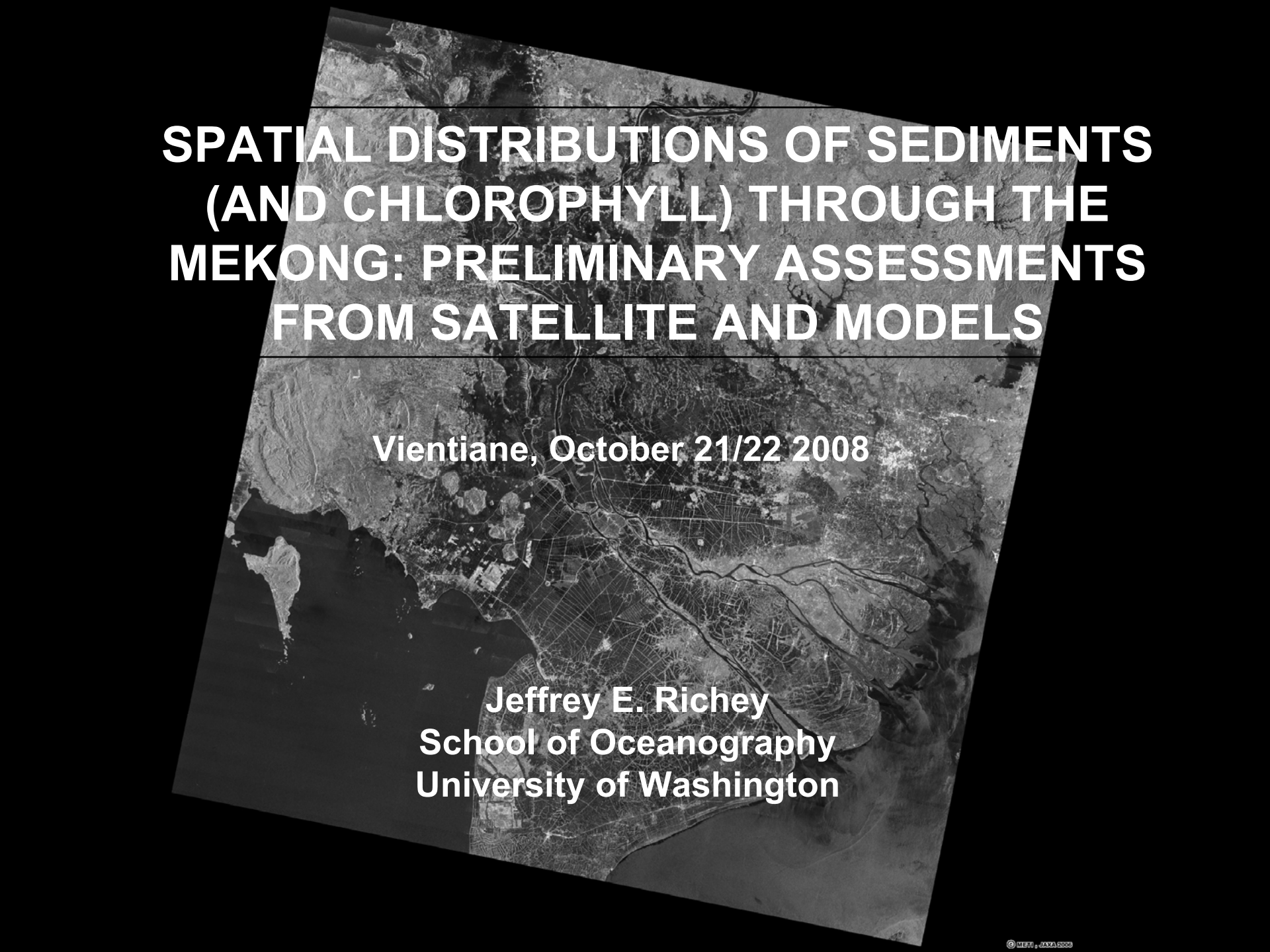
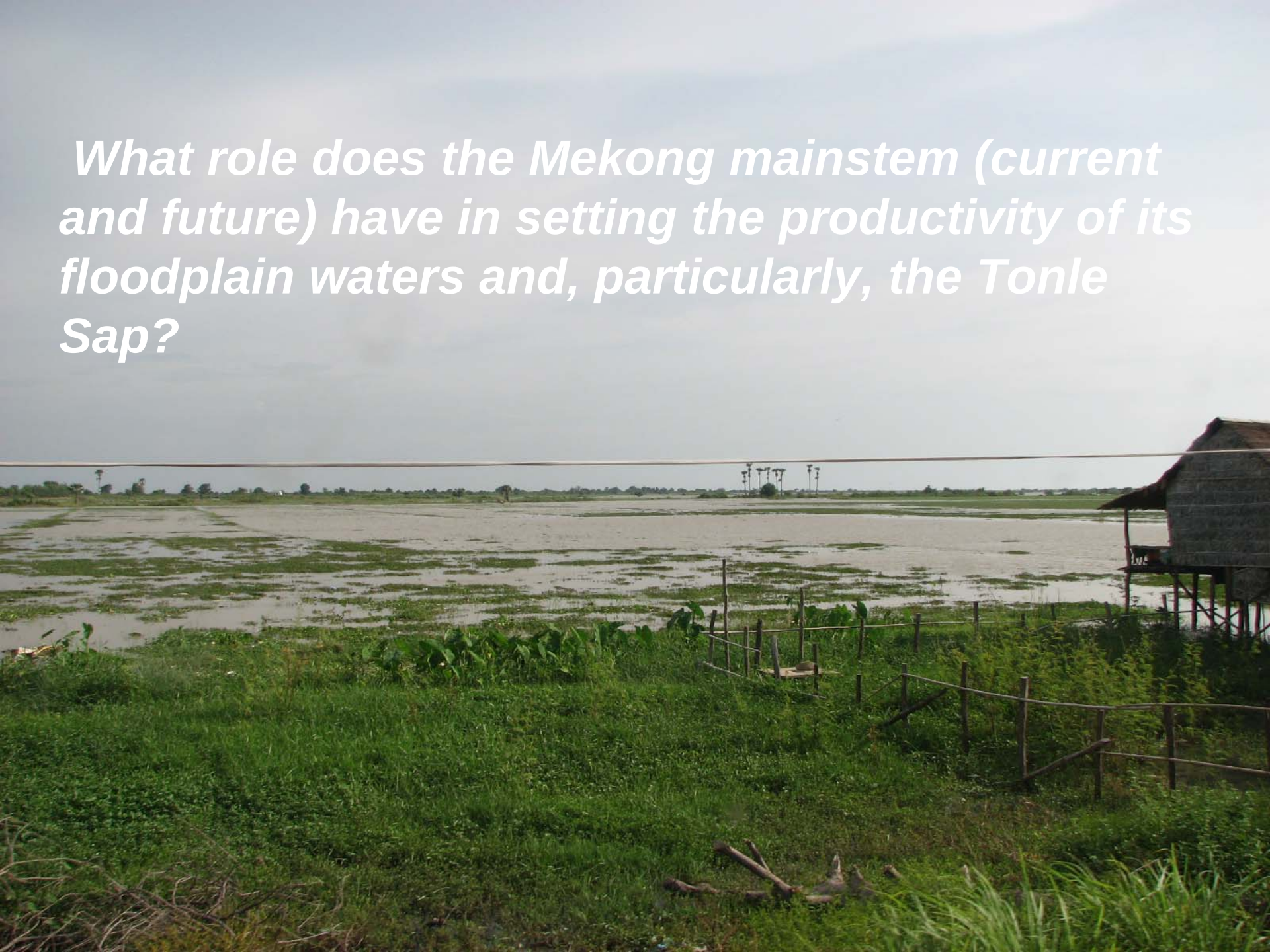


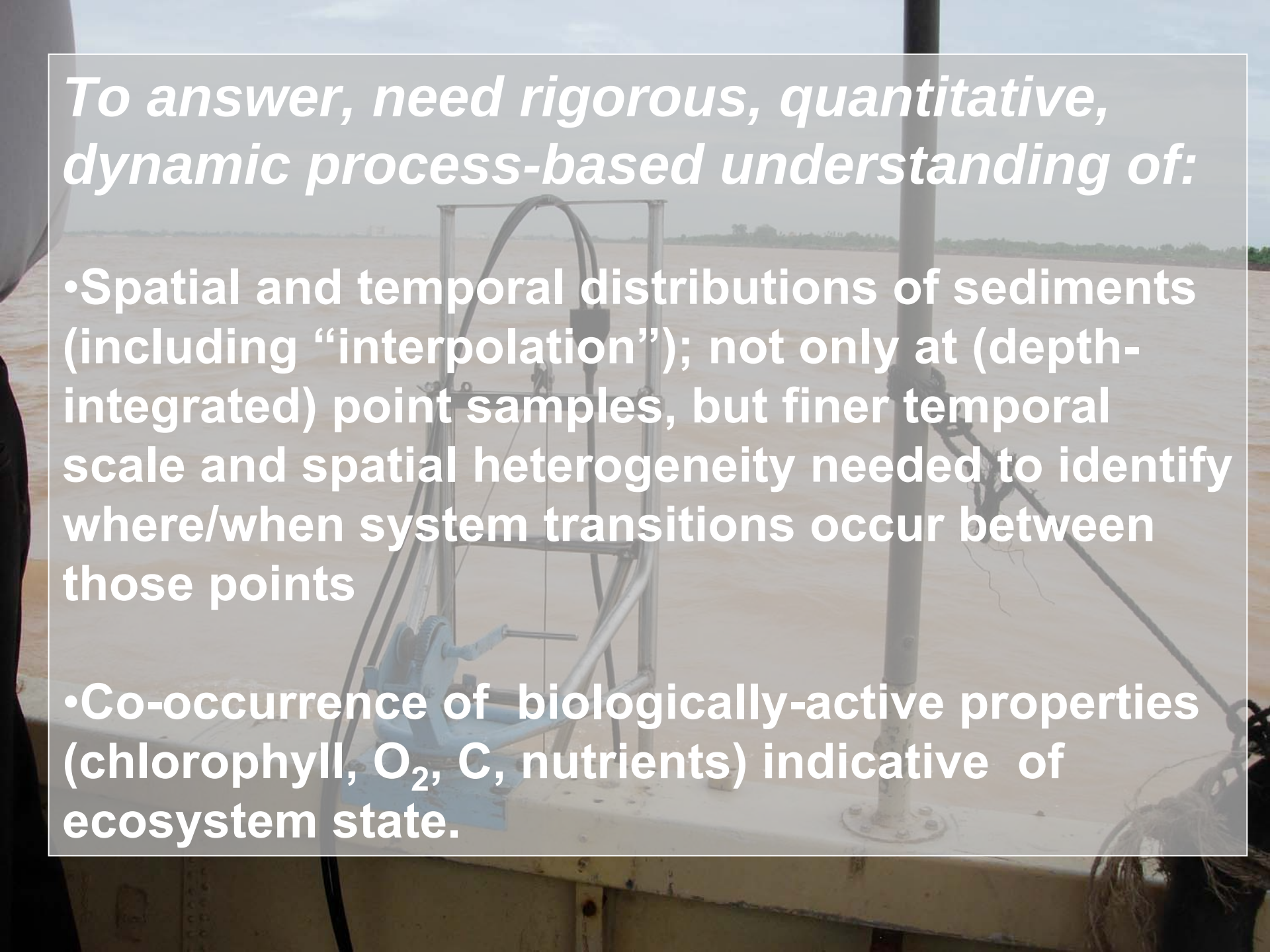
SPATIAL DISTRIBUTIONS OF SEDIMENTS (AND CHLOROPHYLL) THROUGH THE MEKONG: PRELIMINARY ASSESSMENTS FROM SATELLITE AND MODELS

Vientiane, October 21/22 2008

Jeffrey E. Richey
School of Oceanography
University of Washington


What is the relation of landscape structure, climate (change), runoff regimes, and hydropower to sediment mobilization, transport, and fate?


