



WWF®

REVIEW

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# IMPACTS OF SAND MINING ON ECOSYSTEM STRUCTURE, PROCESS & BIODIVERSITY IN RIVERS

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# EXECUTIVE SUMMARY

WWF is a solution-oriented advocate of clean flowing rivers that believes that by better understanding and communicating the impacts of sand mining – aggregate extraction encompasses sand, gravel, pebbles or cobbles, but is collectively referred to as sand mining – on rivers, the organisation can influence key decision-makers to ensure that extraction is done sustainably. To do this, a strong evidence base for past, current and potential impacts of sand mining on rivers and their ecosystems is required.

This report aims to provide an authoritative review and summary of the available scientific literature associated with sand mining impacts, a context for this information with respect to global sources, demands and trends, and an understanding of what the estimated present status and perceived associated impacts of sand mining are on a global scale.

Two evidence-based research approaches have been used in this review. A Quick Scoping Review (QSR) was used to survey the scientific literature describing the impact of sand mining on ecosystems. This highly structured objective approach involved reviewing papers obtained by searching scientific databases using terms relevant to the question ‘What evidence is there of impacts of aggregate mining on ecosystem structure, process and biodiversity in rivers, floodplains and estuaries’. All papers that were relevant to the central question were categorised by geographic location, system type, inference method, type of mining, scale of mining, end use of mined product, geomorphic impacts, social impacts and presence and interaction with other stressors.

The other parts of this review consisted of a web-based literature review that included media articles, government reports and websites. Investigated topics included the trends in sand use and availability, expected future trends, regulation and governance, and the prevalence of sand mining activities not captured in the scientific literature, including illegal activities. Many of the views and conclusions of these pieces are opinions and inferences, as hard facts are in short supply. Potential avenues for future research, community engagement and communication are provided.

Sand and gravel are used in a wide range of applications, but of reported uses, the vast majority is consumed in construction materials such as cement. Global demand has increased rapidly over the past two decades and has largely been driven by growth in the Asia Pacific region, particularly in China. China is the largest cement producer in the world, accounting for 58% of global production. It is predicted that the per capita consumption of concrete in China may decrease, but demand in other developing countries is also rapidly increasing. India is projected to surpass China in population within the next five to ten years and the combination of this population growth and increased urbanisation could quadruple its demand for concrete and aggregate if it follows a similar trajectory to China. The demand for aggregates in other developing nations in Asia and Africa is also expected to increase dramatically in the coming years.

**INTEGRATING THE QUICK SCOPING REVIEW RESULTS WITH THE HIGH AND INCREASING DEMAND FOR AGGREGATE IN DEVELOPING COUNTRIES STRONGLY SUGGESTS THAT THIS DEMAND CANNOT BE MET ON A SUSTAINABLE BASIS FROM RIVERS.**

In addition to construction, land reclamation is a major use of sand and aggregate, with Singapore being the world's largest importer. Neighbouring nations have officially banned the export of sand, but a thriving illegal trade is reported in the mainstream media

The QSR analysis showed that most investigations into the impact of sand mining on ecosystems has been completed in temperate rivers in western countries where sand mining occurred historically, but has since ceased. These countries now have strict regulations governing the extraction of aggregate, and there is little active in-stream mining occurring. The scientific studies overwhelmingly identified channel incision as the most common physical impact, but beyond that, the physical responses of rivers differed depending on the characteristics of the river (underlying material, slope, catchment land use, etc.). Collectively the QSR papers highlight the decadal time-frames over which rivers respond and recover from sand mining disturbances, and the importance of land use in determining river response.

The QSR papers report ecological impacts associated with sand mining including the direct disturbance and removal of habitats in rivers, deltas and coastal areas, loss or changes to the vegetation structure of riparian zones, and increased or decreased downstream sedimentation affecting habitat quality. Sand mining was found to interfere with a number of ecological processes, such as macroinvertebrate drift, fish movements, abundance and community structures, and food web dynamics. The studies often inferred impacts on populations, such as loss of native

species and increases in invasive alien species, but few had long-term data sets to confirm this. There is limited evidence that rivers can sustain sand extraction if the extracted volumes are within the natural variability of the sediment load of the system, based on one year of extractions, but no studies have demonstrated the sustainability of sustained extractions over prolonged time frames.

