IMPACTS OF SAND MINING ON WORLD’S RIVERS

Marc Goichot, WWF Greater Mekong
Rationale for research

• Evidence based information on past, current and potential impacts of sand mining on rivers and ecosystems

• Three pronged approach:
  • Highly structured QSR review of scientific literature
  • Literature review of trends and governance in sand mining
  • Media and literature review
Global Extraction trends

Global material extraction based on domestic extractions by four material categories, 1970-2010, million tonnes. UNEP (2016).

Global extraction based on domestic extractions of non-metallic minerals by material subcategories, 1970-2010, UNEP (2016).

Construction driving expansion

(Miatto, 2016)
Demand for Land Reclamation

Expanding Singapore

(Data.gov.sg)
Regional trends

[Graph showing regional trends with data for different regions including World, Africa, Asia + Pacific, Eastern Europe, Caucasus, and Central Asia, Europe, Latin America and the Caribbean, North America, and West Asia for years 1970, 1990, and 2010 in million tonnes.]
Per capita Domestic Extraction 1970-2010

- China
- India
Recent trends compared to historic usage

Cement consumption
U.S. vs China

US
1900-1999

China
2011-2013

U.S. Geological Survey and International Cement Review
Quick Scoping Review (QSR)

**Intervention**
- Extraction of Sand & Gravel from River Systems

**Direct Impacts**
- Loss of habitats, e.g.
  - Removal of floodplain
  - Removal of gravel beds
- Physical changes to river system

**Indirect Impacts**
- Change to habitats due to channel and sediment grain-size changes
- Water quality changes affecting physical or chemical conditions
- Hydraulic changes affecting movement of fish and habitat availability
Reason for Aggregate Extraction

<table>
<thead>
<tr>
<th>Reason</th>
<th>No of papers</th>
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<tbody>
<tr>
<td>Construction</td>
<td>30</td>
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<tr>
<td>Ecological reasons</td>
<td>1</td>
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<tr>
<td>Channel modification</td>
<td>2</td>
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<td>Gold Mining</td>
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Summary of Physical Impacts

Impacts Associated with Sand Mining

- Channel: Incision, Channel instability, Channel erosion, Widening, Channel narrowing, Change in channel character
- Sediment: Bed coarsening, Increase in bed and sediment load, Sediment reduction
- Morphological: Creation of deep pools, Consolidation of islands, Destruction of aquatic/riparian habitat, Aforestation
- Flow: Flow reduction, Increased flow velocity, Improved flood control, Decrease in flood control
- Water Quality: Increased turbidity, Increased intrusion, Increase in metals
Ecosystem impacts of sand mining

Wide range of impacts, but based on very few papers:
- Reduction in diversity and abundance of fish in mined areas
- Change from lentic to lotic populations due to removal of riffle sequences
- Increase in invasive species in disturbed areas
- High mortality during embryonic stage due to suction dredging
- Temporary and reversible change to abundance and diversity of invertebrates in small scale mining
- Change in food web dynamics in mined areas
- Impacts on larval drift due to increased turbidity
- Changes to riparian vegetation,

... Loss and destruction of habitat is number 1 stressor cited by IUCN on Red List

Link between physical changes to river and impacts on ecosystem often inferred, but limited number of studies demonstrate a direct linkage
- Loss of gravel substrate impacting fish spawning
- Channel alterations affecting migratory patterns
- Decline in native fisheries
- Water quality changes affecting biota
- Decline in deltaic ecosystems and coastal fisheries
Summary of QSR investigation

• Wide range of physical impacts on rivers
• Ecosystem impacts inferred due to physical changes due to sand mining
• Few papers directly document impact on ecosystem. Why?
  • Complex interactions not well understood; long time-scales; requires inter-disciplinary approach; other factors (dams, land use change etc.) make demonstrating cause–effect difficult
Governance of Sand Mining

- Remarkably similar throughout the world
- Regulation tends to be based on State or National laws, but responsibility devolved to local governments
- Regulatory gaps contribute to poor governance, but main issue is widespread occurrence of unregulated, illegal sand mining activities in many countries
Sand mining in the media

Illegal extraction reported in over 70 countries
Synthesis

- The world’s economy is based on sand
- Demand is increasing
- Unprecedented pressure on rivers, floodplains & deltas to provide sand
- Illegal extraction is widespread
- Lack of scientific investigation
Hope for the future?

- Need to recognise sand is not limitless or low value product
- Short term – improved governance can save rivers
- Longer term – alternative materials being developed
- BUT change would require acceptance by consumers and overhaul of construction industry
Thank you for your attention