What role does the Mekong mainstem (current and future) have in setting the productivity of its floodplain waters and, particularly, the Tonle Sap?



To answer, need rigorous, quantitative, dynamic process-based understanding of:

- **Spatial and temporal distributions of sediments (including "interpolation"); not only at (depth-integrated) point samples, but finer temporal scale and spatial heterogeneity needed to identify where/when system transitions occur between those points**

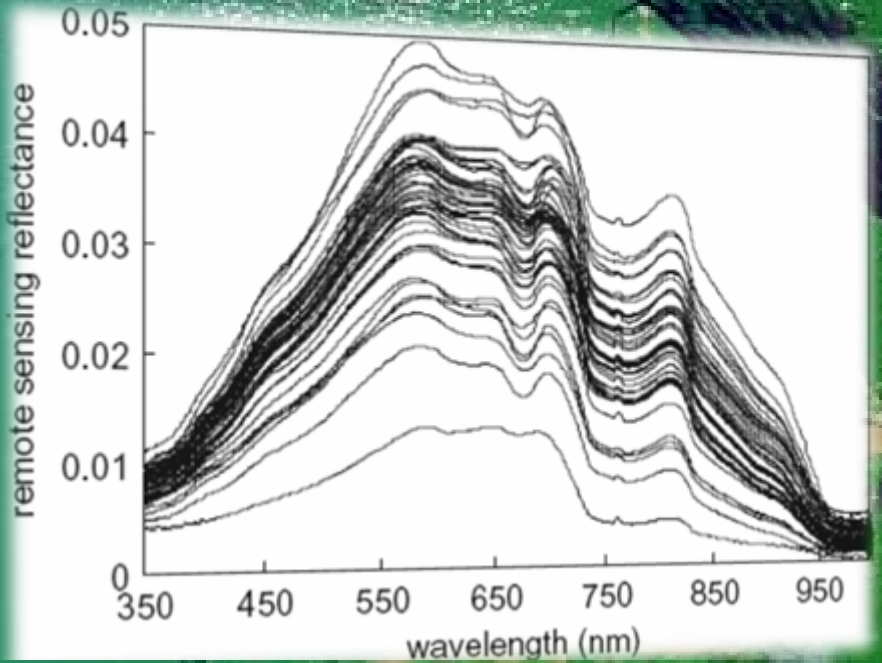
- **Co-occurrence of biologically-active properties (chlorophyll, O_2, C, nutrients) indicative of ecosystem state.**

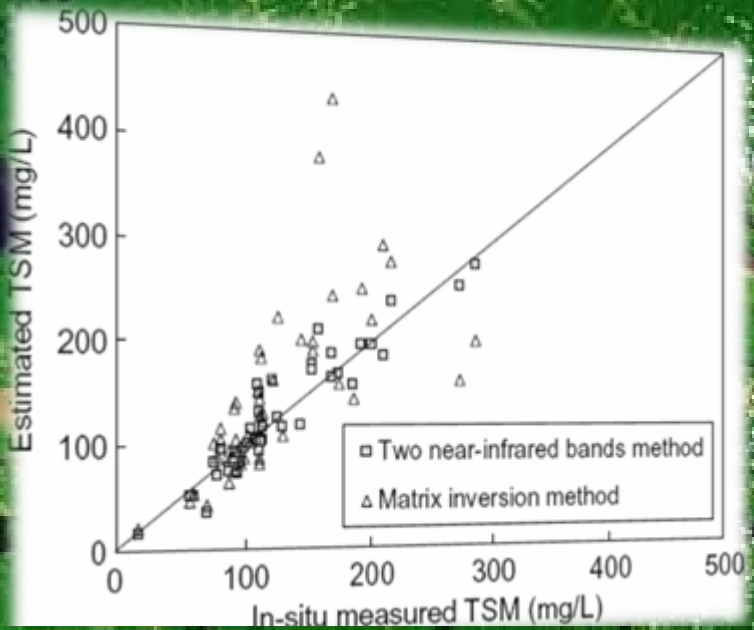
Calls for a convergent strategy of:

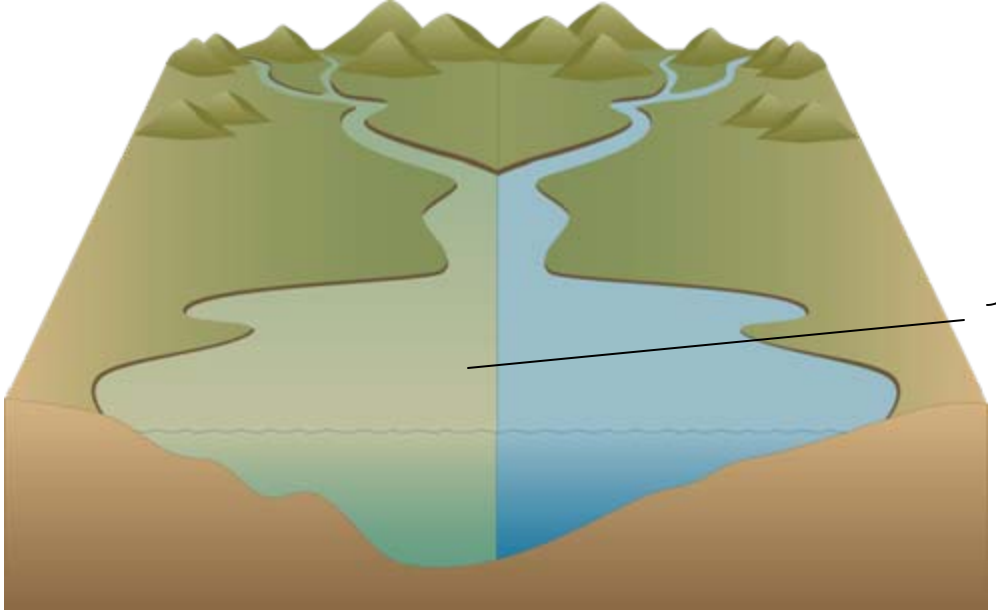
- **(Enhanced) station sampling (per MRC plans!)**
- ***Optical remote sensing – is it "useful" for sediments in rivers???***
- **Surface continuous sensors (of calibrated turbidity, chlorophyll, pH, O_2)**
- **Sediment generation and transport modeling**

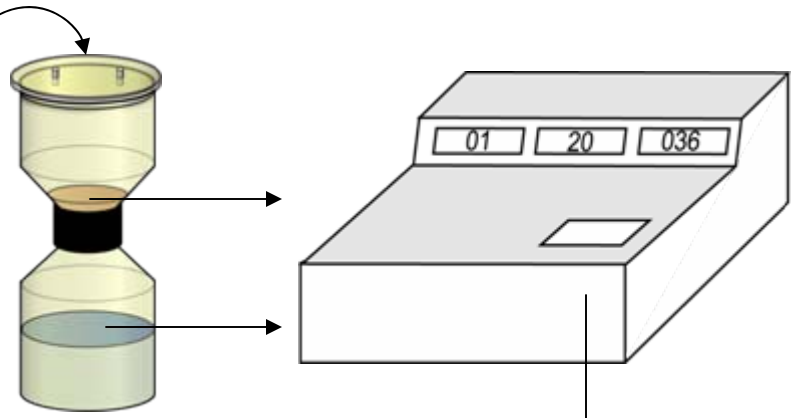
Optical remote sensing of Sediments in rivers/lakes (delta): what can you “see?”

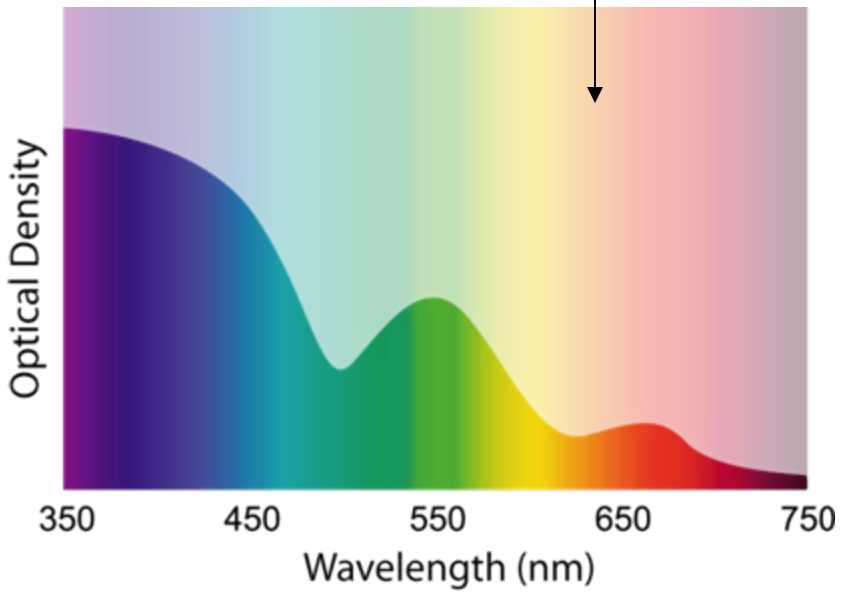
INHERENT OPTICAL PROPERTIES (IOP):
Resolution of “absorption and backscattering coefficients” is basis for remote sensing











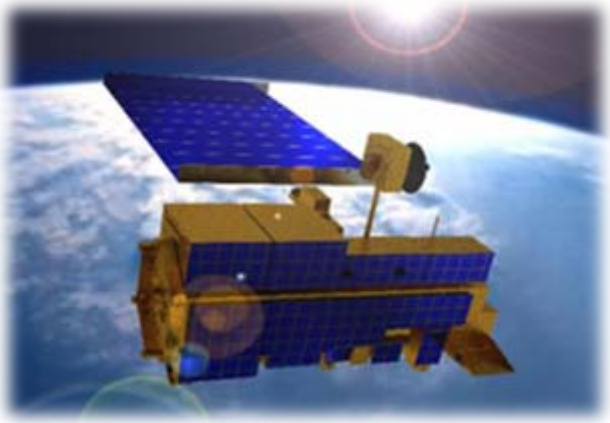
- **The spectral absorption coefficient, a *(*λ), is described in terms of the additive contributions of water, particles, and soluble material**