A significant finding of the QSR is that the countries and rivers for which there is science-based evidence related to the impacts of sand mining are not the countries that are rapidly developing and where extensive illegal sand mining is reported by the media. The lack of scientific and systematic studies of sand mining in these rapidly developing countries prevents accurate quantification of the volumes of material being mined, or the type, extent and magnitude of impacts. An estimate of potential impacts can only be made by inferring that results from studies elsewhere can be applied to locations without direct evidence.

Integrating the QSR results with the high and increasing demand for aggregate in developing countries strongly suggests that this demand cannot be met on a sustainable basis from rivers.

In most countries, sand mining is officially regulated through national mining and environmental protection legislation, with authority for regulation devolved to the State or District level. Legislation is frequently accompanied by non-binding guidelines to improve the sustainability of the activity. This governance structure results in many small administrative entities having responsibility for implementing and enforcing these regulations, hampering management at the catchment level. The lack of enforcement of regulations is a common issue identified by the mainstream media.

Options for reducing the construction industry's dependence on sand mining identified through a literature review, included recycling concrete, fixing rather than replacing concrete, researching the suitability of waste materials as aggregate substitutes, and developing new construction materials and design approaches.



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In contrast to the relatively low number of scientific studies dedicated to impacts associated with sand mining, there is an abundance of media articles highlighting the growing demand yet dwindling availability of sand in developing countries. The illegal extraction of river and coastal sand is reported to occur in as many as 70 countries, often with the support of complicit governments. The social impacts of the illegal trade are also widely reported, with violence commonly reported against protestors or those who attempt to report illegal activities. Media reports highlight that impoverished communities engage in the illegal trade as it provides a higher income than other activities, even though they perceive that sand extraction is destroying the rivers on which they depend for their livelihoods.

#### **The conclusions of the review include:**

- Developed countries with good governance do not in general use rivers as a source of aggregate. In these countries demand is met with terrestrial pits and a growing reliance on marine resources. There is growing social awareness of the impacts marine sand mining has on beaches and coastal ecosystems, and opposition to the activity is increasing;
- The extraction of sand from rivers in developing countries is reported by the press to be having severe and widespread impacts on rivers and coasts, but a lack of reliable information prevents scientific confirmation or quantification; and
- The demand for sand is increasing, and preventing or reducing likely damage to rivers will require the construction industry to be weaned-off river sourced aggregate, either through the substitution of materials or alterations to building designs and methods so that extraction is reduced to levels that are proven to be sustainable/have little negative ecological impact. This type of societal shift is similar to that required to address climate change, and will necessitate changes in the way that sand and rivers are perceived, and cities are designed and constructed.

#### **RECOMMENDATIONS ARISING FROM THIS REVIEW INCLUDE:**

- Increasing public awareness of the growing demand and finite supply of sand is critical to effecting change and is recommended. In the short term, public awareness can increase pressure on governments for stricter regulations and governance, including the identification of off stream sources of aggregate. In the longer-term, public awareness and acceptance will be required for any shift away from the present market system whereby sand underpins all development, yet is the cheapest of commodities;
- Research into economic incentives or certification schemes that could drive a reduction in the extraction of sand from rivers is recommended;
- Scientific research in rivers where in-stream sand mining is active is required to enhance understanding and quantification of impacts, identify management and remediation methods (if and where required) for rivers and underpin communication strategies. Recommendations for future research include quantifying the present situation in rivers where sand mining is occurring through the implementation of short-term 'rapid' assessments, in combination with longer term investigations to understand changes over the time-scales at which rivers and ecosystems respond to change. Rivers where sensitive or endangered species reside, and their habitat needs are known would provide good initial targets for research, and provide robust information for communication. Evidence of where economically valuable species are being lost would provide information on economic trade-offs. The severe lack of information regarding rivers in developing countries must rapidly be addressed.

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# IMPACTS OF SAND MINING

70

Countries reportedly experience illegal extraction of river and coastal sand

80%

Of cement is made up of sand




450

Critically endangered Yangtze finless porpoises live in Poyang Lake, world's largest sand mine

32-50  
BILLION

Tonnes of sand and gravel are extracted globally each year



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