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The Future of Sand: Lack of Legislations, Care and Alertness is failing it, taking us along the Slippery Path

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1.0 Background

After water, sand is the most used resource on earth. Sand is the most used solid resource on earth, including to construct buildings and roads but also for glass, natural gas fracking, silicon chips, and even cosmetics. Although this rather ubiquitous resource is seldom thought of and talked about, its diverse usage in construction, infrastructure, glass, electronics, and personal products puts the resource in high demand worldwide. Mostly driven by demand for concrete, the extraction rates and resulting environmental devastation of sand mining are massive, affecting ecosystems and threatening long-term supply (Figure 1). Poor regulations, by both industry and government authorities have resulted in a thriving sand market often involving 'sand mafias'[1].

2.0 The Crisis

Sand mining has tripled in the past two decades, with demand reaching 50 billion tonnes a year in 2019, according to the United Nations Environment Programme (UNEP). Indeed, the volume of sand and gravel used each year is enough to build a wall around the equator measuring 27 metres high by 27 metres wide. But extraction, sourcing, use and management of sand is unregulated in many parts of the world, which means we are consuming it faster than it can be replaced by geological processes. Urgent action – including a ban on beach extraction – is needed to avert a "sand crisis",



Figure 1. Sand mining in an Indian location. (Courtesy: https://www.lemonde.fr/en/environment/article/2022/09/12/in-india-sand-mafias-have-power-money-and-weapons_5996639_114.html)

> "We are spending our sand 'budget' faster than we can produce it responsibly. By improving the governance of global sand resources, we can better manage this critical resource sustainably and truly demonstrate that infrastructure and nature can go hand in hand," said Joyce Msuya, Acting Executive Director of UN Environment.

UNEP's Sand and Sustainability report says. Around 6 billion tonnes of marine sand is also being dug up each year by the marine dredging industry, "significantly

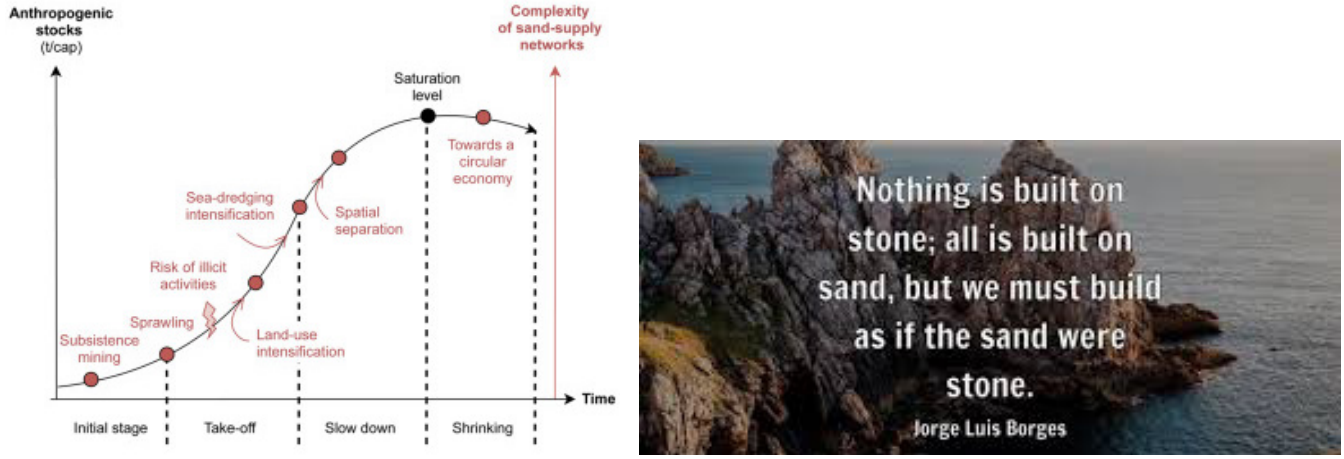


Figure 2. Reducing the stock of sand with the progress of human civilization.