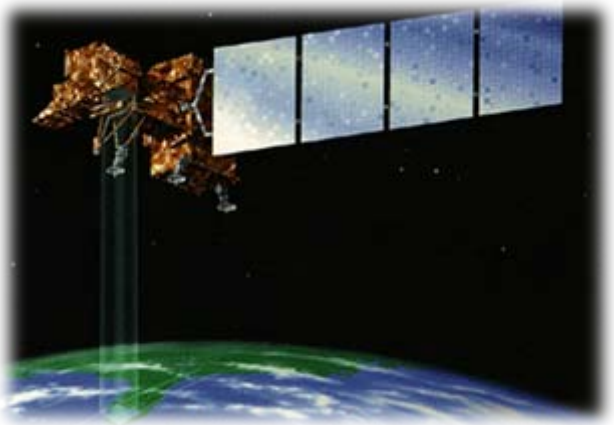
- **Spectrophotometric measurements of processed samples to separate various components of a *(*λ)**

- **Required to interpret aquatic spectral reflectance**

$$a(\lambda) = a_w(\lambda) + a_p(\lambda) + a_g(\lambda)$$

Sources of opertional optical remote sensing data





MODIS Data

Easily available at no cost through various NASA online archives

•Spatial resolution up to **1 km/250m** (Red + NIR bands),

•Temporal resolution: global coverage **1-2 days**

•NIR band at 250m resolution can be used to map sediment conc. in surface waters

MERIS Data

Available at reproduction cost only for scientific use via Category-1 proposal

•Spatial resolution **300m in Full** Resolution Mode (all 15 channels)

•Temporal resolution: global coverage **3 days**

•NIR band at 300m resolution can be used to map sediment conc. in surface waters, various bands can be used for chlorophyll estimates

ETM+/TM/MSS Data

•No-charge Landsat 7 data now available through USGS

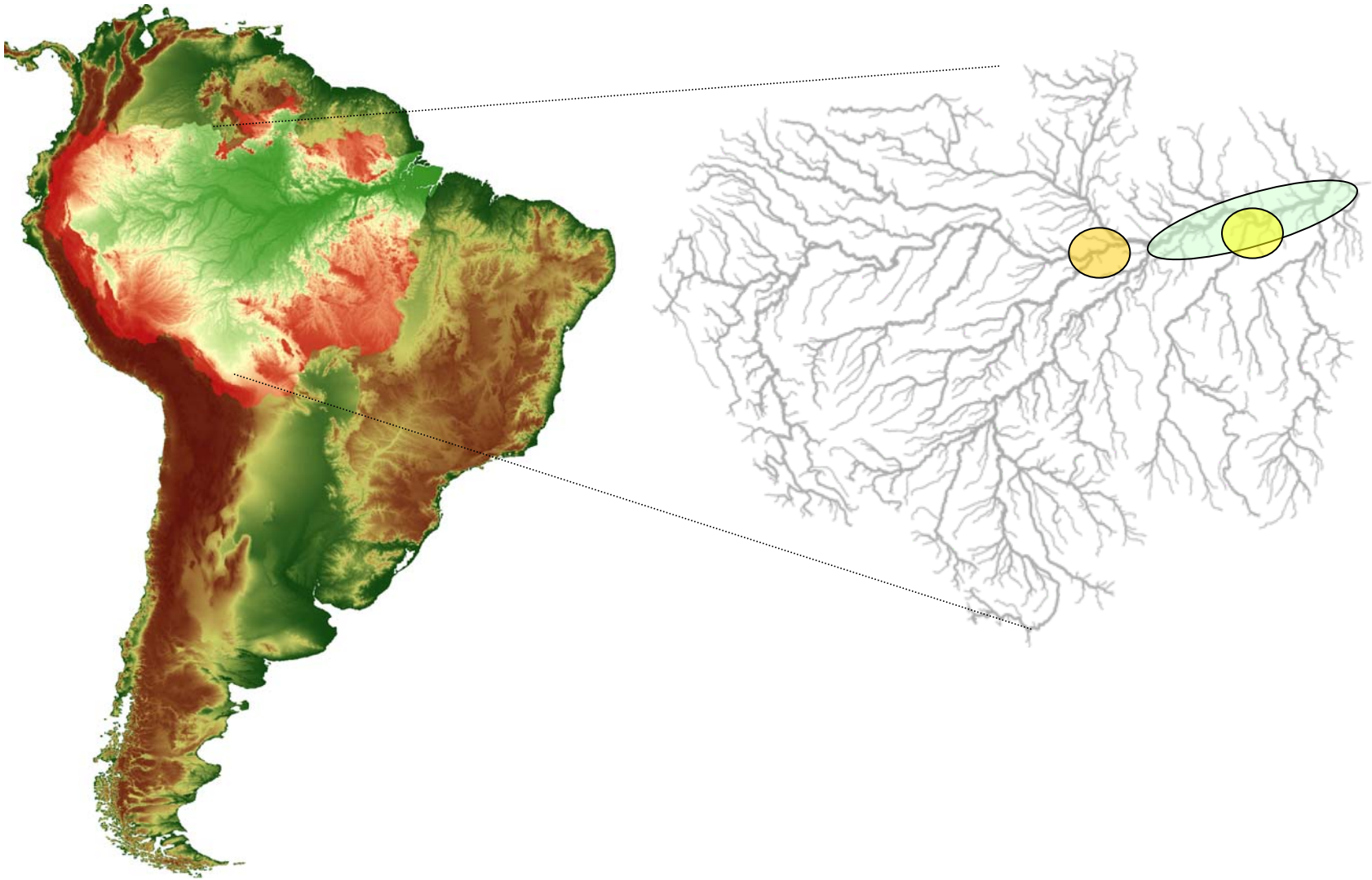
•Spatial resolution **30m**; 60m for thermal and 15m for pan bands

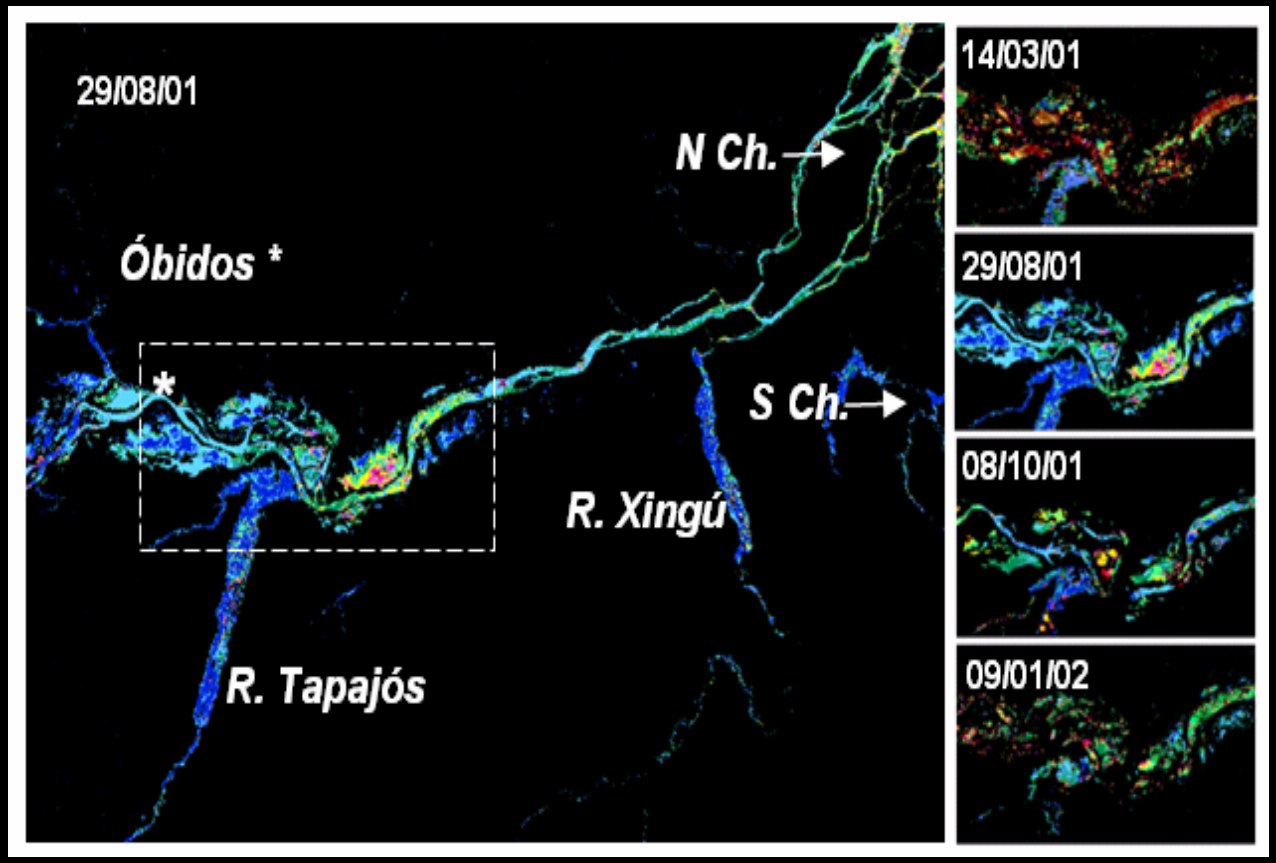
•Temporal resolution: global coverage **16 days**

