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# SALIENT RISKS OF SAND MINING: CONSUMPTION, CONSTRUCTION, AND COMPLIANCE

STRATEGIC

OPERATIONAL

FINANCIAL

COMPLIANCE

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# **SALIENT RISKS OF SAND MINING**

## **CONSUMPTION, CONSTRUCTION, AND COMPLIANCE**

**RISK REPORT**

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## Summary

Sand is a seemingly plain but in fact enormously valuable natural resource. Sand is ubiquitous in the modern world – it is in buildings, roads, glass, and even smart phones. Yet despite its critical importance for the construction industry, infrastructure development, and urbanization projects, the extraction and consumption of sand remain comparatively unregulated in many countries, fostering illegal mining activities and the emergence of sand mafias. At current consumption levels, the world is heading into a silently but gradually mounting sand crisis as the world population continues to grow and sand reserves are slowly depleted. In order to manage sand smartly, stakeholders in the sand supply chain must gain a developed understanding of associated risks, the nature of global sand markets, domestic and international trade patterns, and the importance of regulatory mechanisms.

## List of Abbreviations:

<b><i>IRP</i></b>	<b>International Resource Panel</b>
<b><i>UK</i></b>	<b>United Kingdom</b>
<b><i>UN</i></b>	<b>United Nations</b>
<b><i>UNEP</i></b>	<b>United Nations Environment Programme</b>
<b><i>USGS</i></b>	<b>U.S. Geological Survey</b>
<b><i>U.S.</i></b>	<b>United States</b>
<b><i>WWF</i></b>	<b>World Wildlife Fund</b>

**BOLTS: STRATEGIC, OPERATIONAL, FINANCIAL, COMPLIANCE.**

**TAGS: SAND, SAND MINING, SAND CONSUMPTION, SAND PROCESSING, ILLEGAL MINING, SAND MAFIA, NATURAL RESOURCES, RESOURCE MANAGEMENT, TRADE, DOMESTIC MARKETS, CONSTRUCTION INDUSTRY, COMPLIANCE, CAMBODIA, CHINA, DUBAI, UNITED ARAB EMIRATES, INDIA, INDONESIA, MALAYSIA, MOROCCO, NIGERIA, SINGAPORE, THAILAND, UGANDA, UNITED STATES, UNITED KINGDOM, VIETNAM.**

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## Introduction: Sand and Society

Seemingly unremarkable, sand is in fact one of the most important natural resources in the world. Sand is everywhere; it is in buildings, paved roads, natural oil extraction processes, glass, and even smartphone screens. Human civilization has depended on sand as an essential element of construction since at least the age of ancient Egypt, later refining the utilization of sand in the 15<sup>th</sup> century to create glass for telescopes and facilitating the scientific revolution of the Renaissance.<sup>1</sup> Sand is available in abundance – on beaches, in the sea, in lakes, rivers, and deserts across the globe – yet it is not an infinite resource. Population growth drives sand consumption, creating the risk of resource depletion in the long term. Natural rock and mineral erosion require thousands of years to produce finely ground sand, making it a virtually non-renewable resource.

As the world population grows, so does the demand for sand, allowing infrastructure projects, industrialization, and urbanization to thrive. According to a 2019 assessment of world population prospects by the Population Division of the United Nations, the world population is estimated at 7.7 billion people in 2019 and will rise to 9 to 10 billion people by 2050.<sup>2</sup> Urbanization and the vast population growth in cities lead to particularly strong effects on global sand extraction and consumption. Since 1950, the number of people living in cities has expanded rapidly from 751 million to approximately 4.2 billion in 2018, accounting for slightly more than half of the global population.<sup>3</sup> The percentage of urban dwellers is projected to climb further in the future, reaching 68% of the world population by 2050, with people in India, China, and Nigeria accounting for the largest share of all city residents worldwide at 35% in total.<sup>4</sup> Sustainably managed urbanization and

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<sup>1</sup> Beiser, V. (2015): The deadly global war for sand, *Wired*. Available at: <https://www.wired.com/2015/03/illegal-sand-mining/> (Accessed: August 9, 2019).

<sup>2</sup> United Nations [UN] (2019): *World Population Prospects 2019*. Available at: <https://population.un.org/wpp/Download/Standard/Population/> (Accessed: August 12, 2019).

