

RIVER SEDIMENTS AND COASTAL FISH PRODUCTION: WHAT ABOUT THE MEKONG?

Eric BARAN
Eric GUERIN

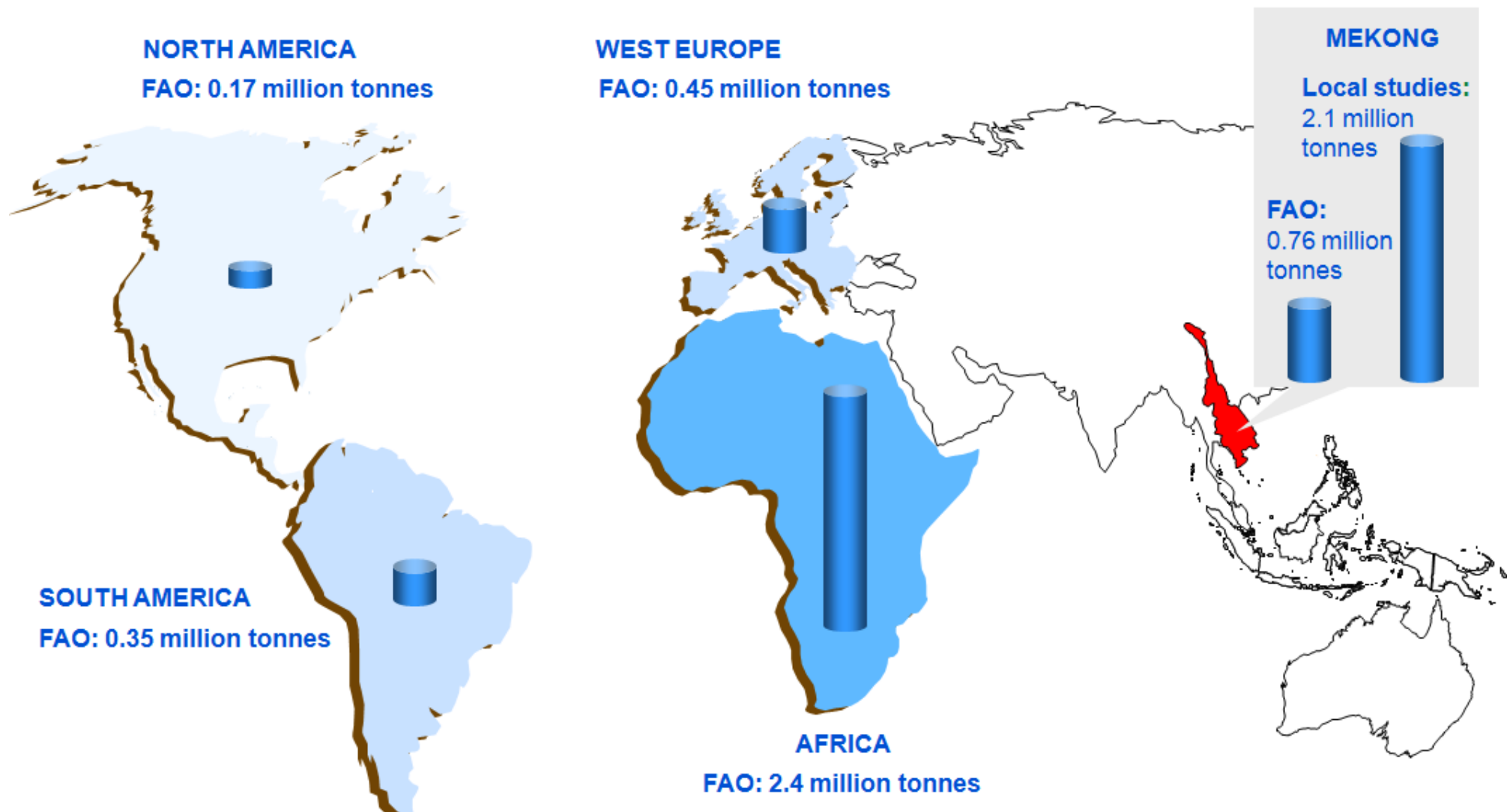
Project “A Climate Resilient Mekong: Maintaining the Flows that Nourish Life”
led by the Natural Heritage Institute and funded by USAID