•NIR bands at 30m resolution can be used to map sediment conc. in surface waters

Frequent high cloud contamination is difficult for sediment and chl estimates

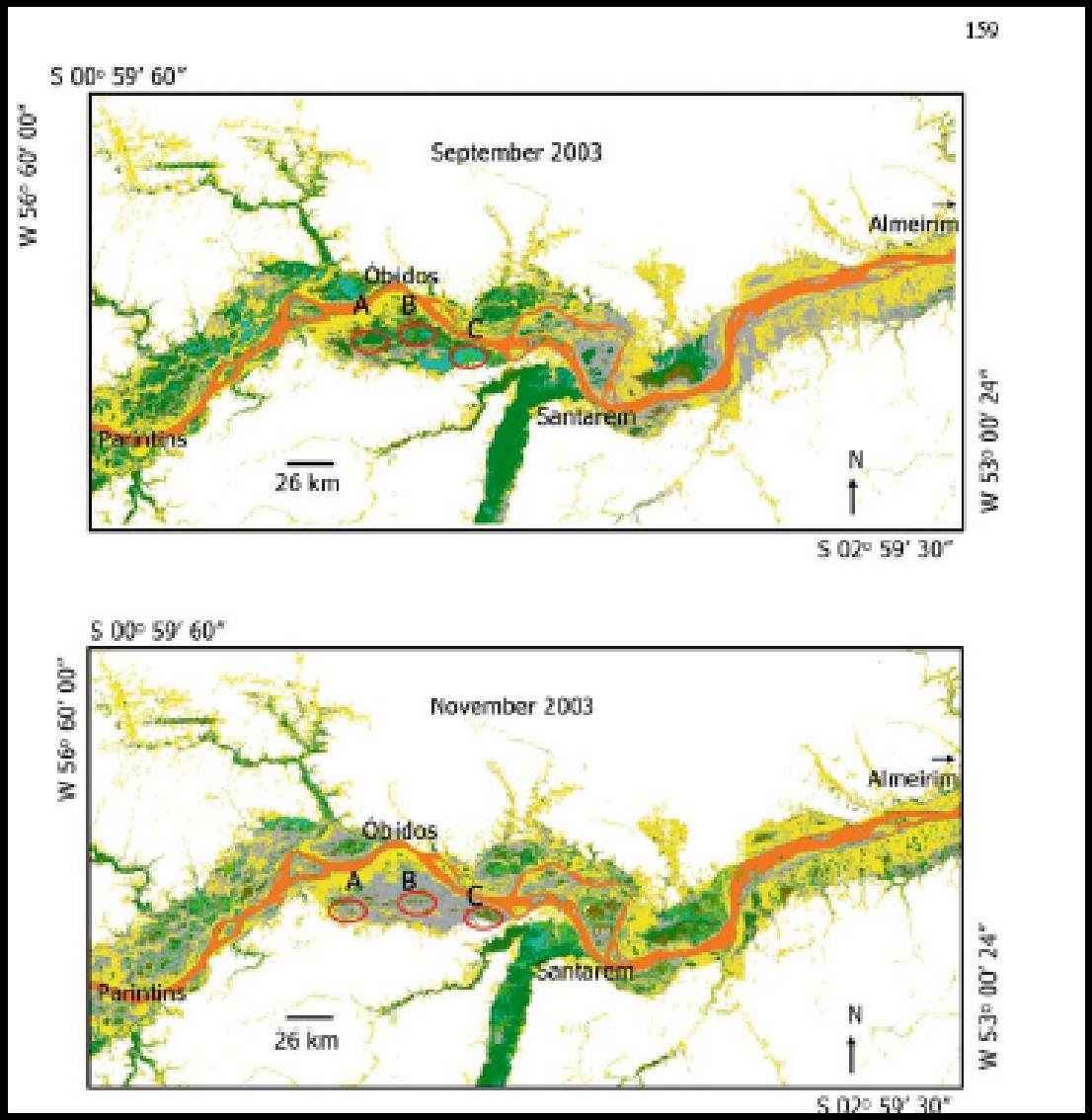
Applications, the Amazon as a testbed

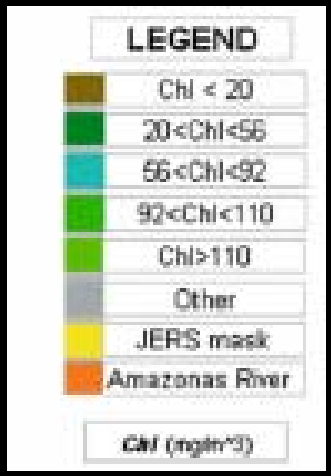




Surface suspended sediment concentrations (mg/L) from MODIS for lower Amazon: "Test of concept" calibration (L.A.K. Mertes, unpubl. data, in memory), from dark blue (0)- to red (~250).

MODIS: Chlorophyll a distribution - from Parintins-Almeinirn)



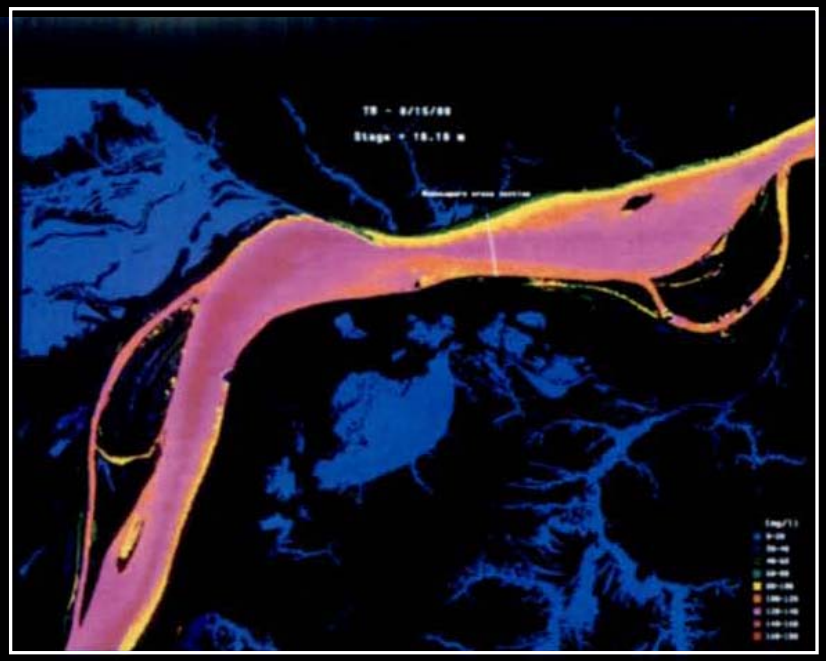


Novo et al 2006. Seasonal changes in chlorophyll distributions in Amazon floodplain lakes derived from MODIS images. Limnology 7:153–161

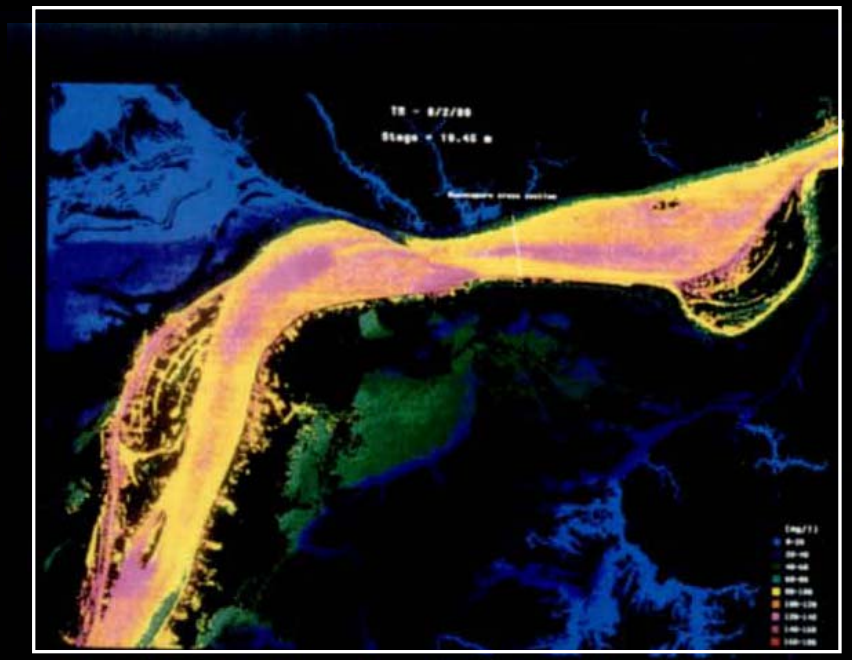
Cross-channel distribution of Surface Suspended Sediments

Landsat TM images (spectral end-member mixing)

