© Elizabeth Kemf / WWF

WWF

WATER

CASE STUDY

2018

WWF-Greater Mekong / WWF Freshwater Practice

THE SANDS ARE RUNNING OUT

How WWF sought to better understand the impact of dam construction and sand mining on sediment flows in the Mekong river basin

Learning about this work

Read this case study

Contact the WWF-Greater Mekong team

Map of the Mekong river basin

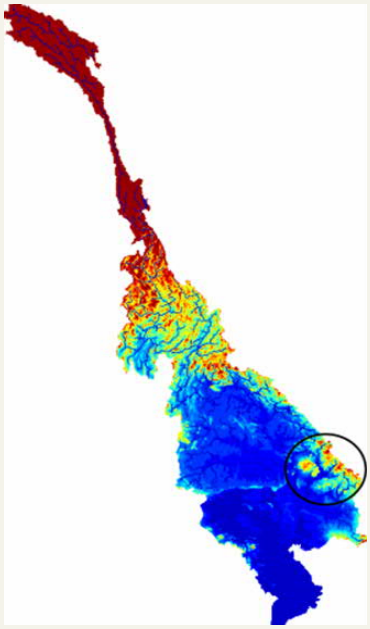
Introduction

Sediment[i] plays a vital role for river basin health: it replenishes soil, carries nutrients and, deposited, preserves the shape of river beds and deltas. Sediment contributes to societies through crop and fishery productivity, construction and land reclamation material and the creation of habitable and cultivable landscapes. Beyond its key role in supporting the regional economy, sediment is also critical to the ecological functioning of the Mekong river basin.

The natural annual sediment discharge from the river is estimated at 160 million tonnes.[1] Today, Mekong river basin dams already trap more than half of this sediment, thus the estimation in 2014 was down to 75Mt, and more dams are planned. Combined with riverbed aggregate mining (mainly of sand), this results in reduced downstream sediment deposition, with associated coastal erosion in the delta.

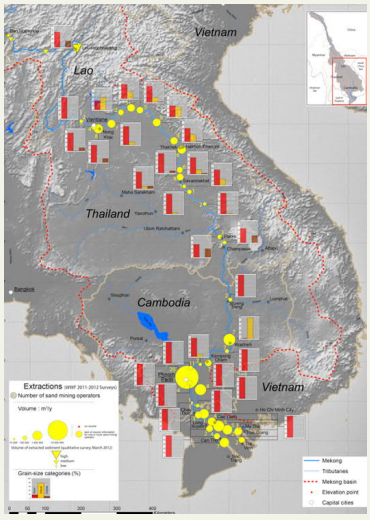
Funded in part via the HSBC Water Programme, WWF-Greater Mekong sought to better understand the scale of both problems and their potential consequence for ecosystems and human societies. This case study summarises the main research findings and WWF's sediment-related activities.

[i] Solid fragmented material of varied particle sizes, from silt to boulders



In red, orange and yellow: high sediment generating areas[2]

Arrow trap, Tonle Sap Lake, Cambodia © Zeb Hogan / WWF



Map of extraction sites, showing extracted volumes (circles)[2]

Sediment, mining and dams in the Mekong river basin

Since 1994, over half of the Mekong River's sediment load – an estimated 90-100 MT per year – came from the Upper Mekong in China (known there as the Lancang River), where high-energy flows incise deep valleys in Yunnan Province.[2]

Sediment deposition is important for the whole river basin, and is particularly vital for Tonle Sap Lake in Cambodia and the Mekong delta in Vietnam. Tonle Sap receives around seven million tonnes of sediment per year – much of it fine sediment, crucial for fish and crop productivity – retaining around 80% of it.[2] The lake, connected to the Mekong main stem by a complex hydraulic flow reversal, is a hotspot for Cambodia's fishery sector. If the sediment input from the Mekong River to Tonle Sap Lake was to reduce by 80%, it is estimated that the lake's fish biomass would decline by 36%.[1] Furthermore, riverbed elevation loss in the Mekong River due to sand mining – if it persists – would result in losses of flow and sediment to Tonle Sap as well as a reduction in inundated land with associated impacts on the productivity of the lake's fisheries (in addition to a reduction in the lake's flood buffering role) (Goichot, M., 2018, personal communication).

