The importance of flood pulse and nutrients on biological production: case Tonle Sap Lake

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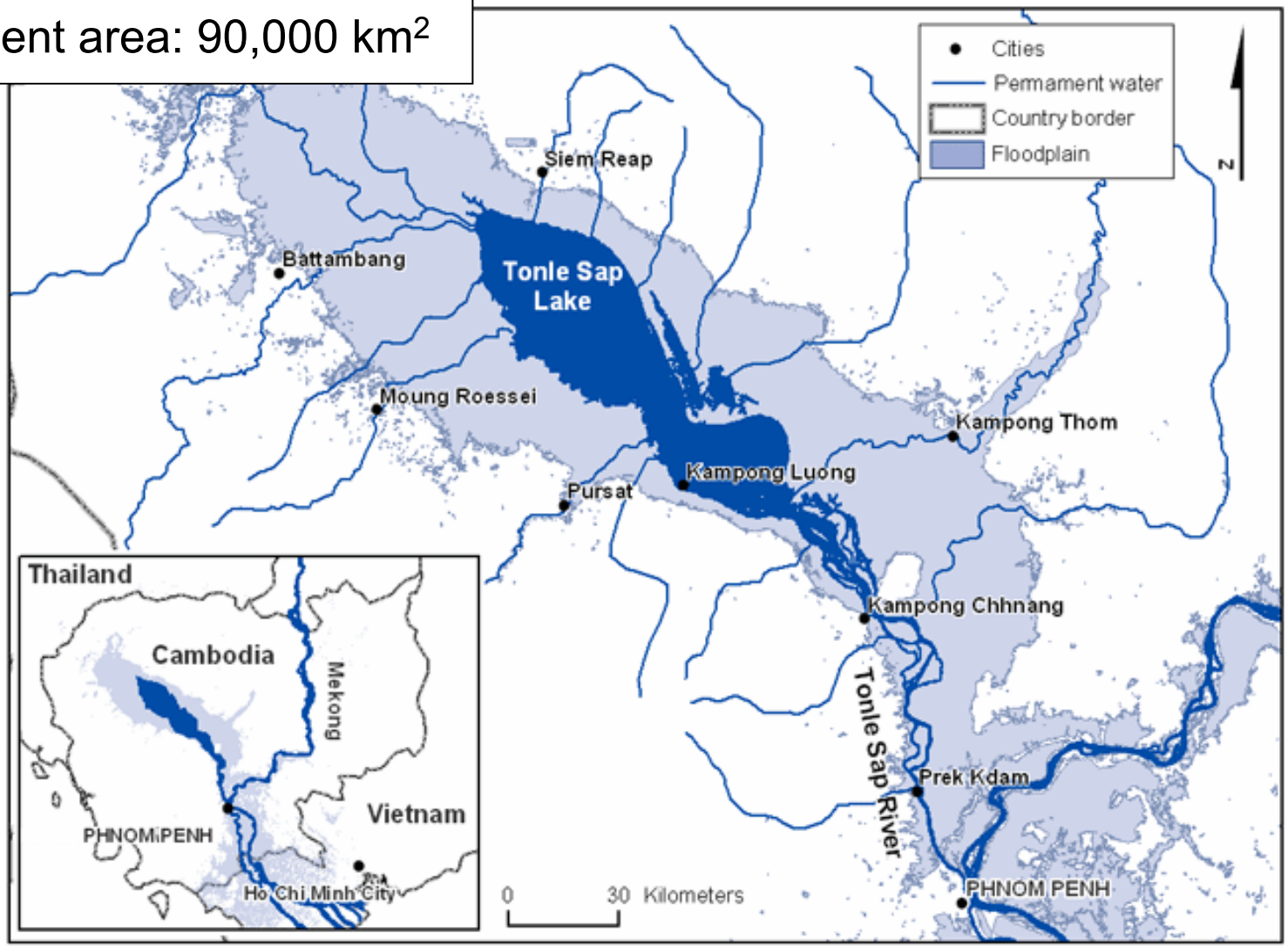
Introduction