<sup>3</sup> United Nations Department of Economic and Social Affairs [UN DESA] (2018): *68% of the world population projected to live in urban areas by 2050, says UN*. Available at: <https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html> (Accessed: August 12, 2019).

<sup>4</sup> Ibid.



infrastructure expansion are therefore increasingly important factors in the sand mining and construction industry.

Extracting sand is relatively cheap and easy, requiring as little as a shovel and a cart for the simplest type of mining. This easy access, however, fosters illegal exploitation of global sand reserves. Despite the wide use of sand as a commodity, sand industries across the world lack comprehensive legal frameworks, rigorous policy implementation, and adequate extraction monitoring to control sand mining and prevent illicit mining activities.<sup>5</sup> Due to this situation, sand mafias are emerging in countries like India or Morocco, where illegal mining is a particularly grave issue.<sup>6</sup> It is estimated that approximately 50% of the annual sand extraction levels in Morocco – approximately 350 million cubic feet (10 million cubic meters) – are mined illegally.<sup>7</sup> Hence, risks pertaining to the global management of sand resources prompt various questions about sand use and trade, the issue of overconsumption, and compliance.

## Sand as a Commodity for Construction

Sand can consist of a number of minerals and metals such as quartz, ilmenite, rutile, and zircon.<sup>8</sup> Contrary to expectations, however, not every type of sand can be used to create cement and concrete for construction. Large deserts such as the Arabian Desert or the Sahara may provide enormous amounts of sand, yet desert winds grind this sand into exceedingly round, smooth, and small grains, rendering them unsuitable for cement and concrete production because it would

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<sup>5</sup> Beiser, V. (2015): The deadly global war for sand, *Wired*. Available at: <https://www.wired.com/2015/03/illegal-sand-mining/> (Accessed: August 9, 2019).

<sup>6</sup> Ibid.

<sup>7</sup> Brown, O. & Peduzzi, P. (2019): Driven to extraction: Can sand mining be sustainable?, *Chatham House*. Available at: <https://hoffmanncentre.chathamhouse.org/article/driven-to-extraction-can-sand-mining-be-sustainable/> (Accessed: August 9, 2019).

<sup>8</sup> Beiser, V. (2015): The deadly global war for sand, *Wired*. Available at: <https://www.wired.com/2015/03/illegal-sand-mining/> (Accessed: August 9, 2019); United Nations Environment Program [UNEP] (2019): *Sand and sustainability: Finding new solutions for environmental governance of global sand resources*. Available at: <https://www.unenvironment.org/news-and-stories/press-release/rising-demand-sand-calls-resource-governance> (Accessed: August 9, 2019).

make the substance corrosive.<sup>9</sup> This explains why Dubai is running out of sand for its land reclamation and large-scale construction projects, importing the resource from Australia instead, even though it is surrounded by the desert. In 2014, the United Arab Emirates procured USD 456 million worth of sand, stone, and gravel from abroad to continue its construction projects.<sup>10</sup>

Ideally, sand for construction is extracted from rivers since it has an appropriately grainy texture and is washed clean by river water. Alternatively, sea sand from the ocean or coastlines can be extracted, but grains must be desalinated in a cleaning process to prepare it for production, otherwise the salt would erode the metal in finished buildings.<sup>11</sup> In Shenzhen, China, unprocessed sand was used to construct at least 15 buildings, before state authorities identified the risk while the projects were under construction.<sup>12</sup> Using unprocessed or unsuitable sand hence produces risks related to the collapse of architectural constructions.

## Sand Extraction, Production, and Consumption

While countries are monitoring cement production, global data on sand extraction and sand management is not as well documented as information on cement. Estimates of global extraction and consumption provide some guidance, yet illegal mining complicates the issue of measuring exact volumes. The International Resource Panel of the United Nations Environment Programme

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<sup>9</sup> Salopek, P. (2019): Inside the deadly world of India's sand mining mafia, *National Geographic*. Available at: <https://www.nationalgeographic.com/environment/2019/06/inside-india-sand-mining-mafia/> (Accessed: August 9, 2019); Tweedie, N. (2018): Is the world running out of sand? The truth behind stolen beaches and dredged islands, *The Guardian*. Available at: <https://www.theguardian.com/cities/2019/feb/25/concrete-the-most-destructive-material-on-earth> (Accessed: August 9, 2019).