The Mekong delta receives much of the river's remaining sediment load, and is also heavily dependent for its fertility and the stability of its entire mass on the replenishment of sediments. The delta is Vietnam's main food production region: it contributes around 70% of Vietnam's fruit production, 50% of its rice and 75% of its fishery production. Overall, the delta contributes more than 27% to Vietnam's GDP and is home to 17 million people.[2]

SEDIMENT EXTRACTION

Sediment, mainly sand, is extracted from the Mekong for land reclamation and for construction: sand is the main ingredient in concrete, asphalt and glass. Although sand makes up most of the extracted material, other aggregates are also mined: coarser material (e.g. pebbles and gravel) is actually more valuable.

Sediment extraction is a particular problem in Cambodia (60% of extractions in 2011-2) but also affects Vietnam, Thailand and Laos.[3] In 2009, Cambodia banned the export of sand following concerns over the volumes exported to Singapore for land reclamation. Vietnam followed suit the same year but in the intervening years sand mining boomed there. In addition, in both countries local sand consumption remains high: for example, the Cambodian government estimated that 15,000 to 20,000 cubic meters of sand per day are required as part of

Phnom Penh's building boom.[2] Furthermore, illegal sand mining also takes place in the region.[3]

Studies found that 55.2 million tons of sediment were extracted from the Mekong main stem in Laos, Thailand, Cambodia and Vietnam in 2011 – a conservative estimate, not covering tributaries or the upper Mekong.[3]

DAM CONSTRUCTION

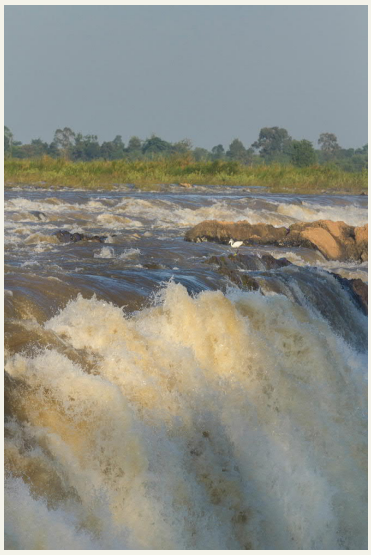
At present, there are a total of 241 completed dams either used for hydropower (the number includes dams over 15MW installed capacity) or irrigation (the number includes dams with reservoirs of over 0.5km^2) in the Mekong river basin.[4] Hydropower is seen by the region's governments as an important solution for increasing electricity access and boosting economic growth. For now, only 10% of the lower Mekong's hydroelectric potential has been developed. A further 91 dams are currently planned[4], 11 of these hydropower dams in the main stem of the river (using the same size definitions as mentioned above).[2]

Dams reservoirs trap part of the sediment suspended load (silt, clay and fine sand) and most of the bed load (sand & gravel), reducing the sediment load in the river downstream. Existing dams are thought to have already reduced the volume of sediment from 160Mt before 1994 to 75Mt in 2014. One study modelled a future 51% sediment flow reduction in the delta based on the presence of 38 existing and planned dams.[5] Dam construction and sand mining are linked: interestingly, the planned dam construction – by reducing the river's sediment load – will reduce the raw material required by the sediment extraction industry.

IMPLICATIONS FOR THE MEKONG RIVER BASIN

Studies point to a progressive increase in the Mekong delta sinking, lowering of the river bed of its main channels and erosion, showing that most of the coastline eroded at rate equivalent to 1.5 football fields every day between 2007 and 2012. Erosion is attributed to the reduction in sediment deposition caused by dams and to the extraction of sand, but groundwater abstraction is compounding the problem by causing further land subsidence, and loss of mangroves is exposing the coast thus causing faster erosion. Furthermore, sea-level rise associated with climate change poses yet an additional growing future challenge for the low-lying delta.[6]

In the Mekong River itself, there is some evidence of significant but irregular bed incision, with many pools expanding and deepening, causing erosion and riverbank collapses.[3]



A waterfall in Cambodia © Thomas Cristofoletti / WWF-US

A fish farmer in the Mekong delta © WWF / Greg Funnell

What did we do?