- Area:
  - Tonle Sap Lake, Cambodia
- Key parts of the Tonle Sap ecosystem
  - Flood pulse
  - Large floodplain and rich biodiversity
  - Floodplain vegetation
  - High nutrient input from Mekong
- Mekong and Tonle Sap
  - Rapid development in the basin → pressure on water resources

Tonle Sap Lake

- Area: 2,500 – 15,000 km^2
- Volume: 1.3 – 70 km^3
- Water depth: 0.7 – 9.0 m
- Catchments: 13
- Catchment area: 90,000 km^2

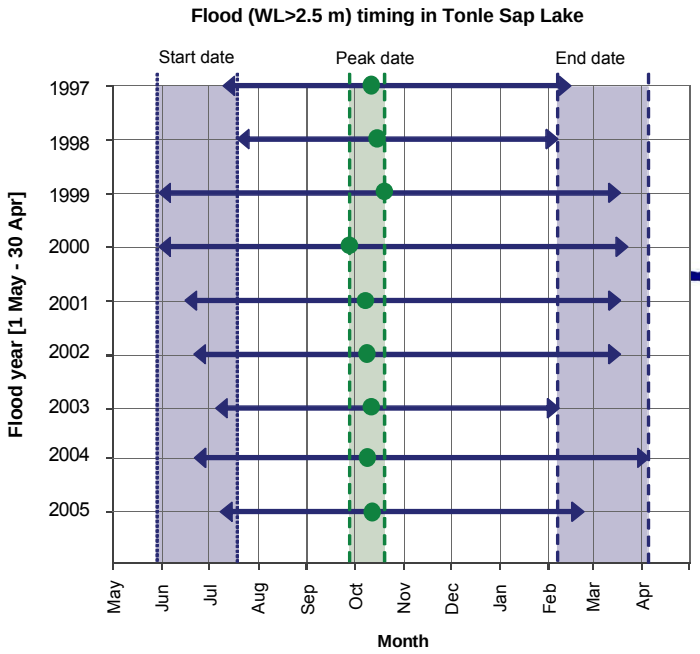


flood pulse

- in recent years, the body of evidence in support of the hypothesis that the flood pulse is the main driving force of the productivity of the Tonle Sap lake and floodplain ecosystem has become solidly established.
- most of the water involved in this flood pulse originates from the Mekong River