<sup>10</sup> Rayasam, R. (2016): Even desert city Dubai imports its sand: This is why, *BBC*. Available at: <https://www.bbc.com/worklife/article/20160502-even-desert-city-dubai-imports-its-sand-this-is-why?ocid=fbcptl> (Accessed: August 9, 2019).

<sup>11</sup> Tweedie, N. (2018): Is the world running out of sand? The truth behind stolen beaches and dredged islands, *The Guardian*. Available at: <https://www.theguardian.com/cities/2019/feb/25/concrete-the-most-destructive-material-on-earth> (Accessed: August 9, 2019).

<sup>12</sup> Steadman, I. (2013): Poor-quality Chinese concrete could lead to skyscrapers collapsing, *Wired*. Available at: <https://www.wired.co.uk/article/china-concrete-sand-quality-scandal> (Accessed: August 9, 2019).

(UNEP) Secretariat estimated that the global total demand for material resources reached almost 90 billion tons in 2017 and projected that this amount is likely to double by 2050.<sup>13</sup> Sand constitutes one of the most important resources if measured by traded volume, following water as the second-most extracted resource.<sup>14</sup> Every year, an estimated 40 billion to 50 billion tons of sand are extracted globally.<sup>15</sup> A highly valuable commodity to the construction industry, roughly half of this amount is used to produce concrete, amounting to between 25.9 billion and 29.6 billion tons in 2012.<sup>16</sup> Urbanization and growing population numbers lead to forecasts of an increasing demand for sand in the future, which is why the global consumption of sand and gravel aggregates is projected to reach an estimated total of 60 billion tons every year by 2030.<sup>17</sup> Moreover, the global sand business is comparatively lucrative, totaling an estimated USD 60 billion per year.<sup>18</sup> According to data by the U.S. Geological Survey (USGS), US companies generated 970 million tons of sand and gravel for construction worth USD 8.7 billion in 2018.<sup>19</sup>

At the top of the global cement production ranking is Asia with China and India in the lead, which account for two thirds of the worldwide cement production.<sup>20</sup> Asia will remain a leader in sand

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<sup>13</sup> International Resource Panel [IRP] (2017): *Assessing global resource use: A systems approach to resource efficiency and pollution reduction*. Available at:

<https://www.resourcepanel.org/reports/assessing-global-resource-use> (Accessed: August 9, 2019).

<sup>14</sup> UNEP (2019): *Sand and sustainability: Finding new solutions for environmental governance of global sand resources*. Available at: <https://www.unenvironment.org/news-and-stories/press-release/rising-demand-sand-calls-resource-governance> (Accessed: August 9, 2019).

<sup>15</sup> Ibid.

<sup>16</sup> UNEP (2014): *Sand, rarer than one thinks*. Available at:

[https://na.unep.net/geas/archive/pdfs/GEAS\\_Mar2014\\_Sand\\_Mining.pdf](https://na.unep.net/geas/archive/pdfs/GEAS_Mar2014_Sand_Mining.pdf) (Accessed: August 9, 2019).

<sup>17</sup> UNEP (2019): *Sand and sustainability: Finding new solutions for environmental governance of global sand resources*. Available at: <https://www.unenvironment.org/news-and-stories/press-release/rising-demand-sand-calls-resource-governance> (Accessed: August 9, 2019).

<sup>18</sup> Tweedie, N. (2018): Is the world running out of sand? The truth behind stolen beaches and dredged islands, *The Guardian*. Available at: <https://www.theguardian.com/cities/2019/feb/25/concrete-the-most-destructive-material-on-earth> (Accessed: August 9, 2019).

<sup>19</sup> US Geological Survey [USGS] (2019): *Sand and Gravel (Construction)*. Available at: <https://prd-wret.s3-us-west-2.amazonaws.com/assets/palladium/production/atoms/files/mcs-2019-sandc.pdf> (Accessed: August 9, 2019).