WWF undertook a number of activities relevant to sediment flows, notably under a grant from FFEM/AFD and some funds to promote those results through the HSBC Water Programme's first phase (2012-2017).

SEDIMENT RESEARCH AND AWARENESS RAISING

WWF-Greater Mekong led research teams looking into:

- Explaining the processes that carry sediment in the Mekong, notably the important volumes of sand transported in graded suspension in the Lao-Thai section of the Mekong River.
- Testing different methods for sediment sampling highlighting bias and low reliability of previous sediment data sets.
- Quantifying the volumes of sand and gravel extracted from the Mekong River, to locate the extraction sites and to identify trends (2013)[3]
- Quantifying the river bed incision in the Mekong Delta's two main channels.
- Quantifying the scale and rates of coastal erosion in the Mekong delta, and identifying how such erosion is mechanistically linked to human activities (2015).[5]
- Quantifying the delivery of suspended sediment & nutrient to the coast.

The field observations and field sampling conducted by WWF and researchers brought new understanding on specific processes at work in the Mekong, and challenged the reliability of previous data sets.

A 2013 paper[3] was based on fieldwork that took place in 2011 and 2012, which involved identifying extraction sites and determining the location, size, sediment type mined, number of employees, as well as number and type of vehicles and equipment operating on site. In addition, for the larger sites operators were also interviewed to obtain information about extraction volumes among other things.

This research helped fill the information gap identified in the Mekong River Commission's 2012 SEA regarding the impact of main stem dams on sediment.

WWF's peer reviewed publications contributed to the International Hydropower Association's decision to set up a

working group on sediment to advise the hydropower industry regarding sustainable practices – WWF is part of this group.

WWF-Greater Mekong disseminated its research on sediment via communications channels, helping to raise awareness of the pressing nature of the problem. For example, articles quoting WWF were published: on the Vietnam News website in 2012 (which helped influence the Vietnamese government to carry out a study on the impacts of main stem hydropower on the Mekong Delta), by AFP with global reprint in 2016, and finally in a WWF-authored a 2016 Third Pole editorial piece.

WWF has also been raising the profile of sediment at the regional level, for example by:

- Providing baseline information about sediment transport at a 2012 regional workshop in Bangkok.
- Running training workshops on sediment transport in Cambodia and Vietnam in 2012/3 for stakeholders from government agencies and research institutes.
- Co-chairing a session on sediment transport at the 2012 Mekong Delta Forum, attended by over 200 people.
- Co-organising a 2014 workshop with Vietnam's Ministry of Natural Resources and the Environment to share sediment research results with 40 participants from government agencies and research institutes.
- Providing the scientific findings about sediment used in the 2014 Mekong Delta Forum which gathered 250 representatives from Vietnam's central government and all 13 Mekong delta provinces.

As a result of WWF's research and dissemination efforts, sediment reduction is now recognised as a major issue in sustainable management of the Mekong River's resources.

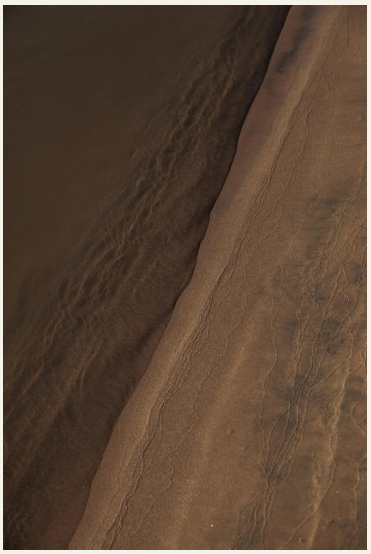
INFLUENCING DAM CONSTRUCTION

WWF's activities aimed at influencing dam construction relate to their impact on sediment flows as well as on other aspects such as migratory species and fish stocks.