Figure 3. Sand is depleting fast.

impacting biodiversity and coastal communities," UNEP's new data platform, Marine Sand Watch reveals. The primary use of sand is for construction since concrete consists of 75% of sand. This adds up to roughly 200 tons of sand for a house, 30.000 tons for every kilometre highway and a staggering 12 million tons of sand for a nuclear power plant. This huge demand for sand has caused the practice of sand mining to become a worldwide environmental issue. Between 1900 and 2010 the global demand for sand increased 23-fold and it is expected to grow to a colossal 82 billion tons by 2060. Currently, around 50 billion tons of sand is used annually and that is already double the amount of sand that is produced by nature in that same period. It takes the earth thousands of years to replenish the sediment stocks that are currently being overexploited. Recent calculations show that at the current extraction rate, the world could be running out of sand as early as 2050[2]. (https://www.sciencedirect.com/science/article/pii/S0048969722029746#:~:text=A%20global%20environmental%20crisis,Mini%20G.%2C%202013).

India is the second largest consumer of sand in the world, after China, and its demand is growing. The Indian sand market is estimated to be worth around 900 million tons per year and is expected to grow by 7–8% over the next five years. In 2023, the market was valued at US $551.1 million and is projected to reach US $908.6 million by 2032.

3.0 Too Important to Neglect

Defined as a solid, granular material between the sizes of 0.125 – 2 mm, sand consists of the harder remnants of rocks – especially quartz but also weaker feldspar and other minerals – generally broken down through chemical and physical weathering. Despite the seemingly massive

natural 'stocks' of sand, shortages of sand are increasing worldwide, leading to a growth in both domestic and international trade of sand, which amounted to about $2 billion in 2019 (2021). An estimated 42 – 55 billion tonnes of sand are mined every year around the world, from quarries, sand dunes, riverbeds, and coastal shorelines. Sand used in concrete or other building materials mostly comes from water-weathered rocks as this process maintains rough edges on sand grains necessary for structural integrity, while desert sand weathered by wind is too smooth to be structurally effective. The resulting environmental devastation of sand mining, including for concrete, is thus massive as it affects riverine, lake beds, coastal, and marine areas, with ecosystem degradation threatening agriculture, biodiversity, fishing, and water supply, especially in a context of climate change exacerbating floods and coastal erosion. As sand becomes scarcer, some countries and companies are exploring 'new frontiers' of extraction and import/export, with for example ice melting in arctic regions opening up access to new potential sediments[3].

4.0 Uses and Losses

Mined and traded across nearly every country to be incorporated into concrete-based materials, sand mining and supply chains present major regulatory challenges at local, national, and international levels. Many governing bodies have long paid scant attention to this supposedly abundant and low-value resource, with often insufficient and inconsistently enforced regulations, although some EU countries, for example, have had quite strict and well-enforced regulations. The industry has had few attempts to self-regulate - it cannot do so, with only very limited reforms due to low standards and non-mandatory participation; and alternative options to 'natural' sand addresses, with attempts to promote alternatives or recycled sand, only covering the tip of the

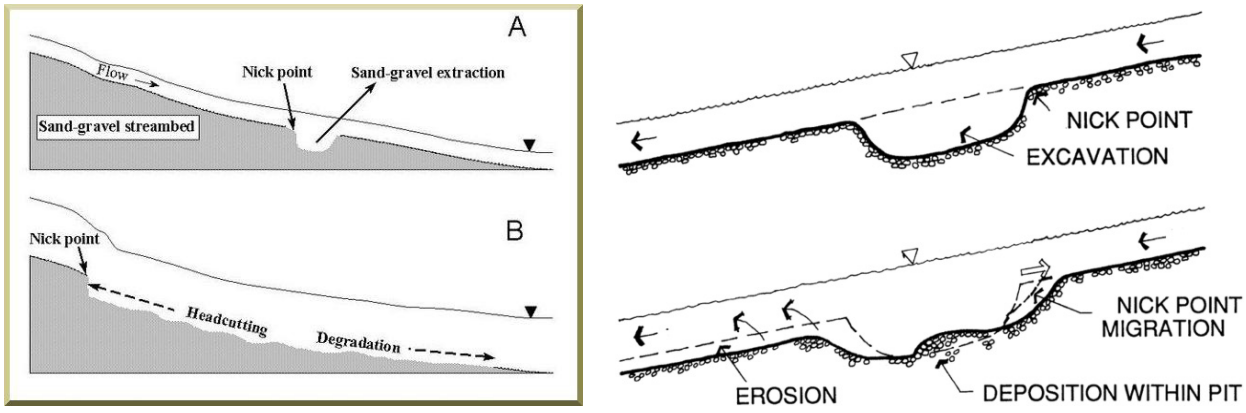


Figure 4. The riverbed effect of sand mining.