15 August 1988, 16.19-m stage

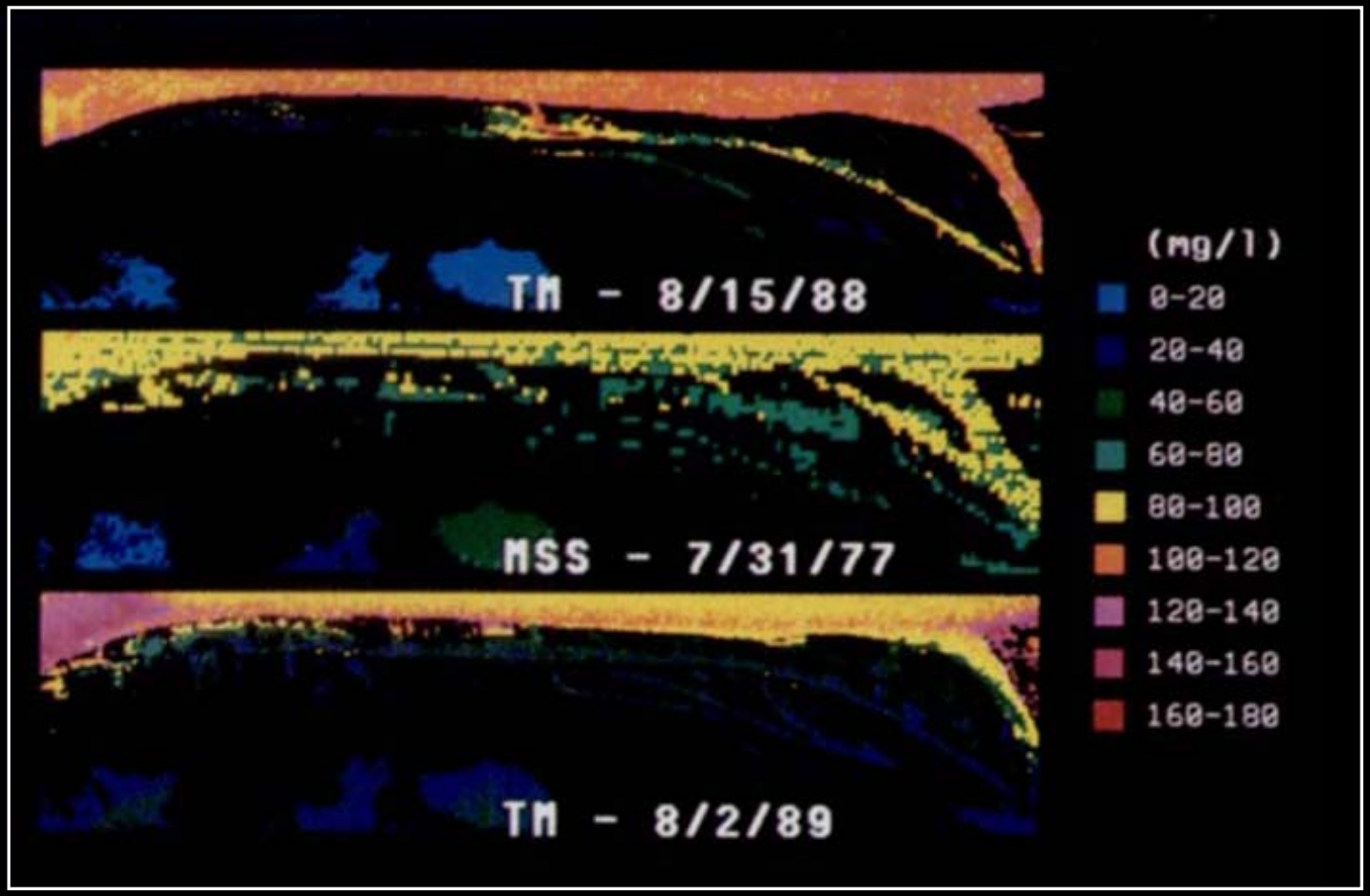


2 August 1989, 19.45-m stage

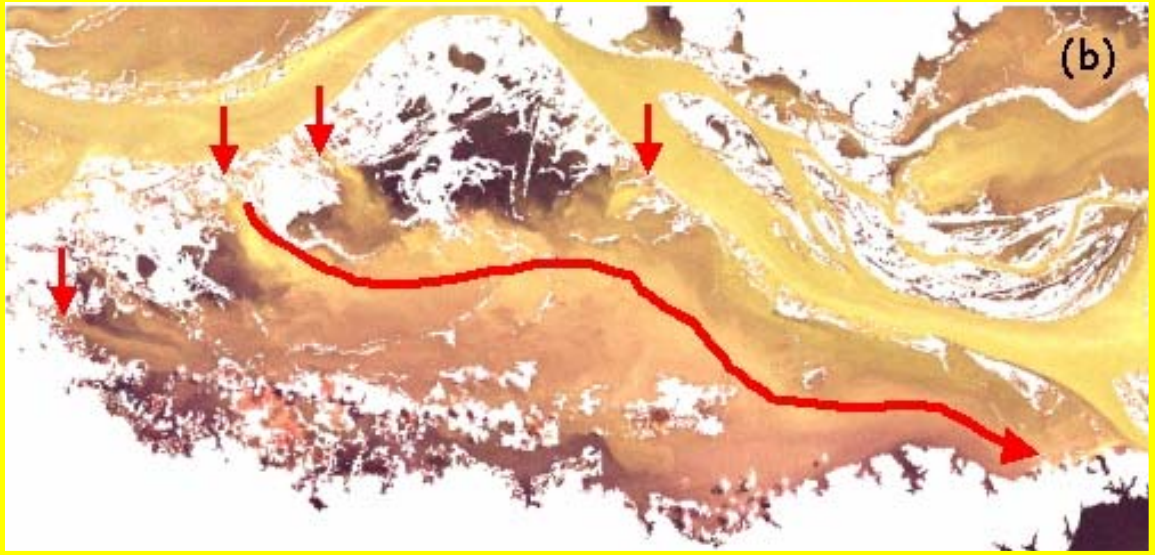


Mertes, L. A. K., M. O. Smith, and J. B. Adams. 1993. Estimating suspended sediment concentrations in surface waters of the Amazon River wetlands from Landsat images. *Remote Sensing of the Environment*, 43: 281-301.

Detailed view of distribution of SSS along the right bank near the Manacapuru XS, showing the rapid decrease in sediment concentration across the main channel-floodplain boundary



Conceptual Model of water circulation in Curuai floodplain



1- Tapajós river reach high level

2 – increase water level at east of Curuai floodplain

3 – east-west flux begins

4 – at 720 cm water level, inputs from igarapés (northern/western borders) are dominants

5 – the system reach equilibrium (May/June)

6 – the water movement is driven by natural barrier. (two distinct regions)

Water composition

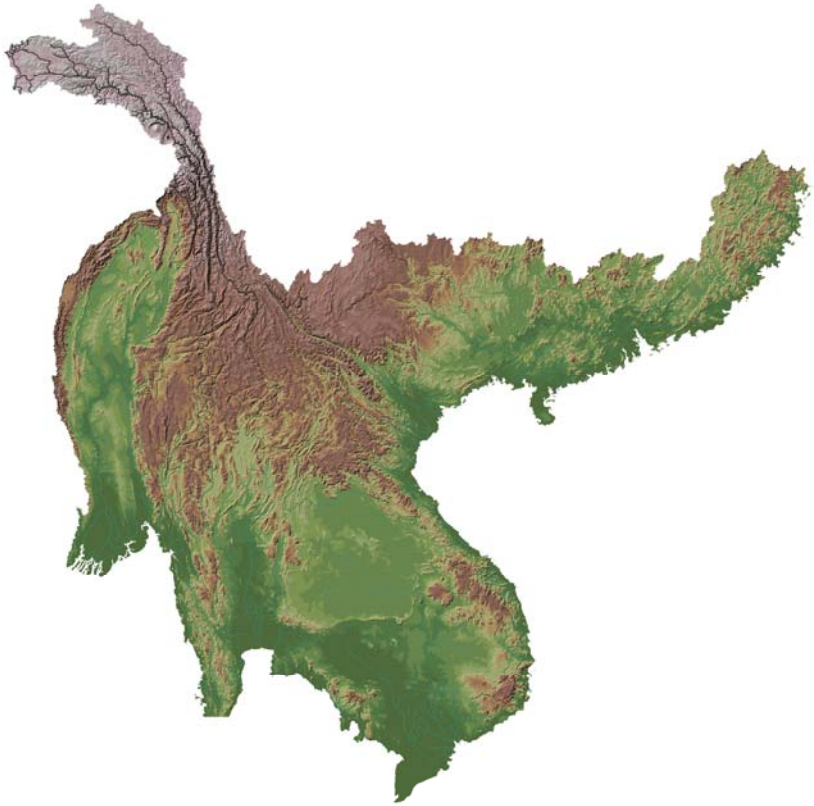
Low and rising (2 e 3)

TSS (dominate)

High and decline (1 e 4)

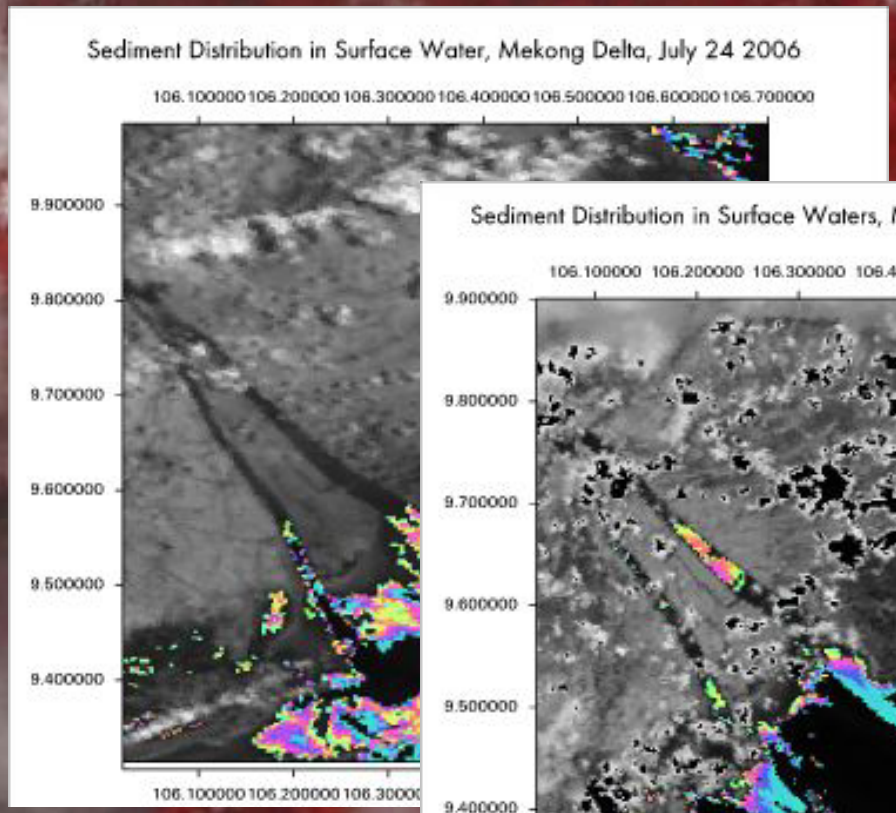
TSS + CLO (dominate)

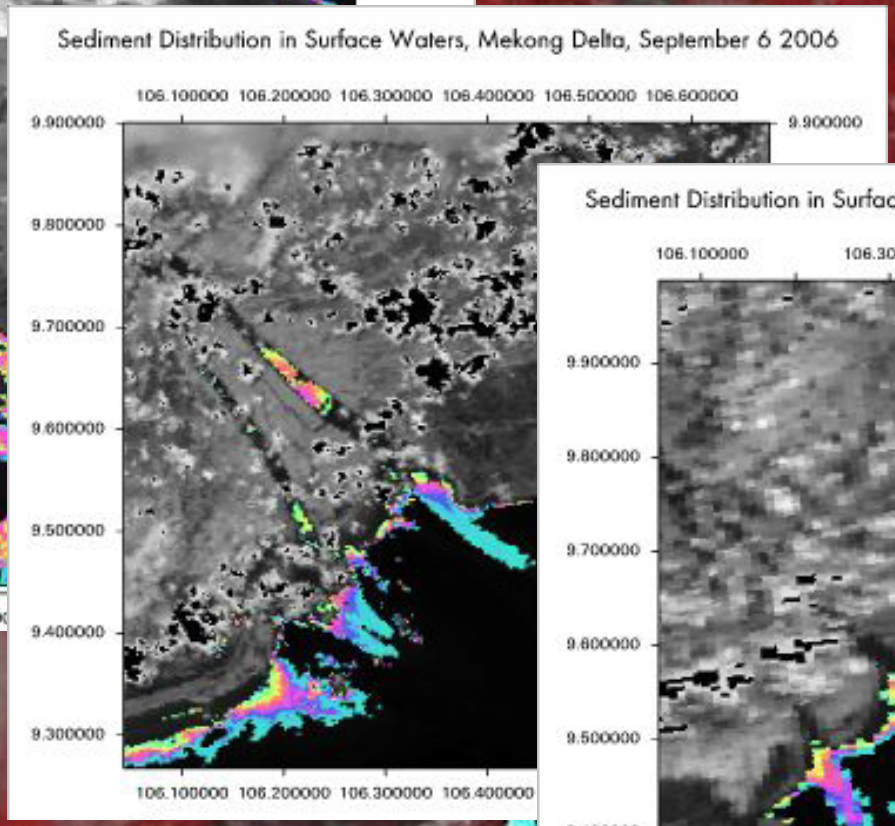
Ramping-up Applications in the Mekong*

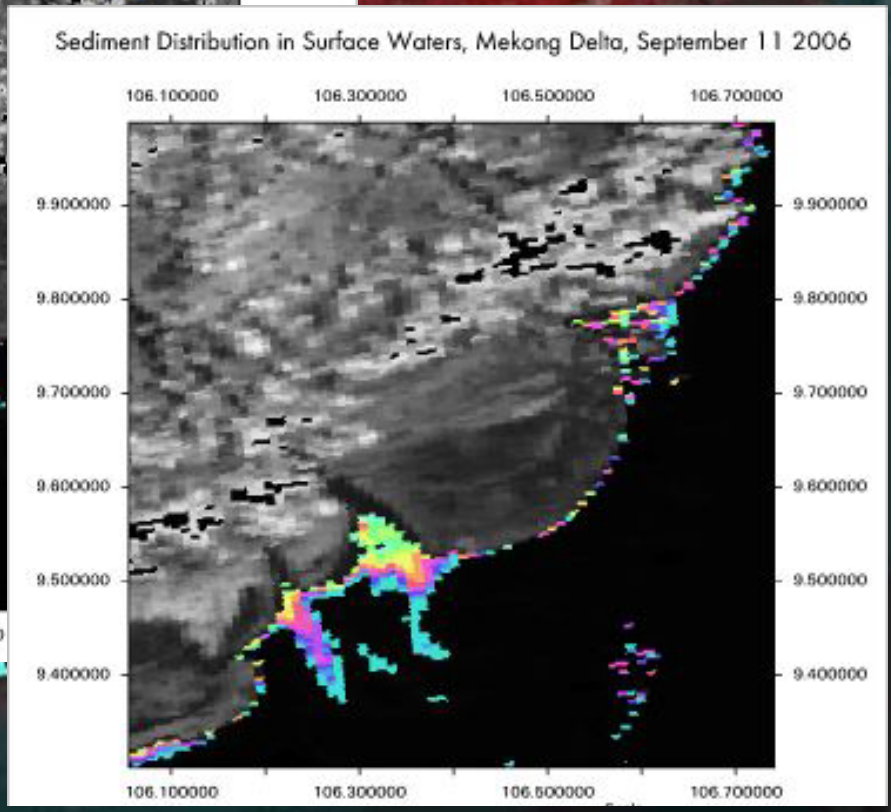


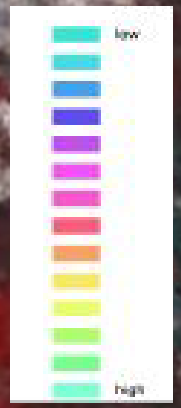
** And certainly other groups*

Sediment through the Delta (MODIS)