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ASIA

SEDIMENTS, NUTRIENTS AND FISH

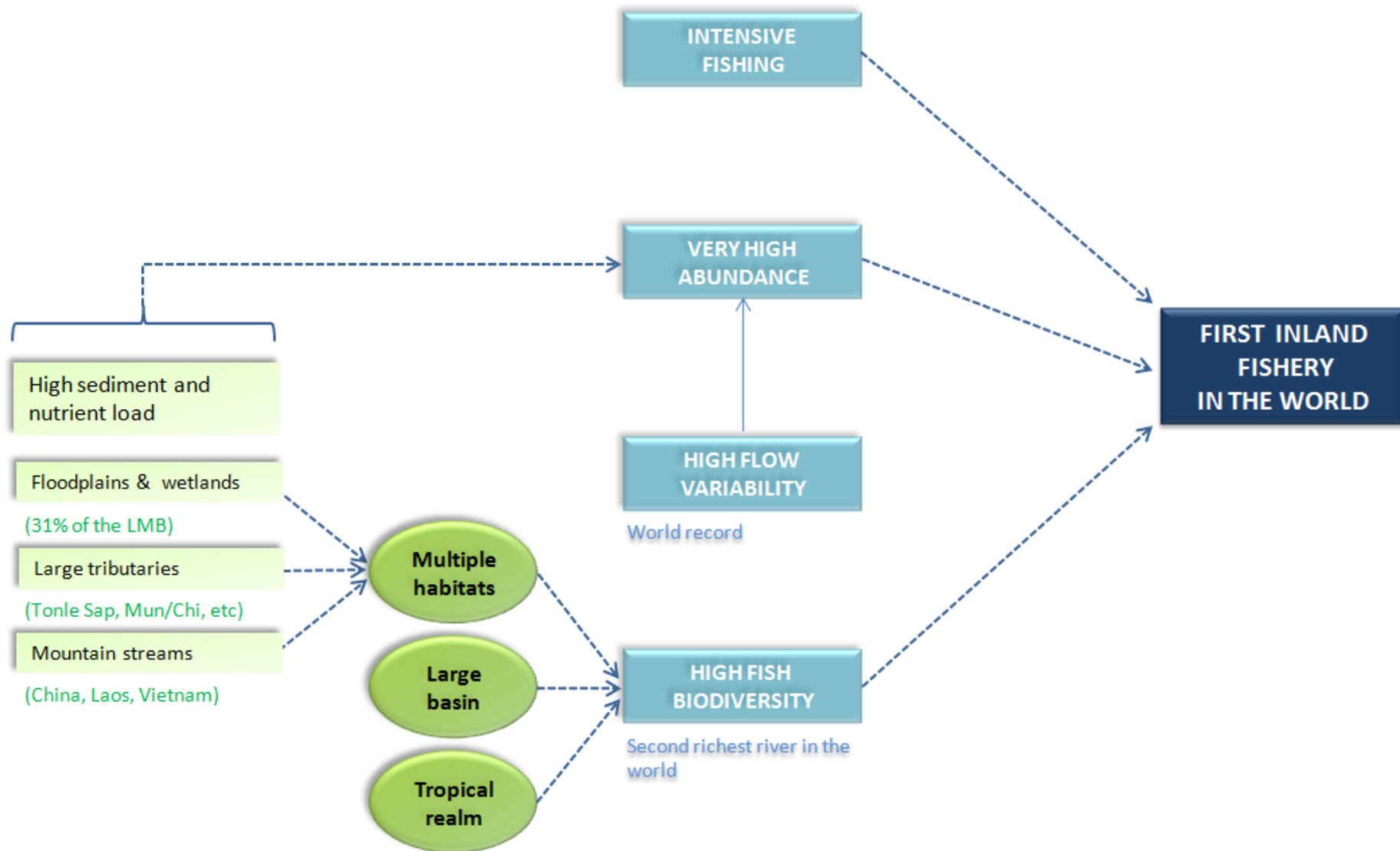


Economic value of Mekong freshwater fish:

US\$2.1-3.8 billion at first sale
US\$ 4.2 - billion on retail markets
(Hortle, 2009).

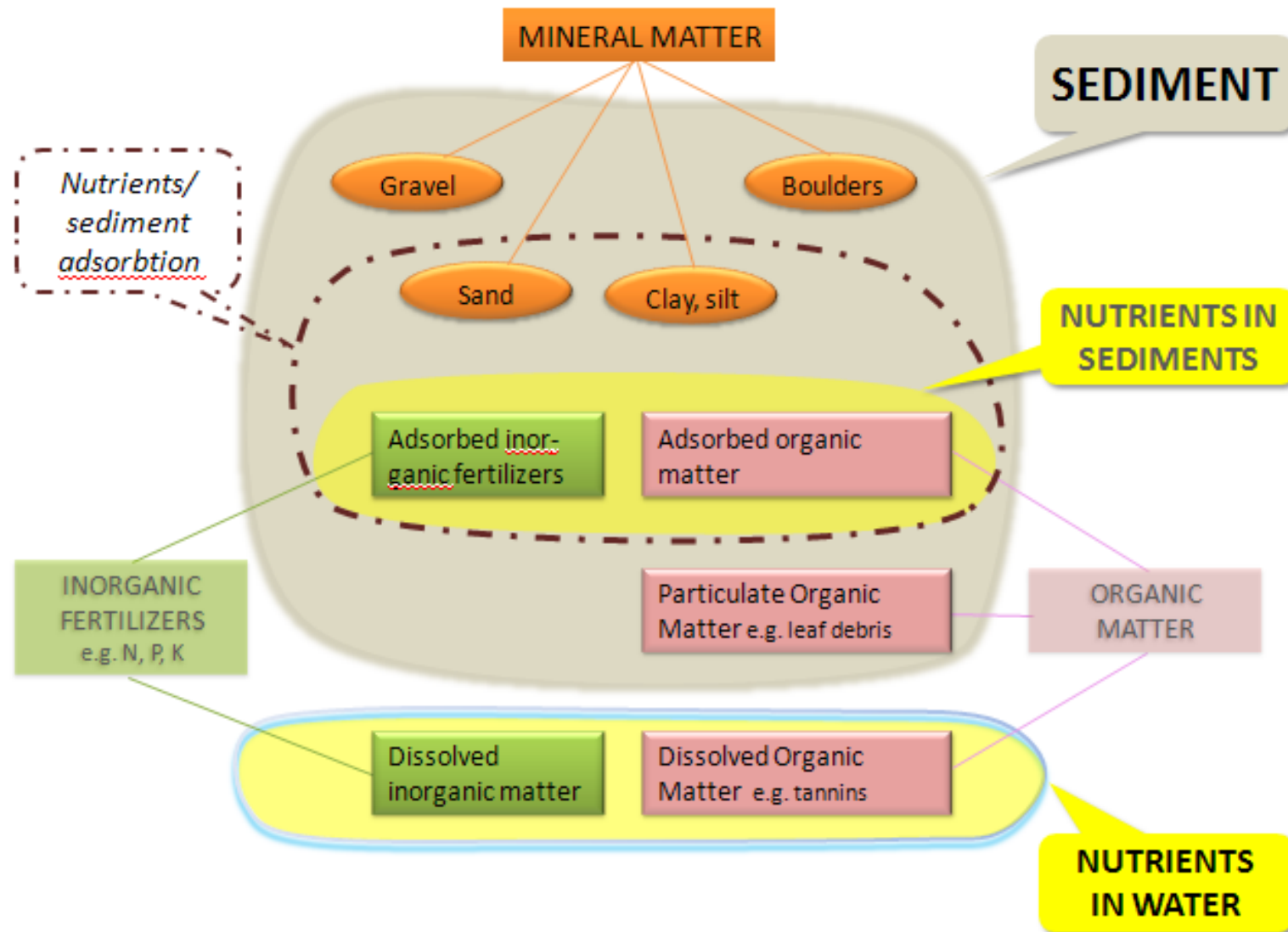
Contribution of freshwater fish to protein inputs in people's diet

