CLIMATE CHANGE IMPACT ASSESSMENT

MRC SEA of Mekong mainstream dams
Regional workshop on SEA Impact Assessment
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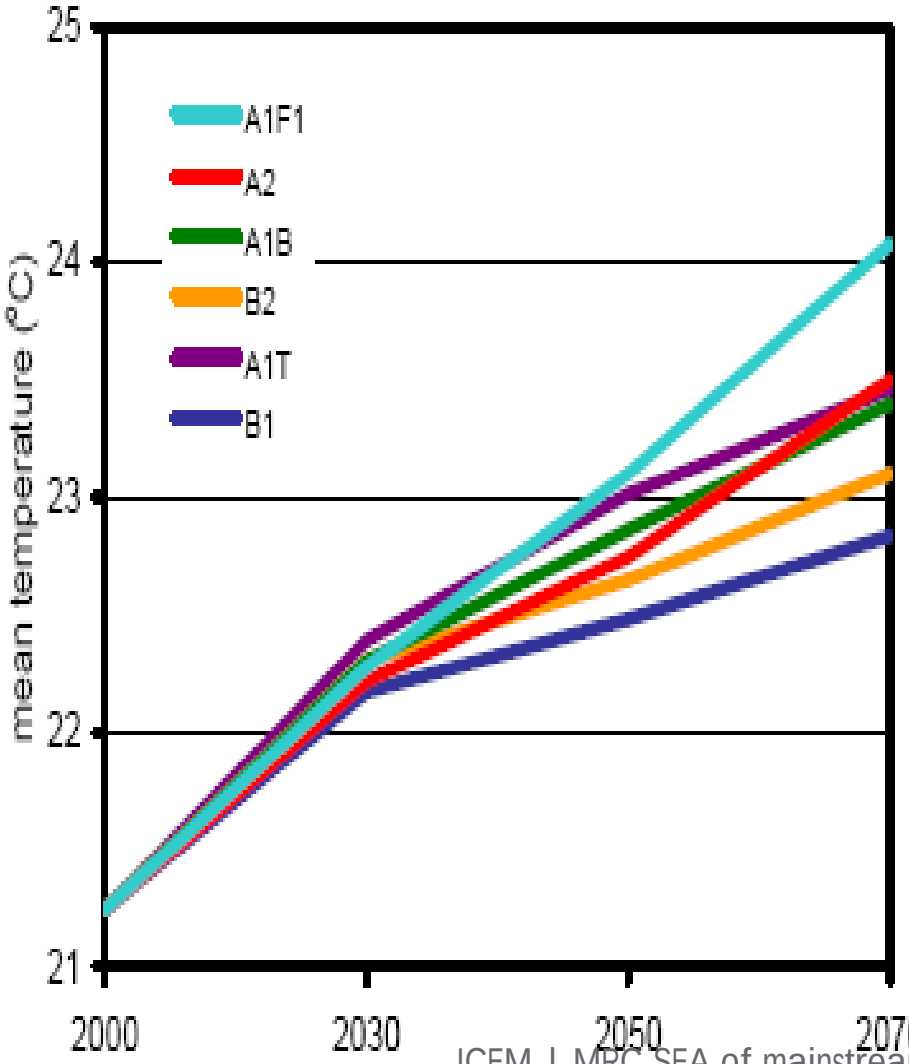
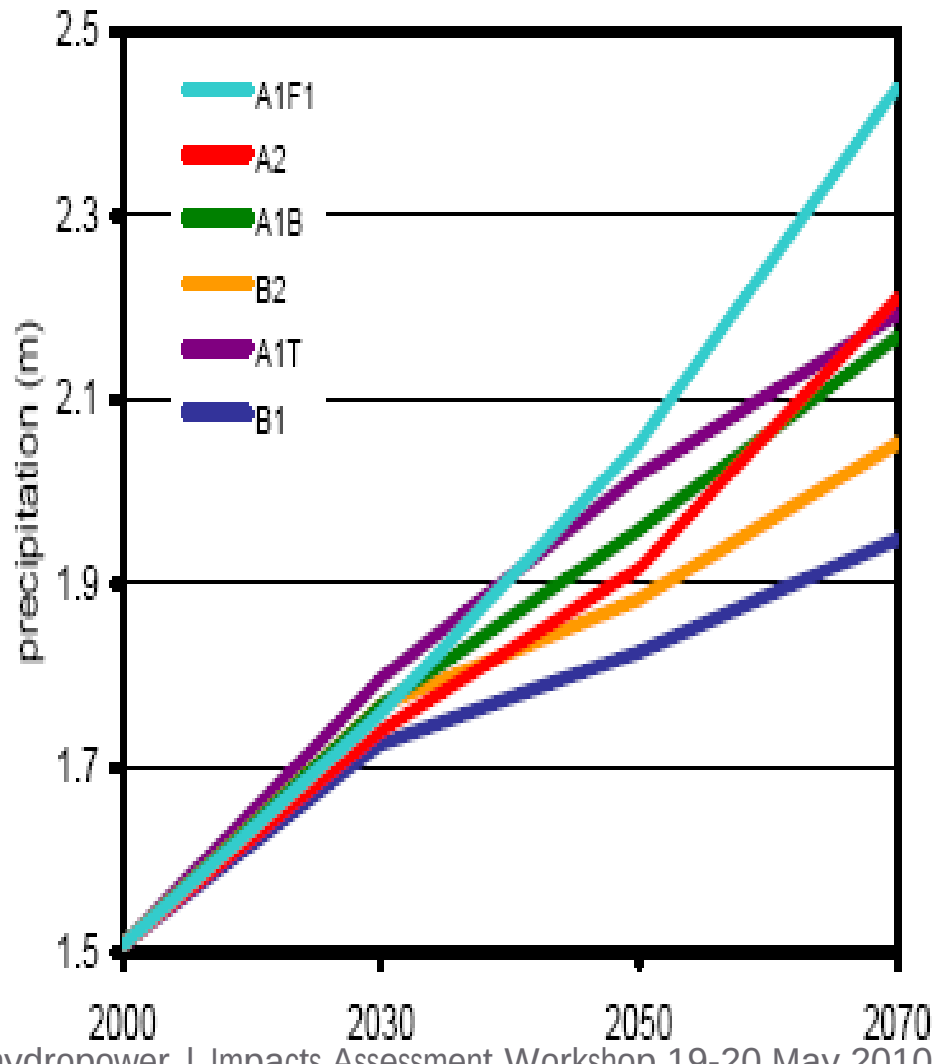
Vientiane