<sup>20</sup> UNEP (2019): *Sand and sustainability: Finding new solutions for environmental governance of global sand resources*. Available at: <https://www.unenvironment.org/news-and-stories/press-release/rising-demand-sand-calls-resource-governance> (Accessed: August 9, 2019).

consumption even in the future. Estimates predict that cement demand will increase threefold to fourfold in Asian developing countries such as Indonesia by 2050.<sup>21</sup> This regional growth correlates positively with data on population growth in urban areas, which contributes to China and India's status as the countries with the most significant increases.<sup>22</sup>

China's enormous demand for sand has rendered the country the world's leading consumer of sand. With vast stretches of urbanized space such as the Pearl River Delta, China's consumption of sand and production of concrete have grown consistently for years. In the past 20 years, the country's demand for concrete has risen by 540%, surpassing the consumption levels of all other countries combined.<sup>23</sup> The construction boom in China has turned Poyang Lake in Jiangxi province into the world's biggest sand mine, with extraction levels reaching 8.3 billion cubic feet (236 million cubic meters) per year.<sup>24</sup> In other words, China dredges an estimated 989,000 tons of sand at Poyang Lake every day.<sup>25</sup>

A more specific use of sand is land reclamation and port development projects. Dubai, for instance, built the artificial archipelago known as the World Islands as well as the Palm Islands, three artificial islands at the city's coast. Hong Kong has also built structures on vast areas of reclaimed land, including Hong Kong International Airport, also known as Chek Lap Kok airport, which ranks among the busiest airports worldwide in terms of passenger traffic. Yet surpassing even Dubai and Hong Kong, Singapore imports the largest amount of sand globally. Since the mid-1960s, land reclamation projects have added 20% to Singapore's land area. In the last 20 years, the Southeast

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<sup>21</sup> Lehne, J. and Preston, F. (2018): *Making concrete change: Innovation in low-carbon cement and concrete*, *Chatham House*. Available at: <https://www.chathamhouse.org/publication/making-concrete-change-innovation-low-carbon-cement-and-concrete> (Accessed: August 9, 2019).

<sup>22</sup> See Introduction: *Sand and Society*.

<sup>23</sup> Lehne, J. and Preston, F. (2018): *Making concrete change: Innovation in low-carbon cement and concrete*, *Chatham House*. Available at: <https://www.chathamhouse.org/publication/making-concrete-change-innovation-low-carbon-cement-and-concrete> (Accessed: August 9, 2019).

<sup>24</sup> Brown, O. & Peduzzi, P. (2019): *Driven to extraction: Can sand mining be sustainable?*, *Chatham House*. Available at: <https://hoffmanncentre.chathamhouse.org/article/driven-to-extraction-can-sand-mining-be-sustainable/> (Accessed: August 9, 2019).

<sup>25</sup> Tweedie, N. (2018): *Is the world running out of sand? The truth behind stolen beaches and dredged islands*, *The Guardian*. Available at: <https://www.theguardian.com/cities/2019/feb/25/concrete-the-most-destructive-material-on-earth> (Accessed: August 9, 2019).

Asian island city-state consumed as much as 517 million tons of sand, importing vast amounts from regional neighbors Indonesia, Malaysia, Thailand, Cambodia, and Vietnam.<sup>26</sup> Singapore's high demand for marine sand has reportedly led to the dissolution and disappearance of about 24 Indonesian islands. Due to these high consumption rates, Singapore's major suppliers such as Indonesia, Malaysia, Cambodia, and Vietnam have imposed restrictions on sand trade with the island city-state.<sup>27</sup>

## Sand Trade: Domestic and International Flows

While sand extraction is relatively cheap and simple, transportation costs can be high because sand is heavy and bulky. Therefore, sand is more often traded domestically rather than internationally, supplying smaller national and subnational markets. Since most of the extracted sand is not transported over long distances, sand mines are commonly close to production and construction sites. Merely 5% of sand is traded internationally, but data shows that international sand trade was valued relatively highly at USD 4.5 billion in 2017.<sup>28</sup> Additionally, forecasts predict that international sand and gravel trade will increase 5.5% annually.<sup>29</sup> The companies that are considered the biggest players in the international sand business are LafargeHolcim, HeidelbergCement, Cemex, CRH, Italcementi, and Sibelco. In comparison, Chinese companies lead in terms of production volume, but they are mainly active in the domestic market.<sup>30</sup> International affairs think tank Chatham House