Cambodia: 50% (81%) Lao PDR: 38%
Thailand: 16% Vietnam: 13 %
(FAO 2003 data)



The exceptional abundance of Mekong fish is explained by a **combination of high fish biodiversity, high productivity** linked to high sediment load and flooding, and a **high exploitation rate**

What matters most for fish productivity is not sediments but **nutrients**. Dissolved nutrient concentration is generally low and nutrients are mostly adsorbed on sediments, which facilitates their transport



**BIG RIVERS AND COASTAL FISH PRODUCTION:
AN UNDISPUTED BUT COMPLEX RELATIONSHIP**

NORTH AMERICA

Strong correlation between river **discharge** and commercial fish landings in the

- Gulf of Mexico, USA and Mexico (*Day et al., 1985*)
- San Francisco Bay, USA (*Rozengurt and Herz, 1985*)
- St Lawrence River, Canada (*Sutcliffe 1972, 1973*)

EUROPE

In the North Sea when the **river load** is reduced by 50%, the net primary production is reduced by 15%

Lenhart et al. 1997 Effects of river input on the coastal zone of the North Sea

AUSTRALIA

High discharge events are clearly the most important component of the flow regime for many species of commercial importance. The reduction or elimination of large flow events is likely to eliminate the associated high catches of fish and crustaceans.

The **nitrogen and phosphorus** seasonally exported from river systems have a significant influence on estuaries and nearshore marine environments by stimulating phytoplankton and benthic microalgal production

Loneragan & Bunn 1999 River flows and estuarine ecosystems

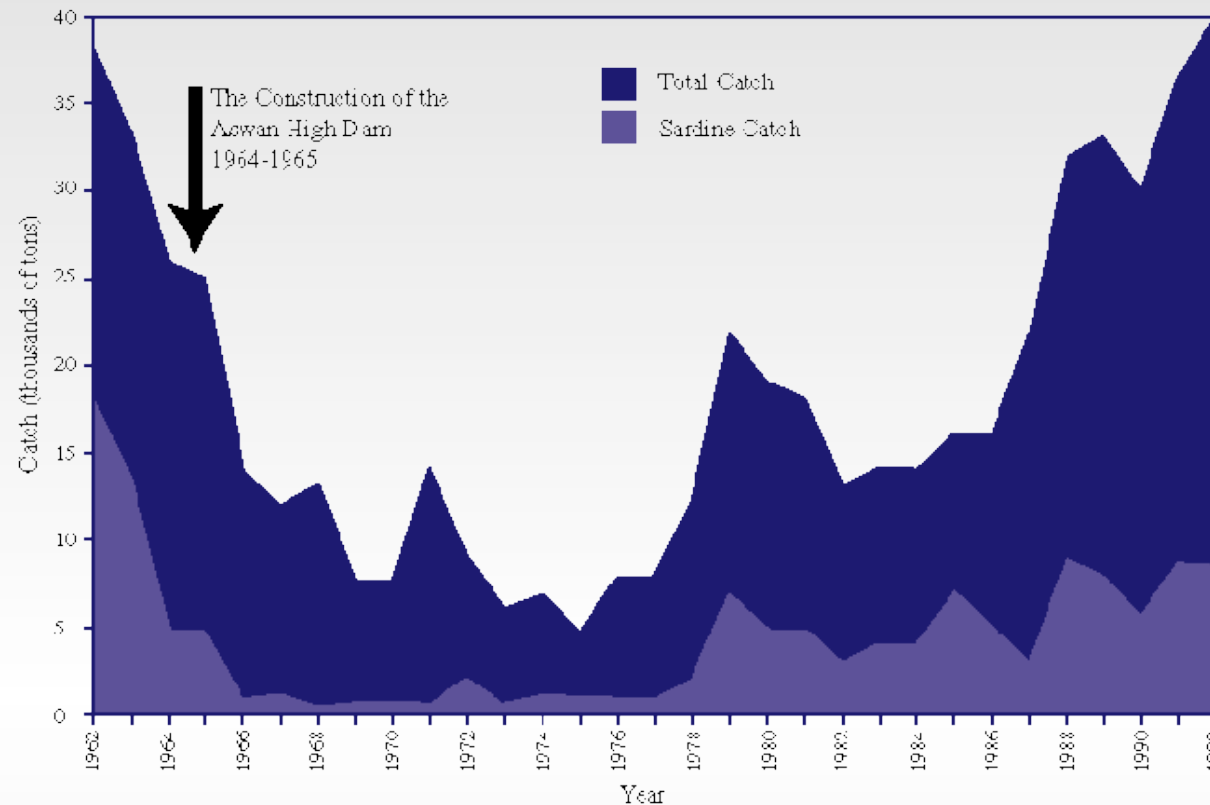
AFRICA

- The impact of the Zaire's waters on production is not obvious: the turbulent and opaque waters do not permit planktonic growth near the coast.
- The outflow of the Niger into the sea also does not perceptibly enrich the coastal waters.
- In Ivory Coast, the flood periods coincide with the main upwelling season at sea, which long blurred the importance of continental inputs.