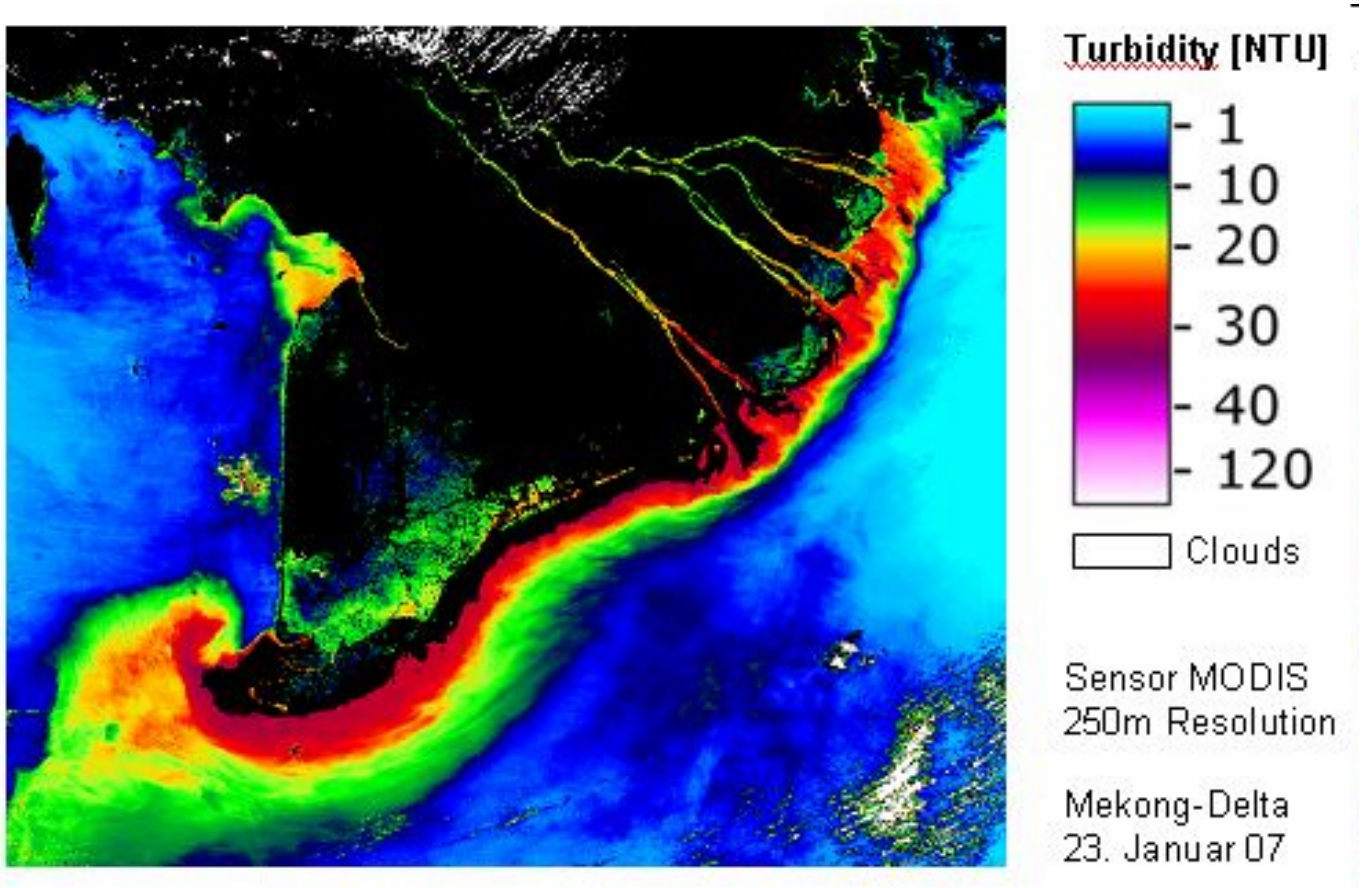








Spatial distribution of turbidity in the Mekong delta

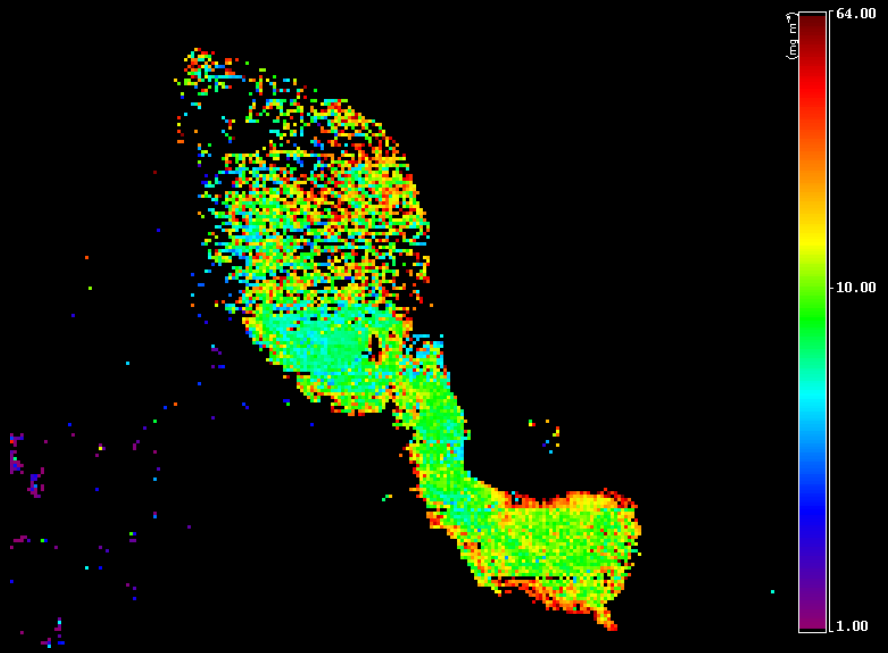


WISDOM
A GERMAN - VIETNAMESE INITIATIVE

http://www.wisdom.caf.dlr.de/results/remote/200806_processor_en.html

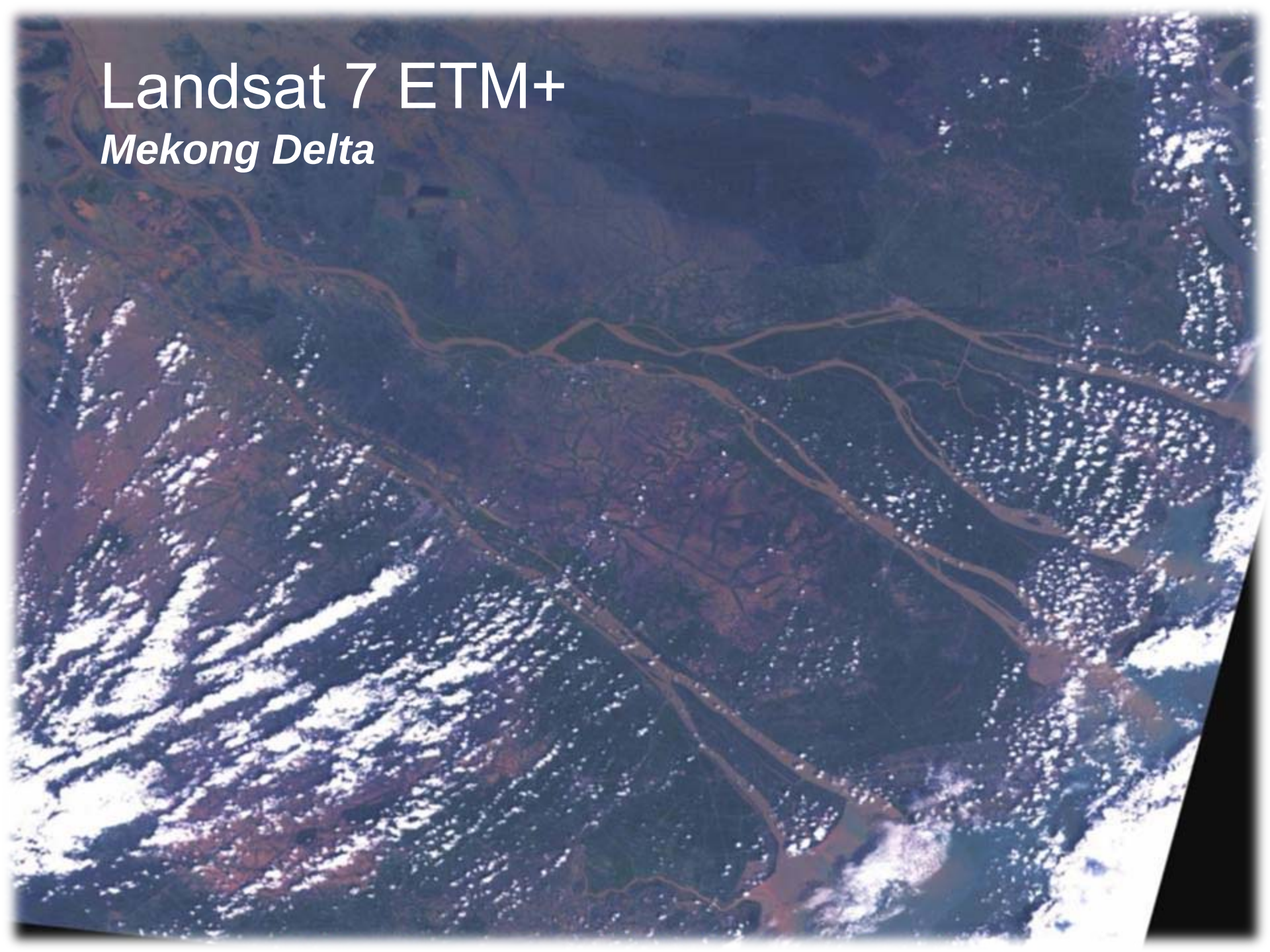
Tonle Sap Jun 30 2007 MODIS 250m

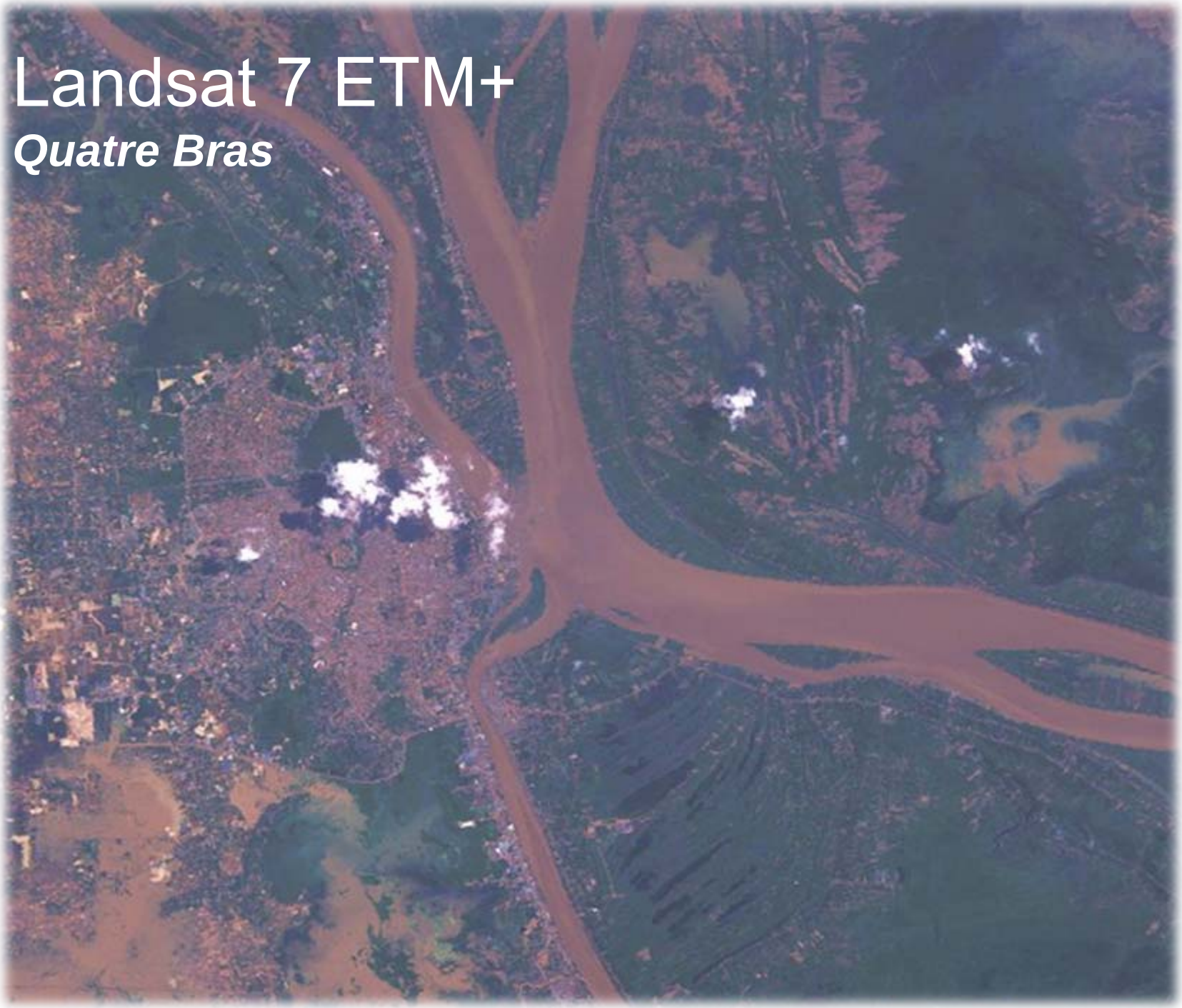
Chl Jun 30 2007



Relative Turbidity

A. Subramanian, prelim. analysis


Landsat 7 ETM+
Mekong Delta

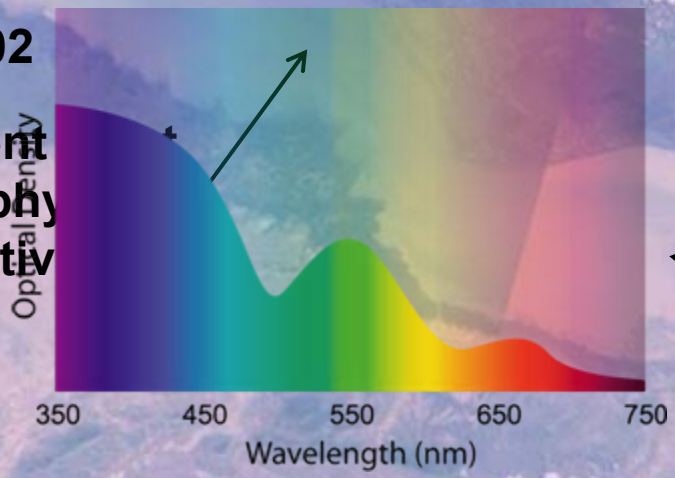

Landsat 7 ETM+
Quatre Bras

Landsat 7 ETM+

Tonle Sap Lake

January 10 2002

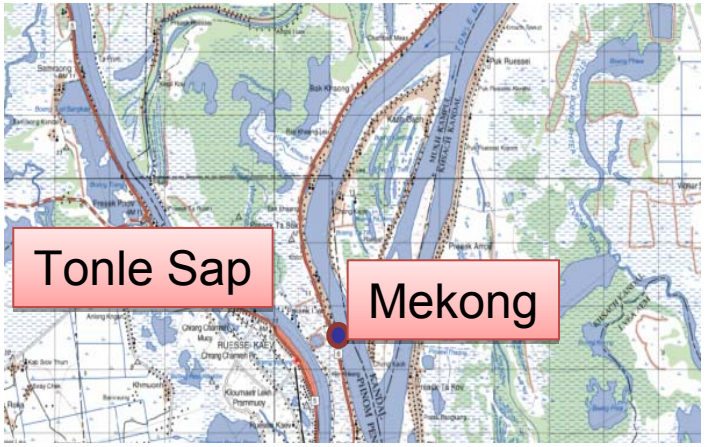