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<sup>26</sup> Brown, O. & Peduzzi, P. (2019): Driven to extraction: Can sand mining be sustainable?, *Chatham House*. Available at: <https://hoffmanncentre.chathamhouse.org/article/driven-to-extraction-can-sand-mining-be-sustainable/> (Accessed: August 9, 2019); UNEP (2019): *Sand and sustainability: Finding new solutions for environmental governance of global sand resources*. Available at: <https://www.unenvironment.org/news-and-stories/press-release/rising-demand-sand-calls-resource-governance> (Accessed: August 9, 2019).

<sup>27</sup> Ibid.

<sup>28</sup> Brown, O. & Peduzzi, P. (2019): Driven to extraction: Can sand mining be sustainable?, *Chatham House*. Available at: <https://hoffmanncentre.chathamhouse.org/article/driven-to-extraction-can-sand-mining-be-sustainable/> (Accessed: August 9, 2019).

<sup>29</sup> Ibid.

<sup>30</sup> Lehne, J. and Preston, F. (2018): Making concrete change: Innovation in low-carbon cement and concrete, *Chatham House*. Available at: <https://www.chathamhouse.org/publication/making-concrete-change-innovation-low-carbon-cement-and-concrete> (Accessed: August 9, 2019); UNEP (2019): *Sand*

calculated that international sand and gravel trade was most actively pursued between the following regions in 2017:<sup>31</sup>

- |                                   |                 |
|-----------------------------------|-----------------|
| 1. United States to Canada        | USD 268 million |
| 2. China to Hong Kong SAR         | USD 183 million |
| 3. Germany to Netherlands         | USD 152 million |
| 4. United Arab Emirates to Kuwait | USD 140 million |
| 5. Netherlands to Belgium         | USD 135 million |

What is salient about the above trade flows is that even in international trade, sand and gravel is transported over relatively short distances, oftentimes moving between neighboring countries and regions. Yet cases such as Dubai's and Singapore's import of foreign sand proves that long-distance trade can occur as well.

## The Political Dimension of Sand Use

Sand extraction and sand consumption can create political tensions among states, either when states reclaim vast areas of land, thereby threatening regional rivals, or when states amass large volumes of externally imported sand, reducing the land and resources of other states.

A case in point is China's strategic expansion of control in the South China Sea, where incidents of saber-rattling between China and rivals such as the United States and regional neighbors like Vietnam, Taiwan or the Philippines have created tension. The South China Sea is a strategically vital area not only from a military standpoint but also from an economic standpoint, harboring vast reserves of natural resources such as oil and gas. Asserting its power in the region, China has built numerous artificial islands in the disputed sea on which military bases have been established. The

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***and sustainability: Finding new solutions for environmental governance of global sand resources.***

**Available at:** <https://www.unenvironment.org/news-and-stories/press-release/rising-demand-sand-calls-resource-governance> (Accessed: August 9, 2019).

<sup>31</sup> Chatham House (2018): *resourcetrade.earth: Sand and gravel*. Available at:

<https://resourcetrade.earth/data?year=2017&category=149&units=value> (Accessed: August 12, 2019).

U.S. Department of Defense reported in 2017 that China had reclaimed 3,200 acres (13 million square meters) of land in the Spratly Islands group in the South China Sea – a fiercely disputed zone – by the end of 2015.<sup>32</sup> The sand to erect these artificial islands was mined from the bottom of the sea, alerting not only the U.S. and its Pacific allies for security reasons but also marine biologists around the world since China covered expansive stretches of coral reef with sand for construction.<sup>33</sup>

Another case in point is Singapore, which has imported enormous amounts of sea sand from neighboring states for its ambitious land reclamation projects. This development has raised tensions with its larger neighbors Indonesia, Vietnam, Malaysia, Cambodia, and Thailand, which provided the city-state with large amounts of illegally extracted sand. While Singapore reported that it had imported 3 million tons of sand from Malaysia in 2008, Malaysia's government claimed that the amount had in fact reached 133 million tons, most of which was allegedly sourced from illegal transfers.<sup>34</sup>