Binet et al. in FAO 1995 Effects of riverine inputs on coastal ecosystems and fisheries resources.

On the Nile, following the building of the Aswan Dam (1965) the concentration of **nitrates**, **phosphates** and **silicates** in coastal waters declined a lot, phytoplankton blooms in coastal waters were greatly reduced, catches of prawns were halved and catches of plankton feeding fishes (*Sardinella* spp.) declined from 15 000 tonnes to 550 tonnes

Aleem 1972 Effect of river outflow management on marine life

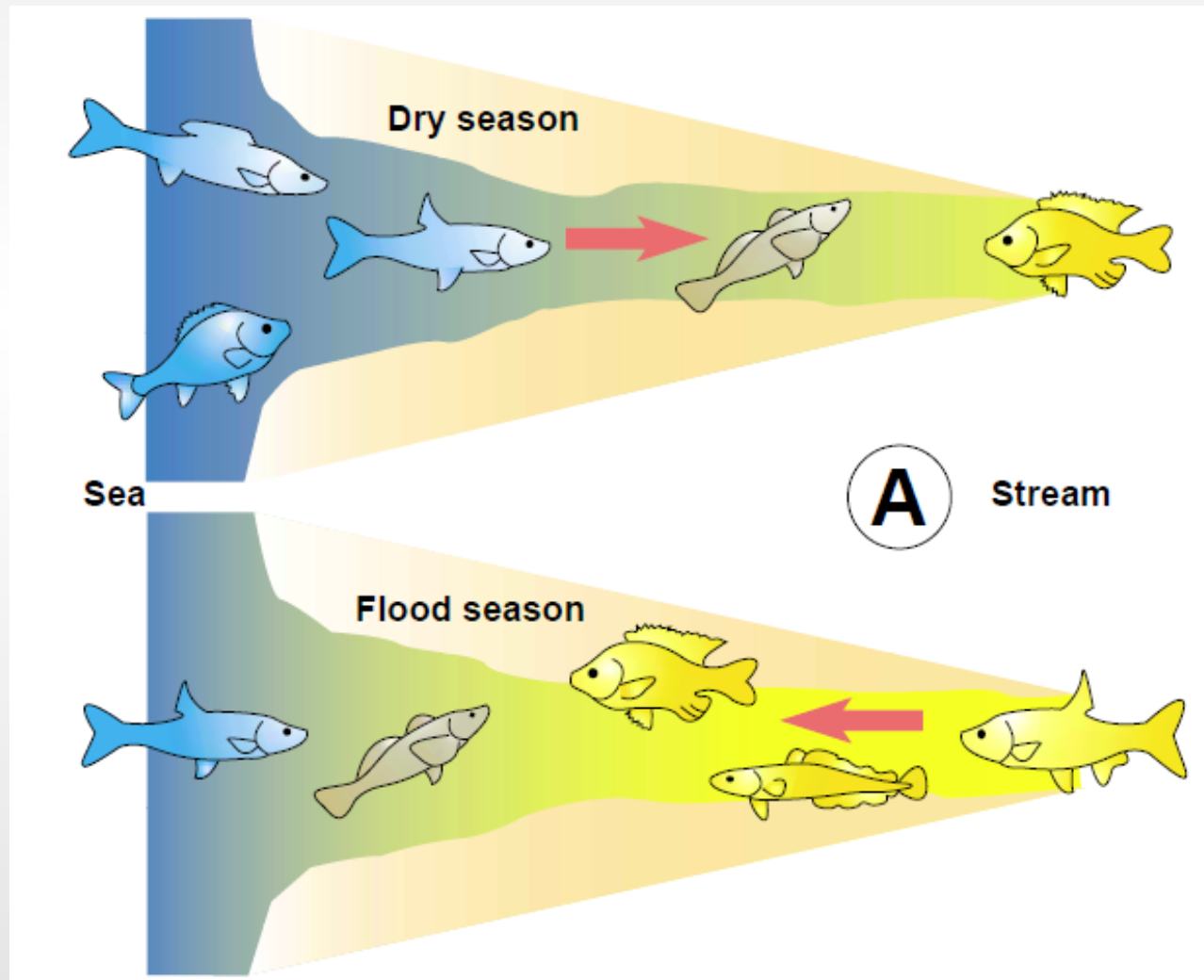


El-Sayed and van Dijken 1995
The southeastern Mediterranean ecosystem revisited

30 years after the construction of the Aswan High Dam, the total fish landings recovered to the pre dam level. But the mismatch between low primary productivity and relatively high levels of fish production is still puzzling (organic effluents from coastal cities, increased fishing effort, changes in selectivity, etc).

Changes in salinity, turbidity and estuary depth trigger changes in species composition in the coastal zone

Baran 2000 Biodiversity of West-African estuaries



SEDIMENTS AND FISH RESOURCES IN THE MEKONG

A remarkable concentration of fish can be noticed at the mouths of the Bassac and Mekong Rivers.at the beginning of the dry season. The fish are attracted by the enormous concentration of nitrogenous material coming from the Mekong and their scales register the sharp acceleration of growth that results. The Great Lake of Cambodia thus imposes its rule and its rhythm to a distant population at sea

Chevey 1933 The Great Lake of Cambodia

The loss of nutrients, either dissolved or in organic silt, from the plume of the Mekong/Bassac will certainly diminish productivity in the near-shore areas and to a lesser extent in the off-shore areas.