Figure 5. Over-exploitation of river sand causes erosion in hills. This is not limited to China, though. If reported, similar instances will found everywhere sand mining is being carried on.

huge un-minded crisis. As a result, a broad range of sand mining organizations have thrived, from informal artisan and small-scale miners to large-scale companies and even organized crime. There exists a clear need for a set of international and domestic policy responses to address the devastating environmental and social impacts of many current sand supply chains. At the same time, initiatives are necessary to increase the share of 'alternative' or 'secondary' sands (e.g. from recycled building materials) within global sand demand, especially for concrete, and to promote less sand-intensive and high-emission materials for human habitats and infrastructures. Sand mining has both short- and long-term consequences. Short-term sand mining impacts include bank erosion, bed incision, and groundwater table modifications while in the long run, sand mining can compromise delta-wide water supply resources, intensify saline water intrusion, and reduce floodplain connectivity[4].

5.0 Over-Exploitation and Under-Reporting

Illegal or unregulated sand mining has been a global problem. This is particularly worrying in Asia in countries like India, Pakistan, Vietnam, Cambodia, and Laos where there is an evident lack of regulatory frameworks and licensing, along with inefficient monitoring. Sand mining is primarily carried out by mechanical shovels on barges that feed a fleet of boats and barges. Dredging operations tend to stay within the same concession area until the area is exhausted or the extraction license expires. Accurate estimates of sand extraction remain largely unknown, and scientific literature suggests that the volume of sand mined is likely to differ significantly from official statistics. As a result, assessing the environmental impacts caused by riverbed sand mining activities is complicated by the immense scale and dynamic environment, but it is also made more complex by the limited regulatory power in the affected countries. This has created opportunities of over-exploitation, often escaping the eyes of vigilance and auditing, by the unscrupulous miners. There is, thus, an urgent need to examine novel approaches to regional-based assessments of riverbed sand mining.

Sand mining culturally has been a law-escaping exercise promoted by the small, quick profit-seeking, marauding commercial short–change profiteering entities and has been in the hold of illiterate but malicious business entities; this has to change[3,4].

6.0 Corruption and Destitution

The ruins of 476 houses haunt the Thottappally hamlet on the southern edges of Kerala's Alappuzha district. These houses were abandoned by the local fishing community after they sustained long-term damage from recurring sea erosion for which the locals blame indiscriminate mineral sand mining. A temple and two elementary school buildings also stand abandoned amidst dried-up mangroves after copious amounts of sand were mined from the Thottappally pozhi (sand bar) near the sea mouth where the Vembanad Backwaters meet the Arabian Sea. Further, near the village's gate, environmentalists, fish workers, and other inhabitants are participating in a prolonged relay hunger strike, which surpassed 1,036 days on April 1, 2024. The protestors, organized under the banner of the Kaimanal Ghanana Virudha Ekopana Samithy (KGVES), claim that their village is gradually disappearing from the map as a result of the large-scale mineral sand mining. The protestors are demanding an immediate halt to mining to protect the last remaining coastal villages near the Thottappally Pozhi, Kerala's largest deposit of exceptionally rich mineral sand.