## Illegal Sand Mining and Sand Mafias

Gaining access to sand and extracting it is a relatively simple matter. This oftentimes results in illicit sand mining and the formation of 'sand mafias', which are organized gangs and syndicates that do not possess mining licenses and profit from black market sand trade. These organizations sometimes even resort to violence and other criminal acts, controlling locals, threatening investigative journalists, and bribing the police. Criminal gangs that extract sand illegally have become an issue in numerous countries worldwide, including India, Morocco, Jamaica, Nigeria,

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<sup>32</sup> U.S. Department of Defense [DoD] (2017): *Annual report to congress: Military and security developments involving the People's Republic of China 2017*. Available at: [https://dod.defense.gov/Portals/1/Documents/pubs/2017\\_China\\_Military\\_Power\\_Report.PDF](https://dod.defense.gov/Portals/1/Documents/pubs/2017_China_Military_Power_Report.PDF) (Accessed: August 12, 2019).

<sup>33</sup> Beiser, V. (2018): The secret ingredient to China's aggression? Sand, *New York Times*. Available at: <https://www.nytimes.com/2018/07/31/opinion/china-spratly-islands-sand.html> (Accessed: August 12, 2019).

<sup>34</sup> Tweedie, N. (2018): Is the world running out of sand? The truth behind stolen beaches and dredged islands, *The Guardian*. Available at: <https://www.theguardian.com/cities/2019/feb/25/concrete-the-most-destructive-material-on-earth> (Accessed: August 9, 2019).



Kenya, and Uganda. Illegal sand mining impacts the lives and sustenance of locals, the ecosystems of extraction sites, the construction industry, as well as revenue for national economies.

Illegal sand mining is a particularly grave issue in India, where demand for the resource is high and mafias seize the opportunity to partake in the lucrative business. In their hunt for profit, sand mafias in India have killed journalists and police officers who attempted to stop their activities. Indian journalist Jagendra Singh was investigating the connection between criminals, the police, and politicians in illegal sand mining activities in northern India when he was killed by members of a sand mafia in June 2015.<sup>35</sup> Similar cases of murder have been reported ever since.

Stopping illegal sand mining and sand mafias in India is a major challenge since the intricate involvement of businesses, local politicians, and the local police inhibits such efforts. Illicit sand miners threaten or bribe officials to either keep them out of their business or involve them in their business.<sup>36</sup> For instance, police authorities may receive royalties from illicit sand mining, which can inflate the price of a truckload of river sand from approximately USD 210 to between USD 560 and USD 1,100.<sup>37</sup> India's government took steps to investigate illegal sand mining in 2013, sending a fact-finding mission from the Ministry of Environment and Forests. The delegates discovered that the extent of illegal, unregulated sand mining was serious across Gautam Buddh Nagar district close to New Delhi.<sup>38</sup> Another step that India's government has taken to advance the regulation of sand mining in the country was the establishment of the National Green Tribunal in 2013, which settles legal matters regarding illegal sand mining.<sup>39</sup> This tribunal gives citizens the opportunity to file a complaint about illegal sand mining activities that can harm the environment and negatively affect

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<sup>35</sup> Watts, J. (2019): Jagendra Singh: The Indian journalist burned to death, *The Guardian*. Available at: <https://www.theguardian.com/environment/2019/jun/17/writing-truth-weighting-heavily-on-my-life-murder-jagendra-singh> (Accessed: August 12, 2019).

<sup>36</sup> Beiser, V. (2015): The deadly global war for sand, *Wired*. Available at: <https://www.wired.com/2015/03/illegal-sand-mining/> (Accessed: August 9, 2019).

<sup>37</sup> Salopek, P. (2019): Inside the deadly world of India's sand mining mafia, *National Geographic*. Available at: <https://www.nationalgeographic.com/environment/2019/06/inside-india-sand-mining-mafia/> (Accessed: August 9, 2019).

<sup>38</sup> Beiser, V. (2015): The deadly global war for sand, *Wired*. Available at: <https://www.wired.com/2015/03/illegal-sand-mining/> (Accessed: August 9, 2019).