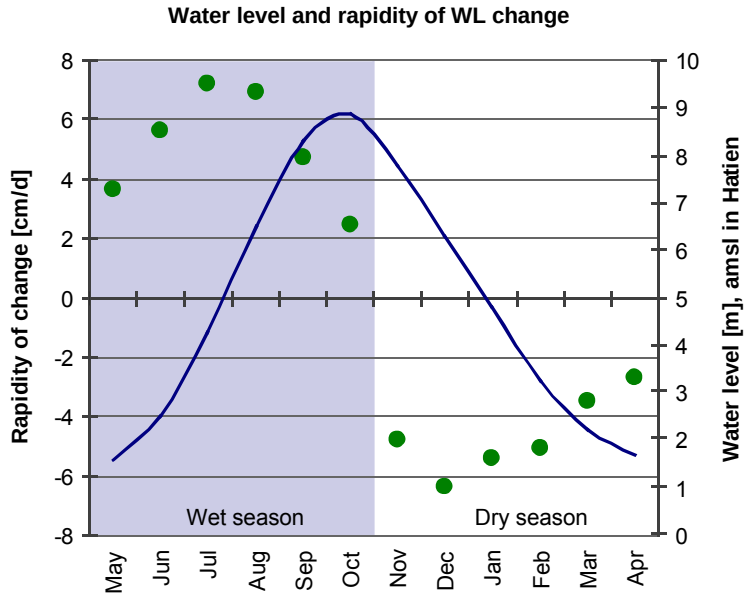


flood pulse of the Tonle Sap

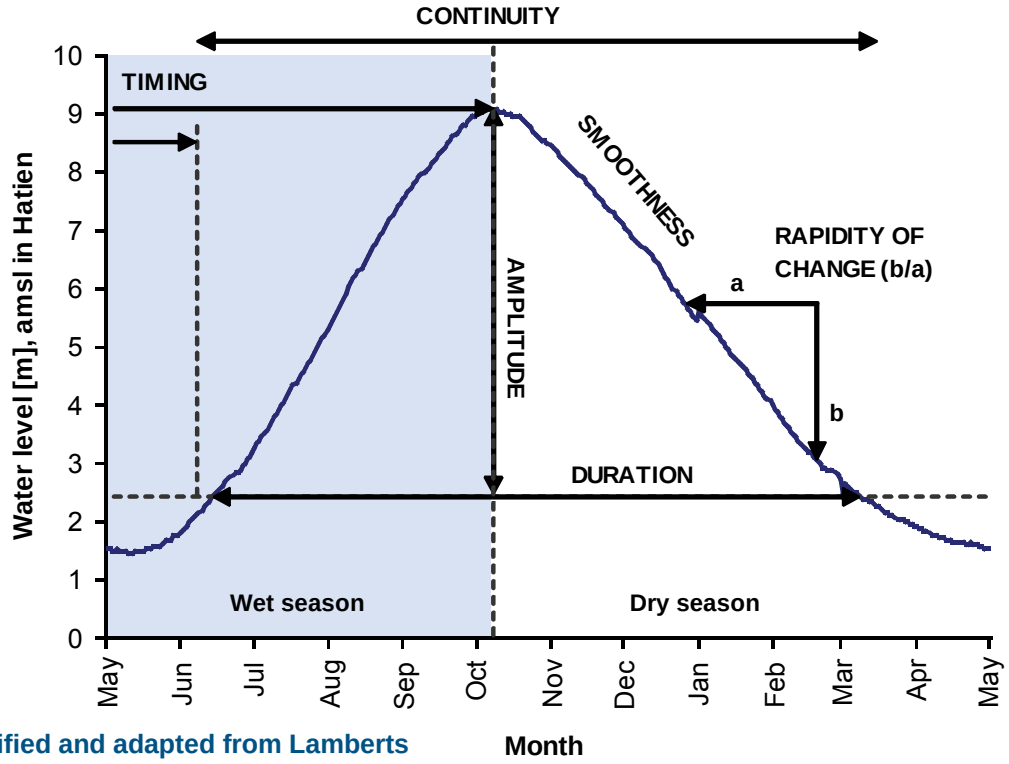


'Flood pulse'

Ecosystems that experience fluctuations between terrestrial and aquatic conditions are called pulsing ecosystems, and fall within the domain of the flood pulse concept *(Junk, 1997).*