Climate change is happening but many details remain uncertain

1. High levels of uncertainty - in scenarios, models and interpretation of effects
2. Climate change requires that decision makers take the precautionary approach in managing risk associated with development
3. We need to talk in terms of trends and ranges rather than specific predictions of impacts – eg in rainfall, runoff, floods
4. Baseline - The trends in climate change for the Mekong are clear and we are starting to get a better idea of the ranges

Projected baseline: Projected mean temperature and mean annual rainfall for the Mekong Basin for different IPCC scenarios at 2030, 2050 and 2070 (CSIRO 2009)





Two way links between cc and mainstream dams

- The relationships between the proposed mainstream projects and climate change is likely to be significant
- There would be direct and indirect/synergistic effects.
- The **direct effects** are two way:

1. Impacts of projects on climate change through green house gas emissions
2. Impacts of climate change on the projects through increased runoff, flow and extreme flood events

Direct impact of climate change on mainstream projects

- The most important direct climate change effect on the mainstream projects would be through:

1. the increase in annual runoff (CSIRO estimate by 21%) bringing with it increases in sediment load,
2. an increase in flow in the range of 9% to 22% and
3. an increase in the incidence, depth and duration of extreme flood waters.

Risk of extreme events

- LMB mainstream dams could be subject to seasonal and extreme event peaks in flow beyond their normal operating design standards.
- Assuming a mainstream project design life of 100 years:
  - Project structures designed for a 1 in 100 year event will see the probability of this event occurring increase from 63% to ~100%.
  - Projects structures designed for a 1 in 1,000 year event - increase from 10% to 63% probability of this event occurring.
  - Project structures designed for a 1 in 10,000yr event - increase from 1% to 10% probability of this event occurring.
- This increase in risk of extreme events emphasizes the importance of the MRC Preliminary Design Guidance (PDG) for lower Mekong Mainstream dams (MRC, 2009)

Indirect or synergistic effects

- The complex inter-linkages between climate changes, the mainstream dams and other trends in the Basin would results in some of the most significant synergistic effects:

1. Reduced food security
2. Changes to water quality
3. Loss of biodiversity
4. Constraints to poverty reduction
5. Increased potential tributary and mainstream hydropower production

Reduced food security (1)

A number of trends overlay to aggravate future food security in the LMB:

- The population of the LMB is expected to double by 2030
- Food demand would double from ~17 million tonnes for 2000 to ~ 33 million tonnes
- **With climate change and agriculture** (and taking into account increases in irrigation due to mainstream projects):

1. Overall agricultural productivity in the LMB is expected to increase by 3.6% due mainly to increased rainfall.
2. Yet, most catchments linked to the LMB mainstream projects will experience reduced rainfall during the dry season, and reduced productivity.
3. Even for those catchments with increased productivity, population increases will maintain or create food scarcity situations
4. Overall in the basin, excess production above food demand will be reduced by 56% to ~11 million tones.

Reduced food security (2)

Other trends influencing food security:

- Mainstream dams will reduce sediment and nutrient load and the extent of flooding (LMB mainstream dams: effective sediment capture)
- Climate change will increase sediment and nutrient load and extent of flooding
- Overall reductions in sediment in the mainstream are likely to be more than increases – resulting in a significant dampening impact on agricultural productivity in areas affected by reduced extent of flooding and deposition
- Overall reduction in area and quality of agricultural land in the Delta – reduction in nutrient deposition (due to dams) and increased saline intrusion (due to cc)

Reduced food security (3): Irrigation potential from new reservoirs

- Agricultural productivity will benefit from increased access to irrigation water from mainstream and tributary reservoirs.
- Yet, irrigation requirement for crops grown in the dry season would be greater for all catchments under future climate – a demand which would need to be met through the increased runoff and reservoir water access.
- Irrigation systems would need to be designed to meet the increased crop water demand.

Reduced food security (4)

- Increasingly, riparian urban and rural communities would look to the river to offset shortfalls in agricultural produce.
- Yet, during construction and operation, the mainstream dams will reduce fish populations, diversity and overall fisheries sector productivity.
- Overall conclusion: When overlaid with climate change, mainstream dams will aggravate growing food scarcity in the LMB.

Changes to water quality (1)

- The LMB mainstream reservoirs are relatively shallow when compared to the UMB projects (ie 10-60m compared to 120-300m).
- Even so, during the dry season the rate of flow in reservoirs and turnover of the water body will fall
- Especially for the dams in Cambodia which have a larger cross section.
- The mainstream projects have a reasonably high sediment capture rate

Changes to water quality (2)

- With climate change the total sediment and organic load entering the mainstream reservoirs areas from tributaries would increase.
- That additional load would be moderated as more tributary dams are built, but - when combined with increasing populations and land use changes and disturbance – overall sediment and organic loads reaching the mainstream reservoir reaches of the river are likely to increase.

Changes to water quality (2)

- Falling agricultural productivity is likely to lead to increased application of agricultural chemicals
- Industries are expected to develop along the mainstream and tributaries within a 50 km radius.
- Those industries and the expanding number and size of urban settlements are likely to increase the pollution loading in the mainstream.
- The combination of increased sediment and organic loading with increased chemical and organic wastes in certain reaches of the mainstream will act to concentrate and accumulate pollutants in reservoirs

Changes to water quality (3)

- The mainstream dams would accentuate the concentration and accumulation of pollutants during the dry season.
- During the wet, thorough flushing is likely although not certain in some reservoirs.
- For the northern cascade in Zone 2, for example, the full supply level is much higher than the highest recorded water levels near the dam wall (almost twice as high at the dam wall for Luang Prabang) constraining total flushing
- Depending on the location of deep pools, the depth of the water column could be 30m (dam wall) + 50-90m (deep pool) in which case there may also be mixing and flushing constraints during the wet.