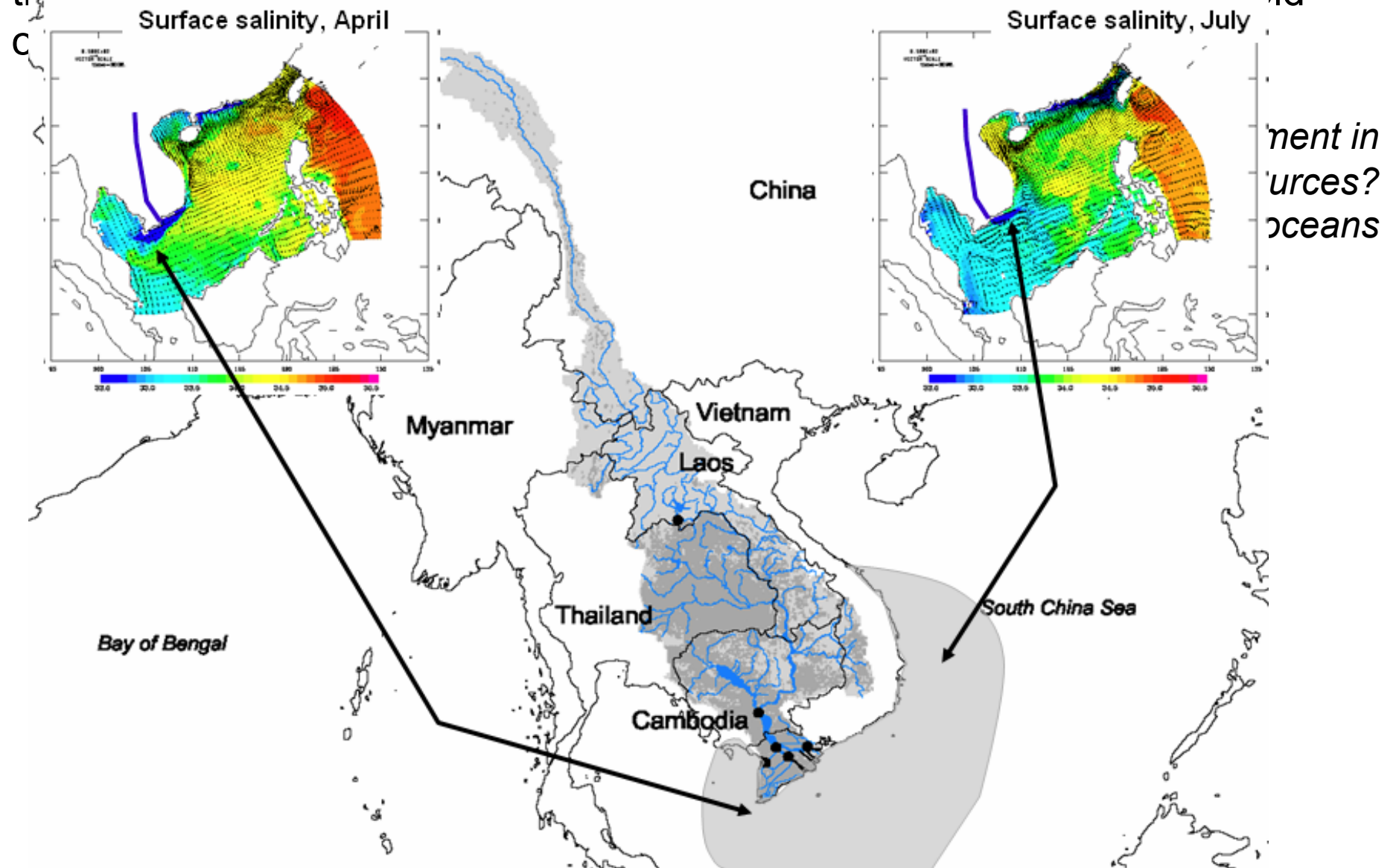
The fishery of the Mekong plume in the South China Sea also will be subject to impacts of the controlled and augmented low-flow regime.

While the characteristics of the fishery are anticipated to change, little is known scientifically of the migratory patterns of fish to and from the plume.