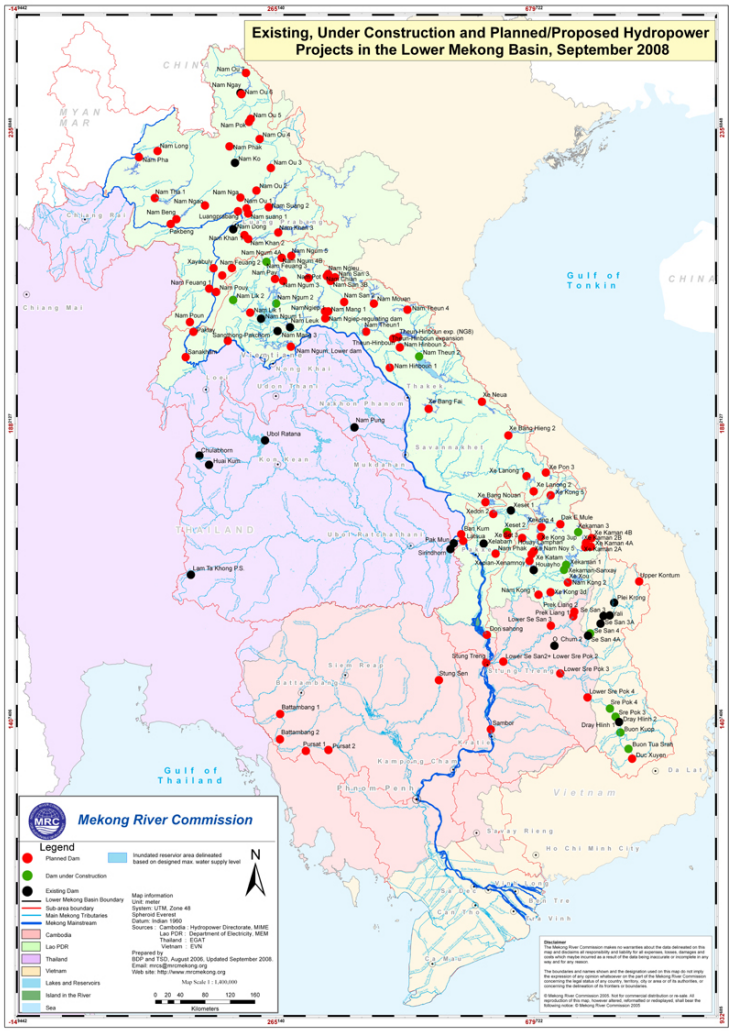
Source: Kummu & Sarkkula 2008



Modified and adapted from Lamberts (2007) and Welcomme & Halls (2004)

threats on flood pulse

- Ongoing and planned developments in the Mekong River basin will affect the flow in the Mekong River, and hence the flood pulse of the Tonle Sap ecosystem.
- The fact that there will be an impact on the Tonle Sap ecosystem is now widely accepted and is often referred to as a major constraint to development of the water resources of the Mekong River



other productivity drivers

- floodplain habitats
- chemical quality of flood water
- sediment load in the flood water
- amount of floodplain exogenous matter that is carried into the ecosystem

the question:

How much will different flow scenarios in the Mekong River affect the Tonle Sap as a productive ecosystem?

the problems

- Scarcity of (good) data
- Complexity of the ecosystem:
  - Flood pulsed → interactions between aquatic and terrestrial phases
  - Biodiversity is high
  - Migration
- Extensive and diverse use of natural resources
- Fisheries productivity ≠ ecosystem productivity

the problems

- In the absence of even approximate fish catch statistics, how to link that productivity to that of the ecosystem?
- Given the poor result of over half a century of fish catch data collection efforts, it is unlikely that meaningful statistics can be collected in the foreseeable future, if ever
- Even with such reliable figures, the complexity of the ecosystem would still be a huge problem to link fisheries productivity directly to environmental factors

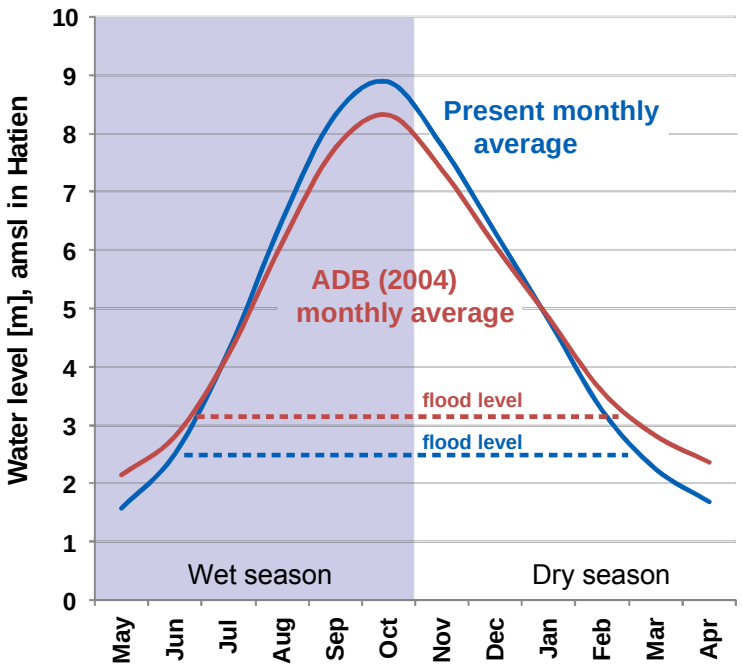
the answers

- concept:
  - to assess the impact of flow alterations on the productivity of the ecosystem as a whole
  - Eventually, the fish production in the Tonle Sap depends on the import of organic matter and the primary production within the ecosystem, and then on the degree to which that basic organic matter enters the secondary aquatic food webs.
- tools:
  - *hydrodynamic modelling* of the Tonle Sap
  - *Modelling of the primary production* of the Tonle Sap ecosystem in function of flood pulse factors

the answers (2)