Changes to biodiversity (1)

Baseline trends:

- Continuing loss in aquatic and terrestrial habitats and species
- A reduction in area of remaining habitat to isolated pockets
- The “hardening” of river banks, channels and boundaries and subsequent losses in connectivity reducing habitat diversity and aquatic system “mobility”
- Reduced natural system resilience in the face of development

Changes to biodiversity (2)

With mainstream projects:

- A contributing force in the progressive ecosystem hardening and simplifying process
- Would reduce aquatic biodiversity and wetlands
- Man made impediments and changes in aquatic system uses and management will restrict species movement and reduce options
- Would further reduce natural system resilience and stability in the face of shocks and stresses

Changes to biodiversity (3)

With climate change:

- Changes in temperature and rainfall (amount and distribution) will require habitats and species to shift and adjust
- Changes in sediment and flooding timing, frequency and area would induce habitat and species shift
- Changing climate and hydrodynamics will combine with human induced changes and disturbances to reduce the capacity of species and habitats to adapt.

Constraints to poverty reduction

- The mainstream project potential benefits to local poor communities include increased access to power, irrigation water, health facilities, roads and other infrastructure
- When combined with climate change and other trends, a number of influences of the projects would work against poverty reduction.

1. Reduced food security, water quality and the diversity and stability of natural systems would make conditions for poor riparian communities more difficult
2. Losses in aquatic and agricultural productivity would increase food prices and access.
3. Losses in fisheries productivity and aquatic products would limit livelihood and subsistence opportunities
4. Natural system instability, including landslides, bank collapse and soil erosion would all affect the poor first and most significantly.

Increased potential power capacity

- **Increase power capacity benefits:** The increased runoff in all LMB catchments with climate change would increase hydropower potential in tributaries and in the mainstream
- Additional potential of new and upgraded existing projects on the tributaries has not been modeled – could this offset urgency for mainstream projects?
- Additional power potential for mainstream projects
- Economic and technical feasibility key considerations
- Phasing and design considations

Comparing climate change factors and groups of mainstream projects

Influential factors include:

- the number of tributaries by hydro-ecological zone
- their flow contribution to the mainstream in addition to the area and geology of their catchments
- climate change effects on agricultural productivity in various tributary catchments,
- effects of the different project groupings on local fish migration and fisheries productivity,
- the likely concentrations of urban and industrial development and populations within reservoir catchments.

Cascade of 6 dams upstream of Vientiane (zone 2)

- The zone least affected by projected increases in runoff due to climate change (relatively large number of planned tributary dams).
- Aggravate the concentration and bio-accumulation of anticipated increases in agricultural, industrial and urban chemical pollutants during dry season.
- All catchments in this zone are expected to suffer losses in agricultural productivity and food deficits.

Middle Mekong dams (zone 3)

- the largest area and a total tributary inflow of 38% will be most affected by projected increases in runoff and sediment due to climate change.
- Mainstream projects would be exposed to significant increases in annual volumes of water and in frequency and magnitude of wet season extremes in flood events.
- Has some of the catchments most seriously affected by reductions in dry season rainfall and agricultural food deficits.
- Overall reductions in aquatic systems productivity
- The large areas of agricultural land in this zone, the most numerous settlements and increasing pockets of industrial development create potential for relatively high pollution levels in runoff entering mainstream reservoirs.

Cambodian dams (zone 4)

- 27% of flow is contributed to this zone of the river from three major tributaries in relatively steep terrains.
- The velocity of runoff in extreme rainfall events will be modulated by intensive development of tributary dams.
- The relatively high sediment load in this zone and increases due to climate change will be reduced by the tributary cascades.
- 43% of the mainstream length will be affected by the reservoirs, with a loss of about 58% of the in-channel wetland areas with a very significant impact on biodiversity and fisheries productivity. This zone would experience severe food deficits.
- Locally sourced pollution would not be as serious in this zone but the contributions from upstream might become a problem especially for Stung Streng reservoir.