Low sediment
Low chlorophy
Low productiv



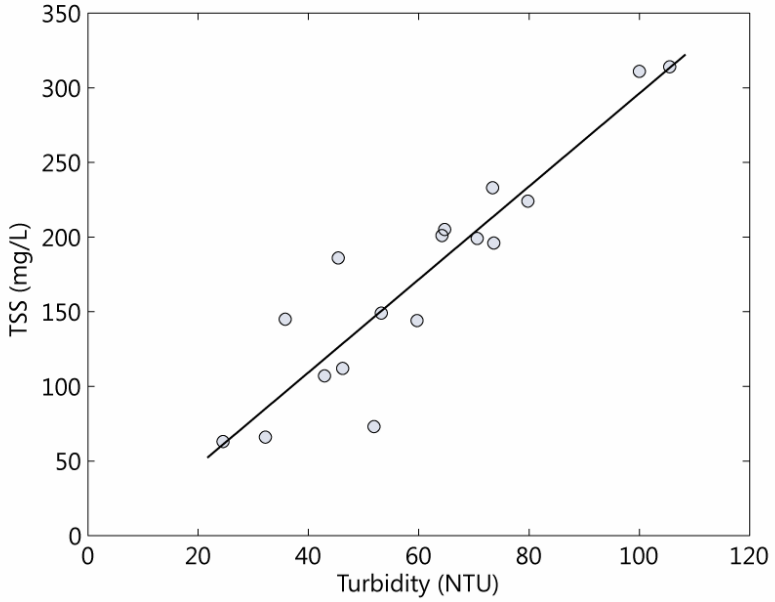
July 11 2001

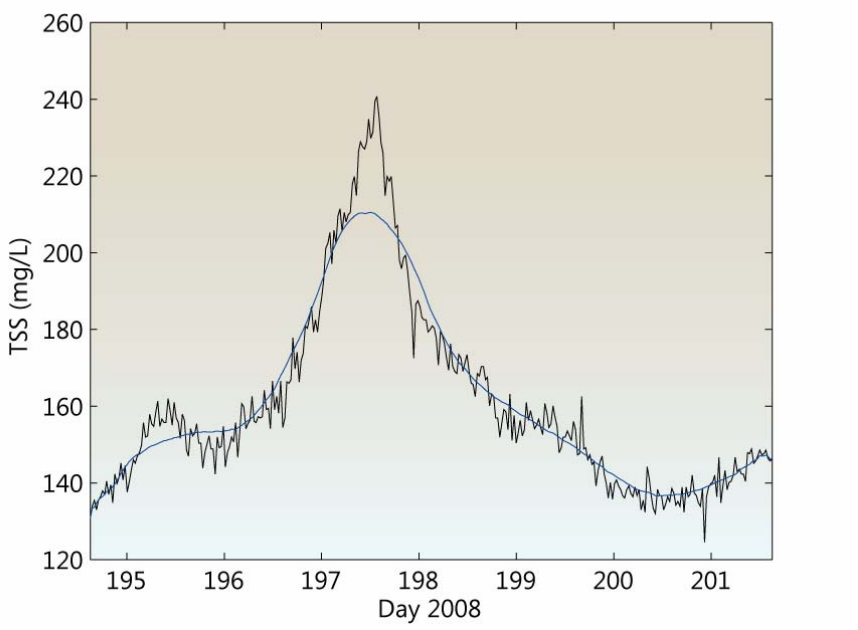
High sediment input
High chlorophyll
High productivity

Surface continuous sensors (YSI)



- Continuous monitoring of pH, DO, turbidity, and flourescence.
- Sediment concentrations correlated with turbidity.
- Groundtruth for instrument images.
- Can be tied in with ADCP profiles to get at total suspended load

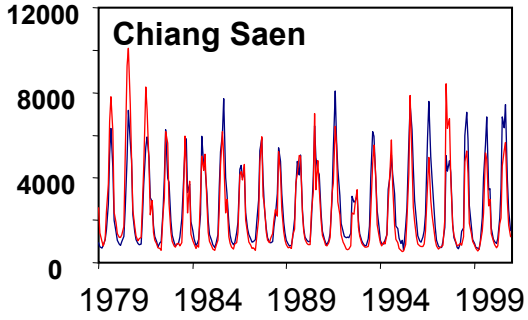


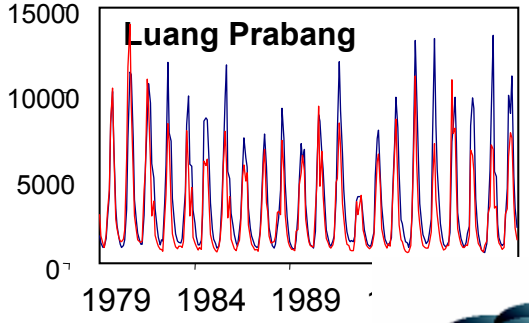


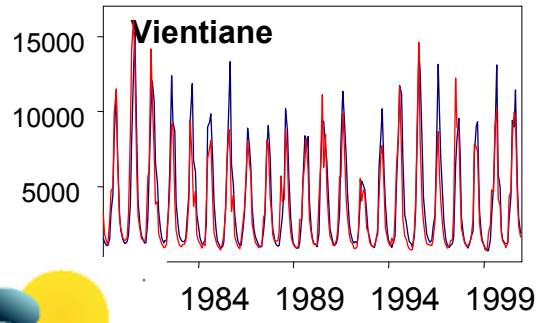
Recommendation: put YSI on Siem Reap tower