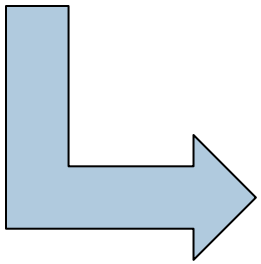
- tools (cont)
  - Combined: powerful tool to assess the impact of flow alterations on the productivity of the Tonle Sap
    - for all elements qualitatively
    - for many elements quantitatively
  - The vast majority of the primary organic matter entering the secondary food webs in the Tonle Sap is produced locally. This means that the secondary production and the fisheries production ultimately depend on and are limited by the primary production of the ecosystem.

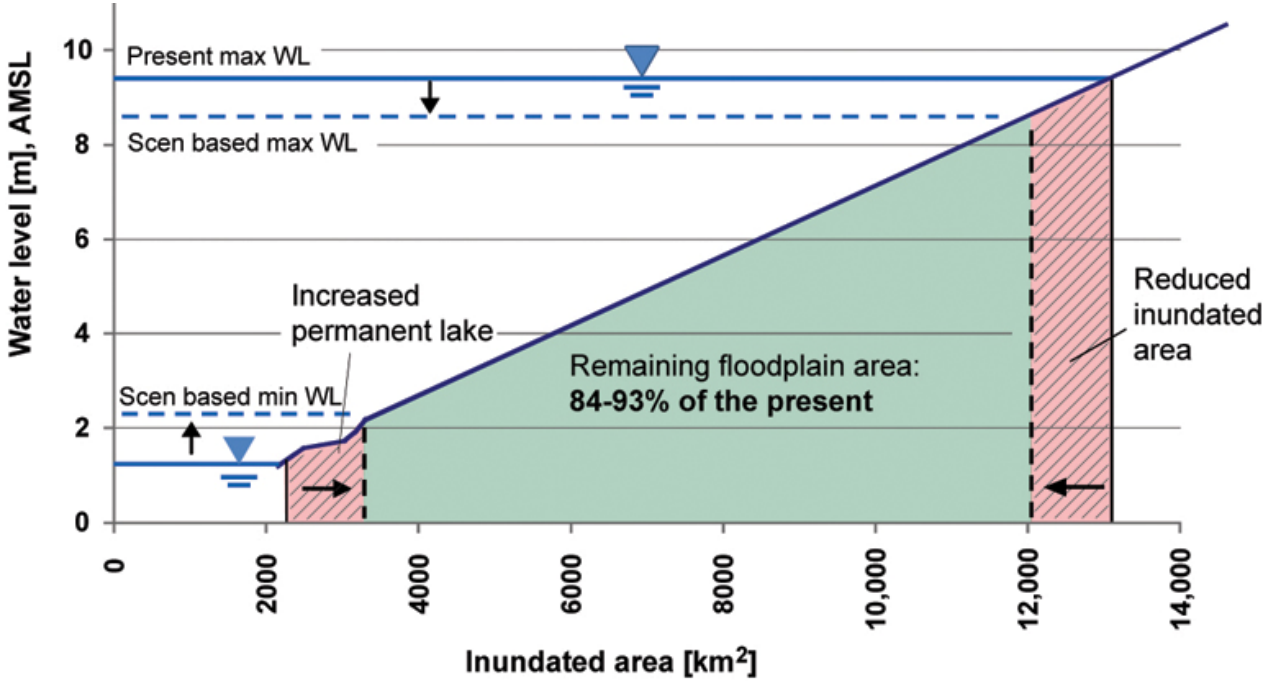
development impact: flood pulse



Impacts on flood *(after ADB, 2004)*:

Duration:	**-5%**	(264→250 d)
Flood volume:	**-16%**	(60→52 km^3)
Floodplain area:	**-16%**	(11,000→9,200 km^2)
Min WL	**+0.6 m**	(1.44→2.04 m)
Max WL:	**-0.6 m**	(9.17→8.57 m)