Lagler 1976 Fisheries and integrated Mekong River Basin development

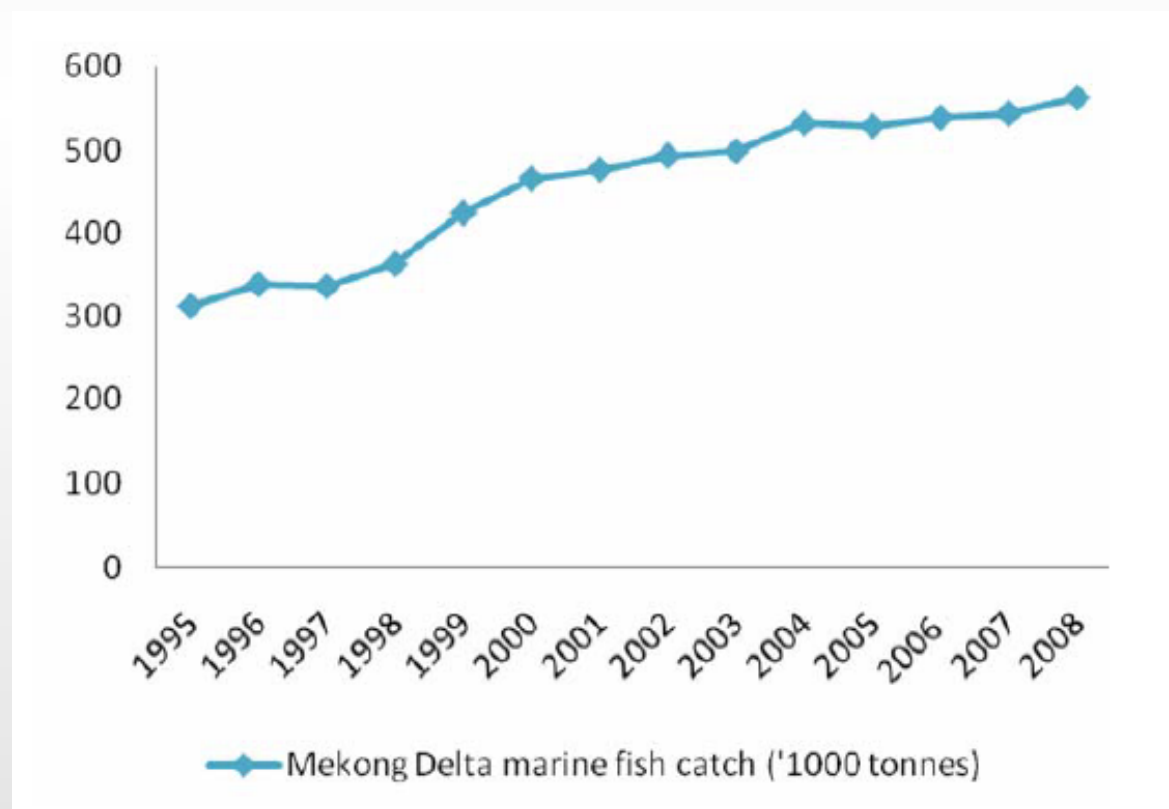
Notion of coastal estuary

In the wet tropics, the upper boundary of an estuarine zone is the limit of tidal influence in a river, and the lower boundary is the limit of the turbid



Mekong marine fisheries are a productive component of the Mekong system and are dependent on the nutrient and sediment dynamics of the river. The Mekong marine fishery is a significant component of the Vietnamese delta economy, with a production in the order of 500,000 – 726,000 tonnes per year.

ICEM 2010. SEA of hydropower on the Mekong mainstream



Sediment retention by dams is expected to have a major impact on coastal fish production, and subsequently on the Vietnamese fishing sector and fish trade. This would also impact the delta aquaculture sector which is dependent on protein from marine 'trash-fish' to feed the aquaculture fish for feedstock.

ICEM 2010. SEA of hydropower on the Mekong mainstream

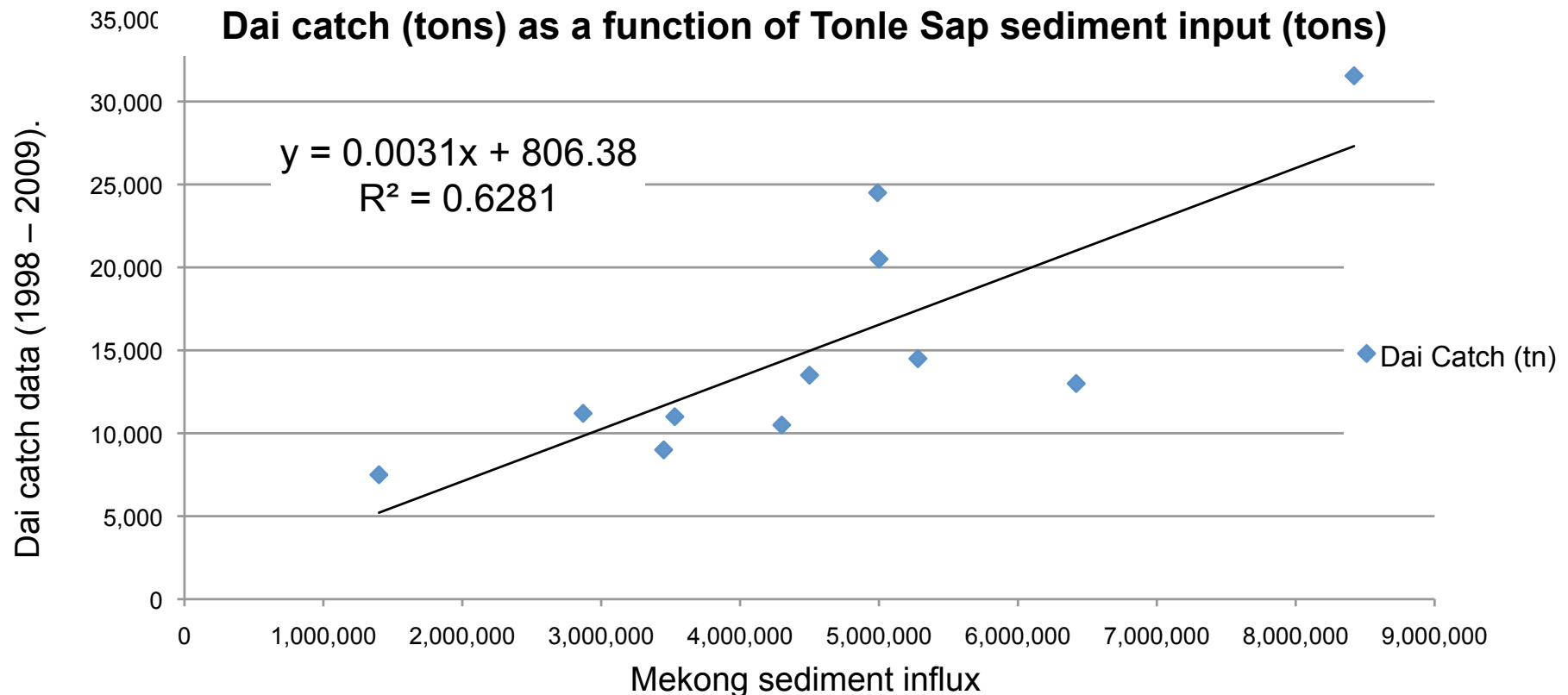
Coastal fisheries will decrease significantly due to reduced sediment and nutrient input to the sea. Increased fertilizer use in the basin will not necessarily compensate for the loss of trapped nutrients; increased chemical fertilizer use is not sustainable in the long run and fertilizer prices have experienced sharp increase lately.