A study reflects that around 418 people died and 438 people got injured in India from December 2020 to March 2022 in sand mining cases. These are only reported cases; the actual number could be at least 5 times more. The highest number of deaths have been reported in North India (95), followed by 42 in West and Central India, 41

Zone wise summary table of death, injuries due to sand mining violence & accidents from Dec. 2020 to March 2022

Zone	Death by drowning in sand pits	Deaths/ Injuries in Mine collapse & accidents	Deaths/ Injuries in Road accidents	Deaths/ Injuries of Citizens/ Villagers/ Farmers in attacks	Deaths/ Injuries of Reporters/ Activists in attacks	Deaths/ Injuries of Govt. officials in attacks	Death/ Injuries in Gang-war/ Encounter/ Infighting	Total Deaths/ Injuries
North	24	19/19	110/130	00/10	00/02	00/21	NA	153/182
East	10	35/01	85/61	05/32	00/05	00/58	04/01	139/158
North East	NA	NA	09/00	NA	NA	NA	NA	09/00
West	17	16/00	42/21	02/01	00/01	00/41	02/03	79/67
South	08	25/01	48/09	05/10	00/02	02/06	01/03	89/31
Total	59	95/21	294/221	12/53	00/10	02/126	07/07	469/438

*NA: Not Available.

Figure 6. Zone wise summary of death, injuries due to sand mining violence and accidents.
Courtesy: https://www.scconline.com/blog/post/2023/02/08/sand-mining-in-india-grain-of-despair-failure-of-regulatory-machinery/



Figure 7. Mining at Thottappally Pozhi, Kerala.

in East India and 15 in South India. The causes of death are drowning in deep sand mining pits, the downfall of sand mounds, and the caving in of sand mines. Vehicles that are involved in the sand mining business are often reported to be damaged by road accidents.

Sand mining in India has been making news mostly for notorious reasons. It has caused irreversible damage to the environment and virtually stymied many rivers. Sand mining has led to the devastation of rivers like Narmada, Chambal, and Betwa in Madhya Pradesh. Similarly, in Kerala, Bharathappuzha River has fallen victim to sand mining. Gujarat, Karnataka, and Tamil Nadu have also reported the negative impact that is the result of sand mining across their rivers.

7.0 Control, Regulate and Organize: Encourage Big Players to Come In

It is almost impossible, and now we must accept it, to make small and artisanal miners responsible and pay for their actions. Even if it makes doubtful economic gains for the local people and helps in rural employment, the scourge greatly outweighs the benefits. The only answer, if at all there is an answer, has to be to encourage the involvement of organized business. Strangely, most governments are reluctant to do that, largely because the legislators and public servants are involved in the corruption, as well as the public is blissfully unaware and so they do not pressurize the politicians and governments to act. Small players are diffused and hardly discernable. The big players will at least be more discernable to start with.

> *"… when the Government is presented with a choice between irreparable injury to the environment and severe damage to economic interests, protection of the environment would have precedence. No permit shall be given to any person for sand mining in the area concerned unless a sand audit is conducted."…* in Paristhithi Samrakshana Sangham v. State of Kerala case, the High Court of Kerala held

> *The High Court of Kerala in Soman v. Geologist20 held: … the principle of sustainable development is now a part of environmental jurisprudence, flowing from Article 21 of the Constitution of India, and hence the State is bound to impose any conditions while granting the permit for sand mining.…*

8.0 Management of Sand

It calls for a better management framework, exploration of river and coastal sand alternatives, an understanding of both the complex sand life cycle and coastal sand-supply network, and greater recognition of the concept of 'sand rights and heritage', via approaches that:

1. Regulate sand mining;
2. Ensure responsible mining with competent persons;
3. Create a legal and regulatory framework to stop illegal mining;
4. Reduce sand consumption;
5. Levy taxes and royalties on sand extraction;
6. Regulate the river and coastal sand mining process;
7. Incentivize change in construction methods and approaches to reduce the use of aggregate;
8. Promote green construction using sustainable materials;
9. Reduce the dependence of rural people on sand mining.

Management of sand waste should be also on the agenda. For example, other mining waste could be dry-mined for sand; concrete could be recycled and used more efficiently; filler materials (e.g. construction waste or pulverised glass) could be used to regenerate beaches (though risks to human health, and impacts on the wider ecosystem and biodiversity would need to be considered); and new materials could be used in place of concrete (e.g. microplastics, timber). Even if it is unrealistic to eliminate

concrete, companies should move towards alternative materials in place of concrete, the researchers say; the construction industry should adopt a lifecycle approach, with the environmental impacts of materials considered and minimised from design through to end-of-life/ disposal[5,6].