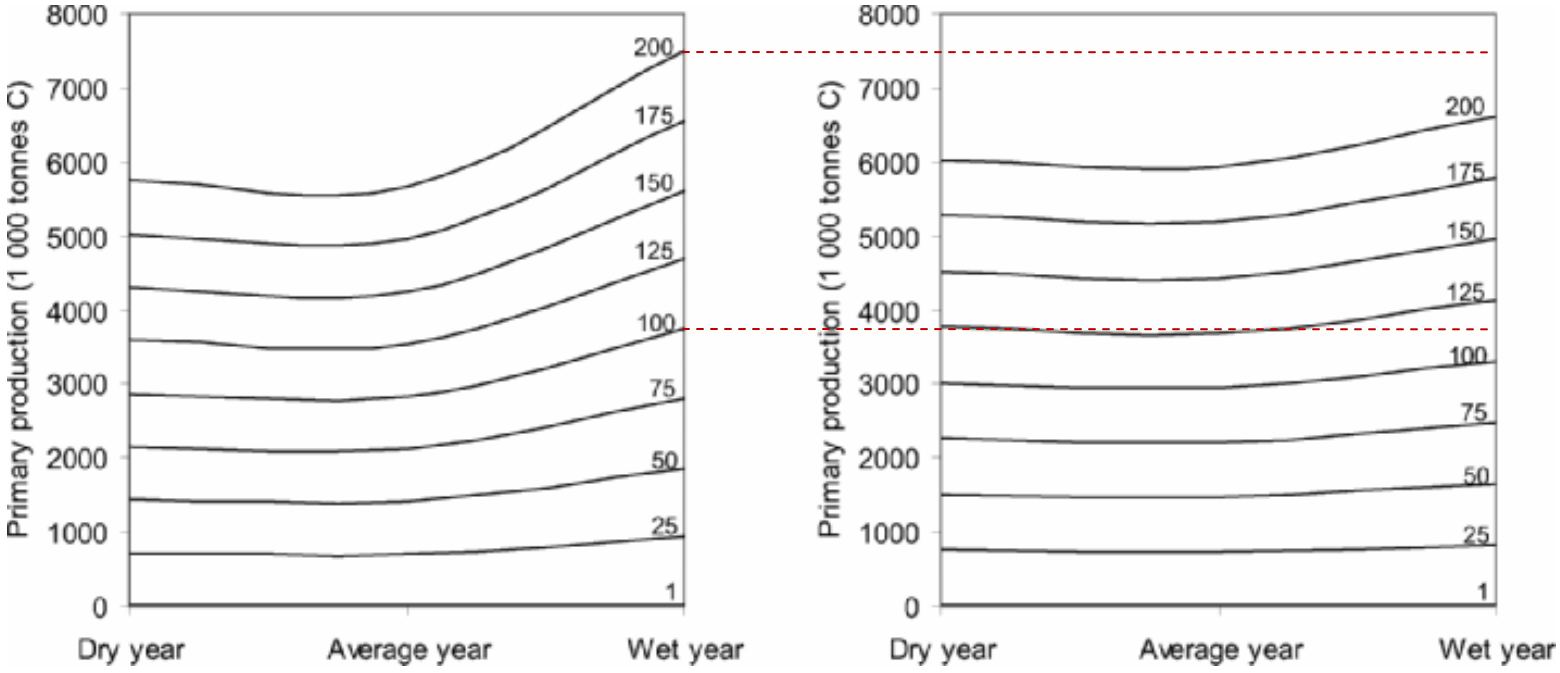


Source: Kummu & Sarkkula 2008

productivity model

- spatially explicit
- quantitative where possible, qualitative where the present knowledge and data would not permit quantification
- potential primary production
- four groups of primary producers in the Tonle Sap ecosystem
  - periphyton
  - phytoplankton
  - rooted macrophytes
  - floating macrophytes