Sarkkula and Koponen 2010 Detailed Modelling Support project final report

CASE OF THE TONLE SAP FISHERY

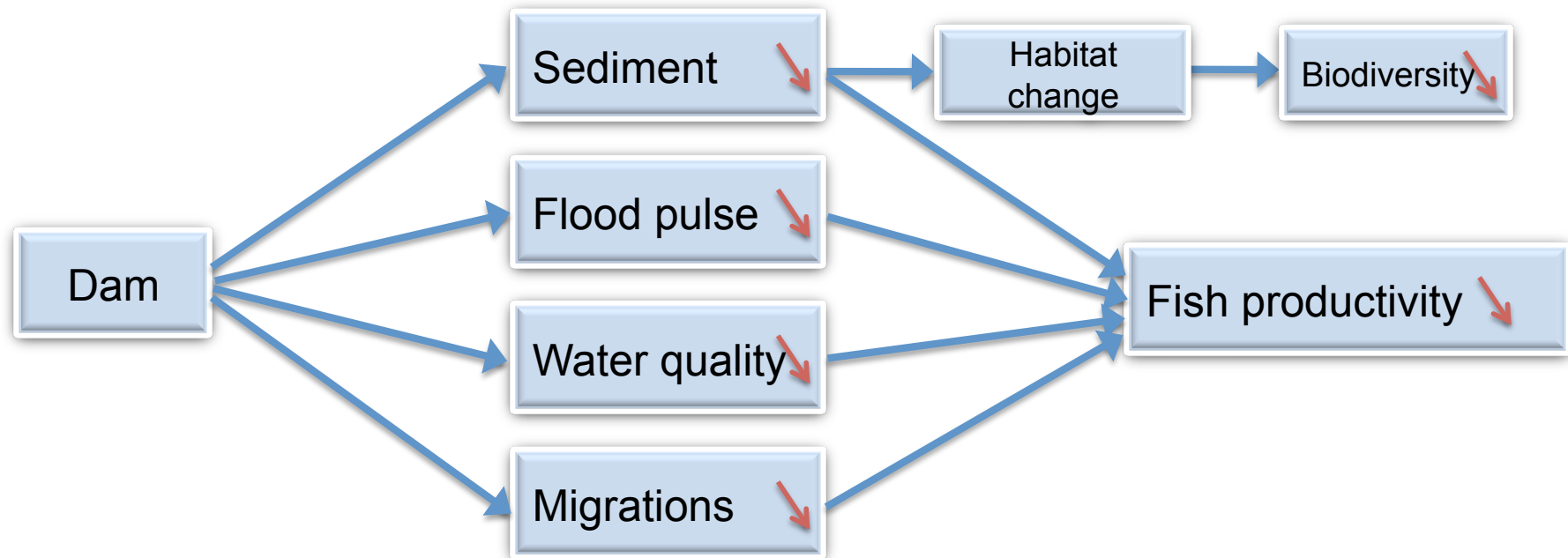
Application of the primary productivity based fisheries model gives 36% decline in [Tonle Sap] total fish biomass production if Mekong sediment input is reduced by 80%.

Sarkkula and Koponen 2010 DMS final report.



Adapted from Koponen et al. 2010 Productivity modeling report

Dam development will reduce the downstream sediment concentration, but will also minimize the flood pulse, alter water quality and block fish migrations. Fishery productivity resulting from these four drivers will be affected in multiple ways that cannot be related to sediments only.



RESEARCH NEEDS

Ecological impacts of **oligotrophication**

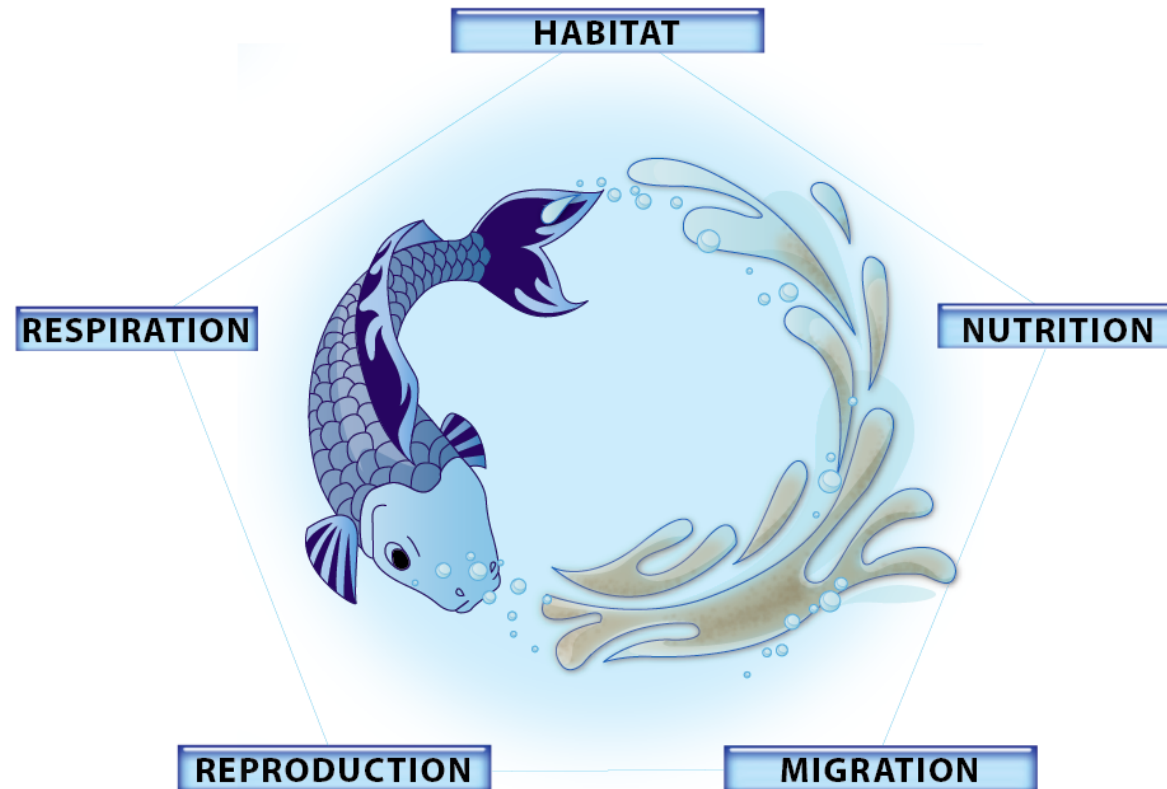
Need to distinguish between sediments and nutrient:

