase in temperature</td>
<td>very high</td>
</tr>
</tbody>
</table>

- **Upland fish species:** Highly impacted by increased temperature, decreased precipitations, storms and flash flood.
- **White/grey species:** highly impacted by increased temperature and decreased precipitation.
- **Black fish:** impacts range: medium – low
- **All guilds are important for food security**

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<tr>
<th>Threat</th>
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<tbody>
<tr>
<td>sea level rise</td>
<td>-</td>
</tr>
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<td>increasing salinity</td>
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3. **Trichogaster pectoralis**  
*NON MIGRATORY, SMALL BLACK FISH, IMPORTANT FOR FOOD SECURITY.*

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<tr>
<td>Increase in Temperature</td>
<td>medium</td>
</tr>
<tr>
<td>Increase in precipitation</td>
<td>medium</td>
</tr>
<tr>
<td>Decrease in precipitation</td>
<td>low</td>
</tr>
<tr>
<td>Decrease in water availability</td>
<td>medium</td>
</tr>
<tr>
<td>Increase in water availability</td>
<td>-</td>
</tr>
<tr>
<td>Drought</td>
<td>medium</td>
</tr>
<tr>
<td>flooding</td>
<td>-</td>
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Source: ICEM 2013
### Vulnerability – aquaculture

<table>
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<tr>
<th>System &amp; species</th>
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<th>Vulnerability</th>
</tr>
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<tbody>
<tr>
<td>Increase in temperature</td>
<td>high</td>
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- **Intensive pond monoculture:** Very high-high impacts.
- **Semi-intensive pond polyculture:** High-medium impacts.
- **Extensive pond polyculture:** Medium-low impacts

**EXTENSIVE POND POLYCulture OF CARPS & TILAPIA**

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Source: ICEM 2013
Vulnerability of people’s livelihoods

- **Clime change** altering fisheries production are likely to have the greatest impact on people who depend on fishing and fish farming as a primary livelihood source.
- They are often poorer than those who own land and have other primary sources of income. They can afford only limited access to healthcare, education and other public services.
- Thus: effects of climate change on fisheries in LMB will affect those least equipped to cope/adapt with major changes.

⇒ **Fishing and fish farming dependent people are highly vulnerable to impacts of climate impacts.**
Fisheries adaptation to climate change

Photo: Cambodia Human Development Report, 2011
Fisheries adaptation measures

Capture Fisheries:

- **Upland fish:**
  - to retain or rehabilitate forest cover to protect the stream environments and small valley catchments.

- **Migratory white fish:**
  - to maintain and improve the connectivity of habitat and their access to spawning, nursing and feeding ground and dry season refuge habitats such as deep pools.

Source: (ICEM 2013)

Poulsen et al. 2002
Fisheries adaptation measures

Capture Fisheries:

- **Black fish:**
  - creation and management of dry season refuge areas and CFI conservation areas from which they can repopulate the flood plains each wet season.

- **Estuarine species:**
  - maintenance of habitat – replanting mangrove forests

- **Invasive aquatic species:**
  - Application of good aquaculture and stock enhancement practices, monitoring and enforcement

Source: (ICEM 2013)
Fisheries adaptation measures

Aquaculture:

- Invest on-site storage to reduce risks of water availability
- Promote small farm ponds - Thailand
- Strengthen pond embankments to protect against floods (flash flood and storms).
- Shift in species – stenothermal vs eurythermal species – adjusting stocking density to manage unexpected high temperatures.
- Promote integrated shrimp and rice farming – to avoid conflict
- Reforest mangroves in derelict shrimp farms for coast line protection and siltation.
- Promote tiger shrimp and crap production in mangrove areas.

Source: (ICEM 2013)
LMB countries are expected to be impacted by climate change according to various climate change studies/models. Fisheries potentially will be impacted via various pathways.

Changes in temperature, rainfalls/flows and sea level will have impacts on fish reproduction, growth, migration, catch, species composition and stocks.

Change in fisheries resources will directly affect the livelihoods of people – fishing and fish farming dependent communities

Adaptive measures are fish-guild specific.
Fisheries-Hydrology Model is on-going with FP and expected to complete by June 2015.

The model will be used with MRC hydrology scenarios (including CC and water development scenarios) to project change in fish catch and species composition in relation to climate change.

www.mrcmekong.org
Thank You!