phytoplankton primary production

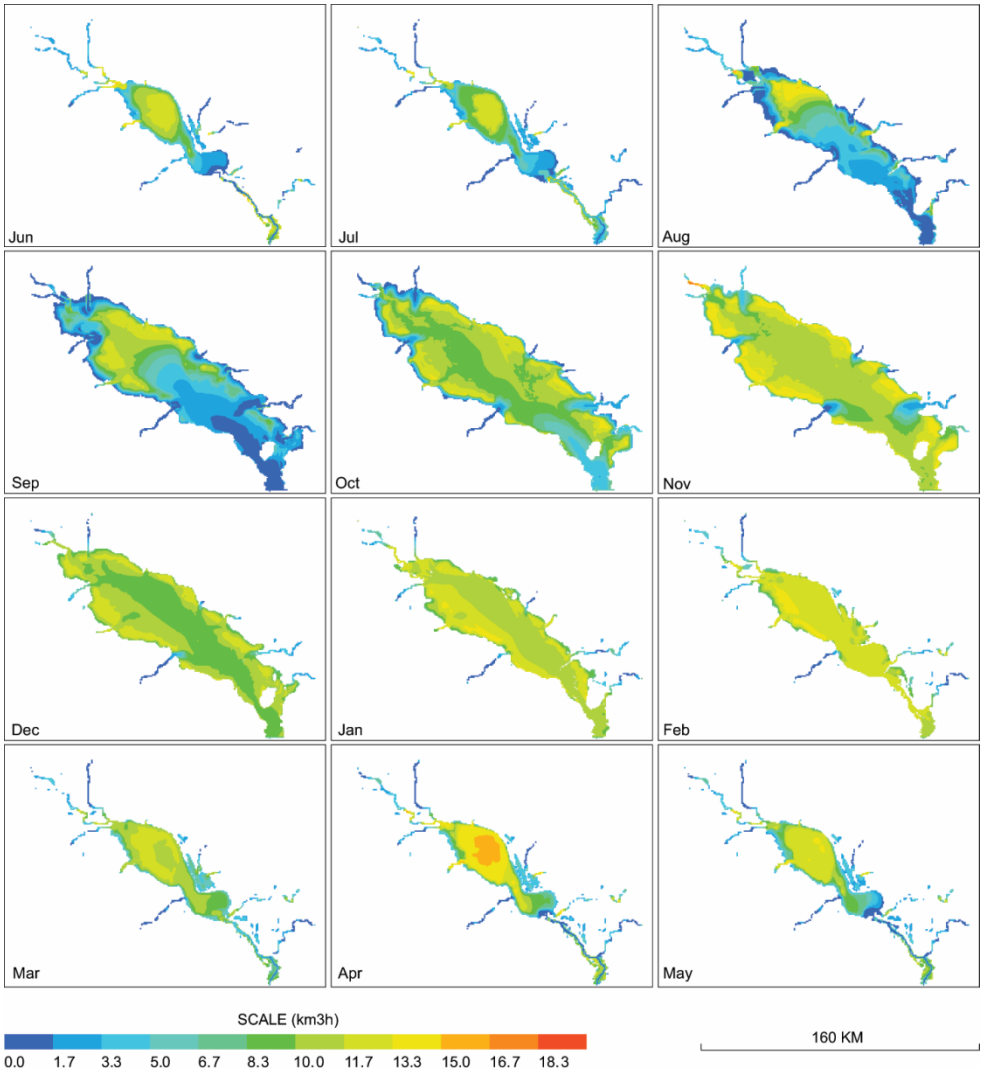


simulation of current situation

simulation of development situation

euphotic volume

- Cumulative monthly exposure time in the euphotic volume for the Tonle Sap ecosystem (1997)



Conclusions and way forward...

- effective set of models to assess impacts on flood pulse and potential primary production
- ”traditional” EIA not enough to assess the developments impacts
  - cross-sectoral and cumulative IA needed
  - tools exist, although still many knowledge gaps (baseline not fully understood)
- way forward – 3Cs:
  - combine, collaborate and communicate

Thank you for your attention!

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content

- flood pulse
- threats on flood pulse
- other productivity drivers
- the question, the problems and the answers
- results of assessment
- conclusions