WWF is continuing to engage with dam construction processes, for example creating tools and approaches to improve the planning, design and operation of planned dams. WWF is also rolling out tools relating to safeguards around the environmental and social impact of dams.

RIVER IN THE ECONOMY

WWF has pioneered the development of 'Water in the Economy' narratives. These highlight the interconnections and



Sandy banks of the Anlung Cheauteal Pool, Cambodia. © Thomas Cristofoletti / WWF-US

Aerial view of a newly developing extraction site on a large convex sand bar, at low flow, downstream of Vientiane, Laos[3]

Barges transporting sand in the Lower Mekong, Vietnam

interdependencies between rivers and national or regional economies, demonstrating the economic and social consequences of current and future potential mismanagement.

WWF commissioned a 'Mekong River in the Economy' report, published in 2016, which reviewed – among other things – the scale and impacts of changes in sediment flows in the lower Mekong basin countries.[2]

Where will we go from here?

IDENTIFY ALTERNATIVES TO UNSUSTAINABLE DAMS

WWF plans to continue promoting tools that help improve the planning, design and operation of planned dams. In addition, WWF is working towards developing bankable project on non-hydro renewable energy investment as alternative solutions to replace unsustainable large dam construction.

One potential investment is a large solar power generation facility in Cambodia as an alternative to the Sambor hydropower dam, the lowest downstream and potentially the most destructive dam proposed on the Mekong main stem.

PROMOTE SUSTAINABLE SAND AND GRAVEL MINING

With potential support from the International Climate Initiative of the Government of Germany, WWF will undertake actions to improve policies and practices on sustainable sand and gravel mining in order to increase adaptive capacity to climate change in the Mekong Delta. This goal will be achieved through:

- Establishing a basin-wide sand and gravel budget in consultation with key actors.
- Making the economic case of the negative impacts of unsustainable sand mining in the Delta area.
- Providing information to key actors in construction business on the risks and opportunities of different sourcing for sand and gravel and more efficient use of these resources.
- Recommending policy changes to incentivize sustainable sand mining and using and work towards policy enforcement.

RIVER IN THE ECONOMY

WWF will use the 'Mekong River in the Economy' report's findings, including those relating to sediment, to lobby the

public and private sector for sustainable and integrated regional development.

FOR MORE INFORMATION

Contact the WWF-Greater Mekong team

Resources and references

[1] Baran E., Guerin E., Nasielski J. 2015 Fish, sediment and dams in the Mekong. Penang, Malaysia: WorldFish, and CGIAR Research Program on Water, Land and Ecosystems (WLE). 108 pp
[2] Pegasys Consulting. 2016. Mekong River in the Economy. WWF-Greater Mekong. Available here: http://wwf.panda.org/what_we_do/where_we_work/greatermekong/our_solutions/mekongintheeconomy/
[3] Bravard, J-P., Goichot, M. and S. Gaillot. 2013. Geography of Sand and Gravel Mining in the Lower Mekong River: First Survey and Impact Assessment. EchoGéo 26: 1-20. Available here: https://echogeo.revues.org/13659
[4] CGIAR https://wle-mekong.cgiar.org/maps/ Accessed 22/03/2017
[5] Kondolf, G. M., Rubin, Z. K., Minear, J. T. Dams on the Mekong: Cumulative sediment starvation. Water Resources Res. 50, 5158–5169 (2014), as cited in Anthony, E., Brunier, G., Besset, M., Goichot, M., Dussouillez, P. and V. Nguyen. 2015. Linking rapid erosion of the Mekong River delta to human activities. Nature Scientific Reports 5: 14745.
[6] Anthony, E., Brunier, G., Besset, M., Goichot, M., Dussouillez, P. and V. Nguyen. 2015. Linking rapid erosion of the Mekong River delta to human activities. Nature Scientific Reports 5: 14745. Available here: http://www.nature.com/articles/srep14745