9.0 People's Activism

India Sand Watch – which aims to monitor every stage of both legal and illegal sand mining operations in the country by Kolkata's Veditum India Foundation, India Sand Watch has been designed to become a one-stop destination for those concerned about sand mining in the country, from activists and journalists to researchers and policymakers. The industry exacts a human toll: during the past two years, a total of 124 people in India's eastern states have died in accidents and violence related to sand mining. Launching in early August 2023 the India Sand Watch platform should enable users to find out the location of a sand mine, its legal status, any documented impacts on local communities and rivers, as well as any related legal documentation. Reporting on the lucrative sand trade can be a dangerous undertaking in India and journalists covering it often face serious threats. Siddharth Agarwal, founder of both India Sand Watch and the Veditum India Foundation, says one of the project's goals is to provide a method for information sharing that doesn't compromise contributors' safety[6] (https://dialogue.earth/en/water/new-platform-unites-tech-and-activism-to-monitor-sand-mining-in-india/#:~:text=A%20booming%20business%20anchored%20by,billion%20(USD%202%20billion).

10.0 Replacement of Sand in Concrete

Globally there are initiatives to replace sand by other material in concrete. Here are some materials that can replace sand in concrete:

a. Quarry dust
A byproduct of the crushing process, quarry dust is becoming more popular as a replacement for natural sand because of its environmental and economic benefits.

b. Ground Granulated Blast-furnace Slag (GGBS)
When combined with Portland cement, GGBS can create durable concrete structures and reduce thermal cracking.

c. Bottom ash
Bottom ash can be used to replace natural sand and has shown good results in compressive strength compared to conventional concrete.

d. Fly ash
Fly ash can replace sand by up to 10% and increase the strength of the concrete, making it more economical.

e. Recycled glass
Replacing fine natural aggregates with recycled glass can help preserve natural sand and reduce glass waste.

f. Recycled concrete aggregate
Recycled aggregates can be a good replacement for natural aggregates, but they may be less strong because of the low bonding between the cement matrix and aggregate particles.

g. Copper slag
Copper slag can be used as a partial replacement for sand because of its chemical and physical composition, which includes high iron, silica, and aluminum oxide.

h. Crushed stone
Crushed stone sand is often considered a natural successor to river sand and is usually free of contaminants, making it ideal for concrete.

i. Coarse aggregate
Coarse aggregate can replace most of the sand in concrete, creating space for water to permeate and preventing runoff[7].

11.0 Last Word

The sand extraction is fast becoming a transboundary issue due to sand extraction bans, international sourcing of sand for land reclamation projects and impacts of uncontrolled sand extraction beyond national borders. International trade in sand and gravel is growing due to high demand in regions without local sand and gravel

resources and is forecast to rise 5.5 per cent a year with urbanization and infrastructure development trends.

Unsustainable sand extraction does not only impact the environment but can also have far-reaching social implications. Sand removal from beaches can jeopardize the development of the local tourism industry while removing sand from rivers and mangrove forests leads to a decrease in crab populations—negatively affecting women whose livelihood depends on the collection of crabs.

Illegal sand mining is a widespread and organized criminal activity not only in India but also over the world that can lead to corruption and other negative impacts7 :

Revenue loss: Illegal sand mining can directly result in revenue loss for the state.

Social evils: Illegal sand mining can involve bonded labor and other social evils.

Conflicts: Illegal sand mining can lead to conflicts between local communities, sand miners, and government authorities. For example, in 2022, there were widespread conflicts over sand mining in rivers in Tamil Nadu.

Displacement: Illegal sand mining can displace communities that depend on riverbanks for their livelihoods, such as fishing and agriculture.

Hazardous Working Conditions: Sand mining often involves hazardous working conditions, with workers at risk of accidents, injuries, and exposure to harmful substances.

Illegal sand mining is rampant in states like West Bengal, Bihar, Maharashtra, Gujarat, Karnataka, Tamil Nadu, Kerala and Uttar Pradesh. It is becoming more common in almost all the states of the country. Sand extraction often targets riverbeds, coastal areas, and agricultural lands. For example, in Kerala, there have been allegations that the state government helped a company unlawfully mine mineral sand from the southern shores.

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