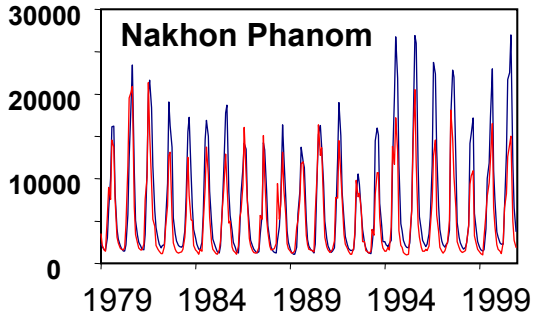
"VIC/HP" Mekong Flow (m^3/s): 1979-2000

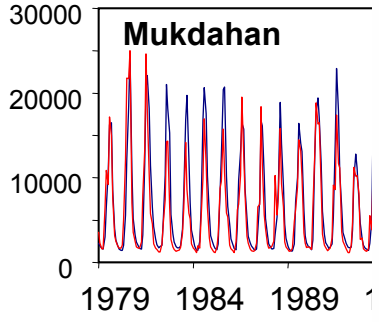
Observed —— **Simulated** ——

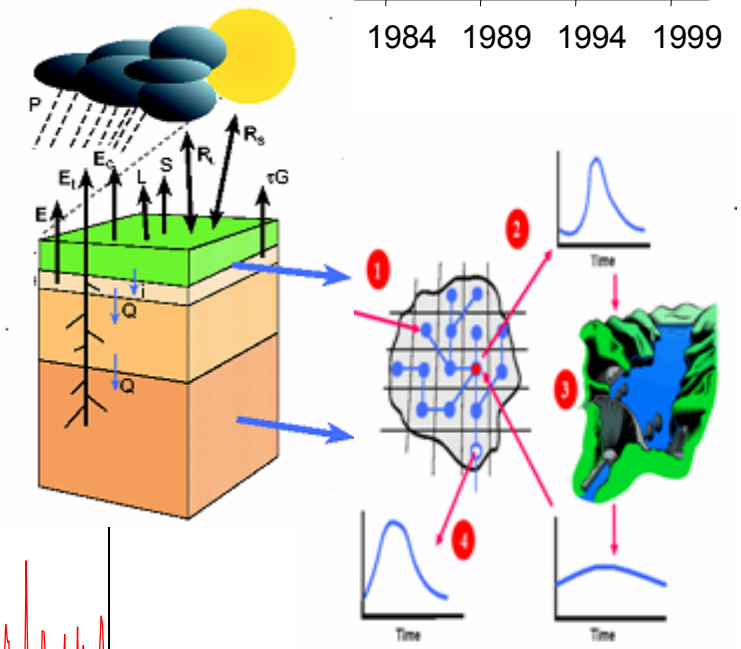


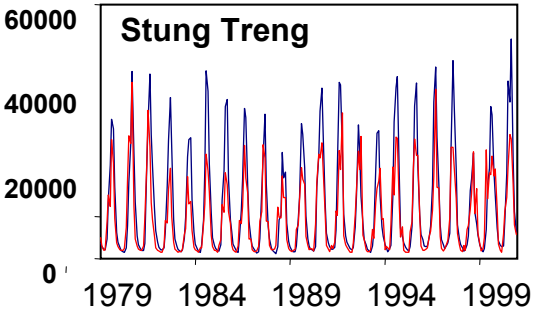


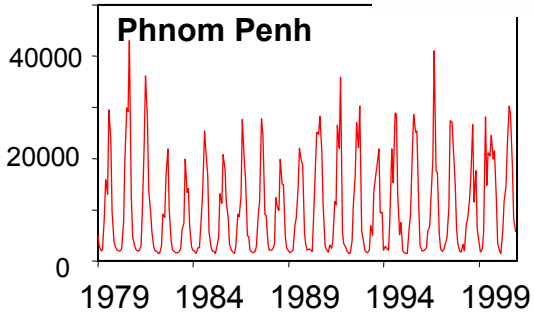




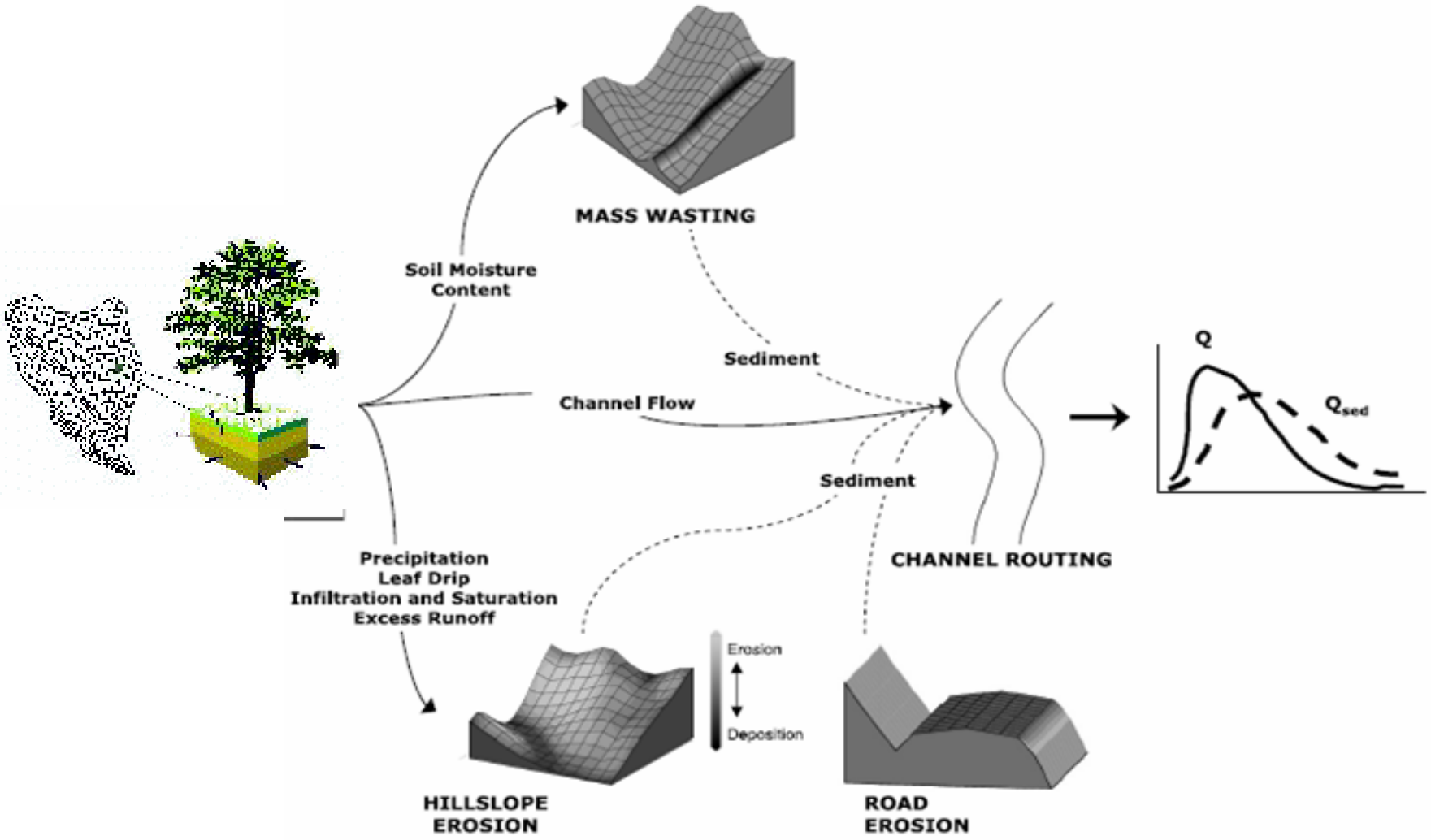




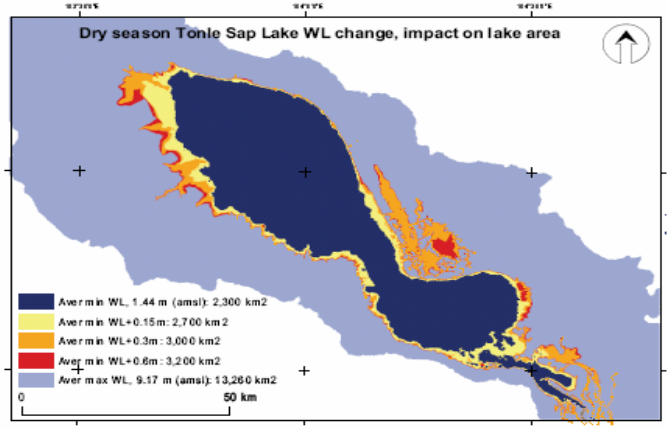


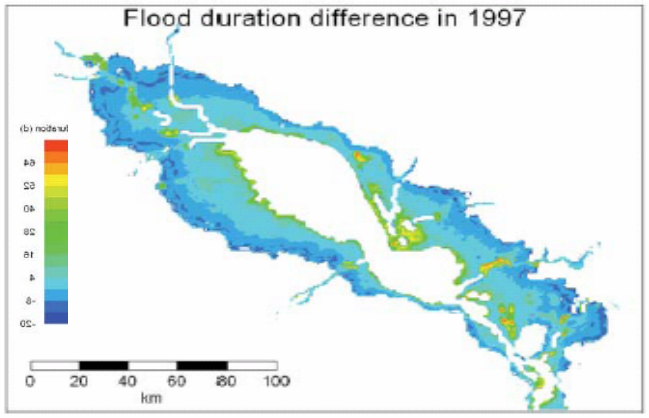


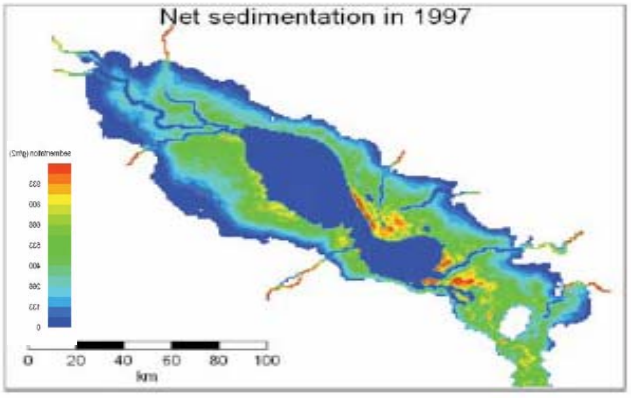
(Sub-Grid) Sediment Generation
DHSVM 3.0 Hydrology-Sediment Model



Doten et al. 2006. A spatially distributed model fordynamic prediction of sediemnt eroision and transport in mountainous forested watersheds. WRR 42







1-D Models

e.g. Tonle Sap EIA
123D Model (WUP-FIN)

Evaluation of means to extend base systematic point sampling for spatial/temporal patterns

* Optical remote sensing for in-river and Tonle Sap (surface) sediments and chlorophyll. Work to do, but looks very promising

* Continuous remote samplers – useful means to augment surface measurements, key remote sensing, and co-occurrence "biology"

* Feeding coupled hydrology/sediment transport models

Next steps, relative to MRC IKMP Objectives?