Behavior of **nutrients**

- sources of nutrients
- limiting factors (P?)
- linkage sediments / nutrients
- behavior of nutrients in presence of dams

Role of cities and agriculture intensification in terms of nutrient inputs

Need for **multidisciplinary collaborations** between fish biologists (coastal fishery data, fish communities), chemists (nutrient inputs) and sedimentologists (sediment inputs)



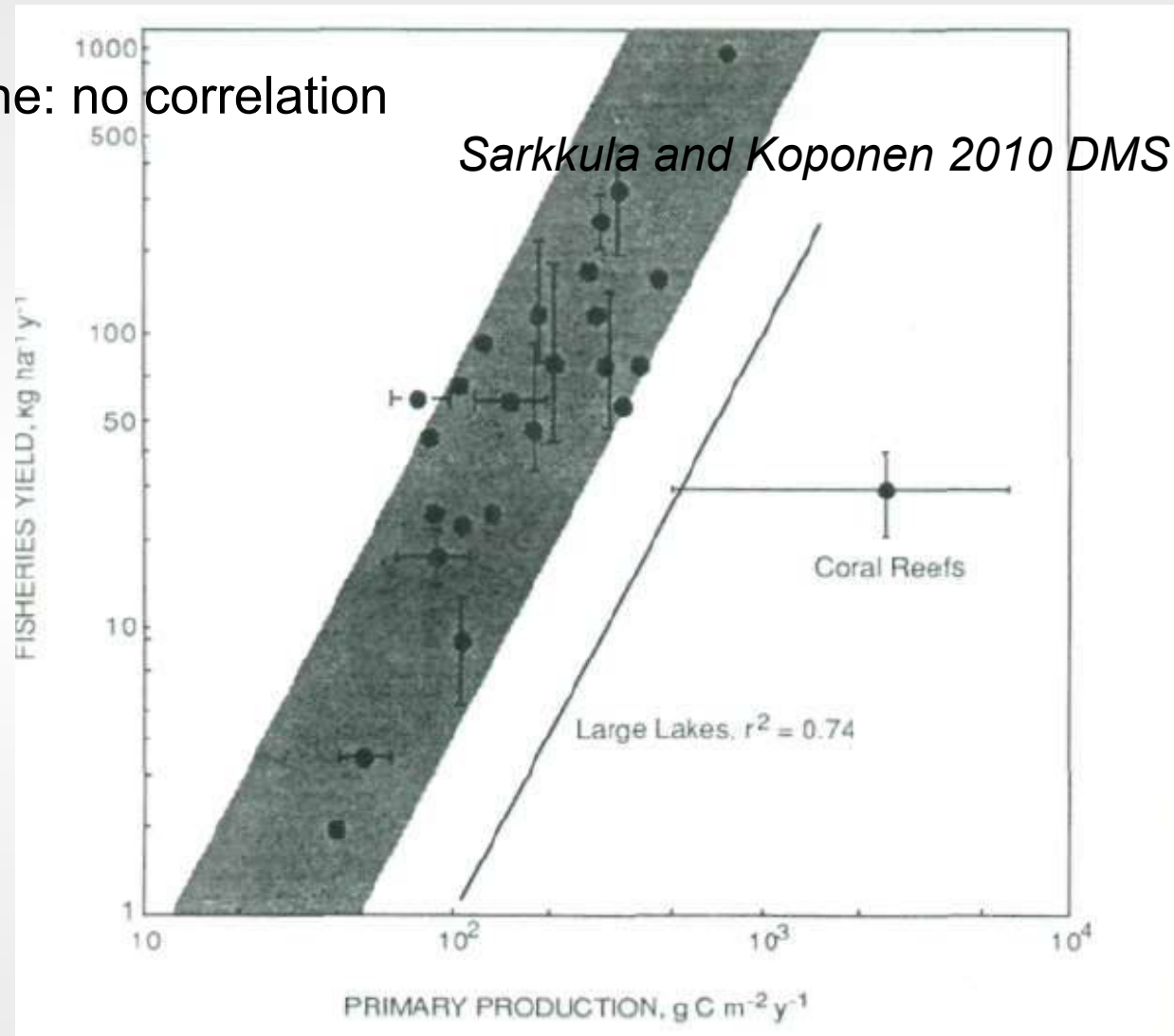
Thank you!

- River discharge has a strong positive effect on the production of coastal fisheries.
- Seasonal patterns of flow are as important as their magnitude
- However the connection between rivers and coastal productivity can be blurred by:
 - i) flow dynamics and coastal hydromorphology;
 - ii) the chemical element studied (carbon, nitrogen or phosphorus);
 - iii) the resource studied (plankton dependent on turbidity and local upwellings, fish dependent on coastal nurseries, etc)
- River regulation is likely to have a dramatic effect on the production of coastal fisheries (plus other factors such as costal geomorphology)

Dugan et al. 2002 The contribution of aquatic ecosystems and fisheries to food security and livelihoods: a research agenda

Coastal zone: no correlation

Sarkkula and Koponen 2010 DMS Final Report.



Nixon S.W.1982