<sup>39</sup> National Green Tribunal of India (n.d.): *National Green Tribunal Homepage*. Available at: <http://www.greentribunal.gov.in/history.aspx> (Accessed: August 12, 2019).



the preservation of forests and natural resources. Yet despite such efforts to inflict penalties on illicit sand mining, the illegal sand business appears to continue thriving in India.

## Sand Mining Regulations and Compliance

Sand mining is commonly regulated on the national and sub-national level through the establishment of mining and environmental protection laws. Some countries have also adopted national legislation to protect the domestic market and national businesses. The U.S., for instance, enforced a national legislation that allows only domestic companies to extract marine sand, and market leader Great Lakes Ltd has a big stake in this domestic market. Similarly, only a small number of companies provides the UK with sand aggregates, demonstrating that the UK also seeks to control its domestic market.<sup>40</sup>

National regulations, however, can also be comparatively underdeveloped in many countries across the world, but particularly in developing countries.<sup>41</sup> Even if states adopt legislation on sand mining and environmental protection, adherence to these legal regulations may fall through when enforcement is weak on the local level, and the destructive impact of unregulated mining on the ecological, geological, and hydrological condition of a mining site is disregarded. The UNEP reports that many countries have restricted mining at lakes, rivers, or beaches, but enforcement is oftentimes thwarted by corruption, a lack of monitoring, and limited resources to hold offenders accountable.<sup>42</sup> Therefore, understanding and acknowledging the risks and regulations of sand mining is critical at the smallest administrative levels in order to ensure safe and legal sand mining practices.

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<sup>40</sup> UNEP (2019): *Sand and sustainability: Finding new solutions for environmental governance of global sand resources*. Available at: <https://www.unenvironment.org/news-and-stories/press-release/rising-demand-sand-calls-resource-governance> (Accessed: August 9, 2019).

<sup>41</sup> Beiser, V. (2015): The deadly global war for sand, *Wired*. Available at: <https://www.wired.com/2015/03/illegal-sand-mining/> (Accessed: August 9, 2019).

<sup>42</sup> UNEP (2019): *Sand and sustainability: Finding new solutions for environmental governance of global sand resources*. Available at: <https://www.unenvironment.org/news-and-stories/press-release/rising-demand-sand-calls-resource-governance> (Accessed: August 9, 2019).

Globally, greater awareness for adequate sand governance should be promoted to improve legal frameworks and enforcement mechanisms and to ensure that all stakeholders in the sand supply chain maintain sustainable practices. Furthermore, improved tracking of sand extraction and consumption levels to create transparency can additionally help in strengthening good sand governance worldwide. These approaches can limit illegal activity and minimize negative implications for the environment. Finally, urban planners and construction businesses should seek ways to improve sustainability and develop alternative construction materials in times when growing urbanization risks the depletion of global sand resources in the long-term future.

## Environmental Risks

An excessive extraction of sand can incur several risks, including negative implications for the natural environment, ecosystems at mining sites, biodiversity, fisheries, and local communities. Ecosystems can suffer from excessive mining activity, resulting in disruptions in rivers, deltas, coastlines, and oceans. Sand mining can decrease water levels in rivers and result in water shortages; pollute clean (drinking) water because of stirred up sand particles and mud; damage coral reefs and sand banks; erode beaches; cause subsidence and landslides; and put workers at risk of drowning when they scoop sand from river beds.<sup>43</sup> Particularly riverbeds that are drying out are a substantial risk for local communities, which depend on rivers and lakes for their sustenance and for watering their crops and fields. In addition, negative effects on the subsistence of local populations are exacerbated by the impact of climate change, which causes droughts, storms, and floods.

Organisms such as fish, turtles, and crocodiles that live in rivers, lakes, and oceans suffer when the dredging of sand alters or destroys their habitats. Clouded water can block sunlight, which

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<sup>43</sup> Tweedie, N. (2018): Is the world running out of sand? The truth behind stolen beaches and dredged islands, *The Guardian*. Available at: <https://www.theguardian.com/cities/2019/feb/25/concrete-the-most-destructive-material-on-earth> (Accessed: August 9, 2019); UNEP (2019): *Sand and sustainability: Finding new solutions for environmental governance of global sand resources*. Available at: <https://www.unenvironment.org/news-and-stories/press-release/rising-demand-sand-calls-resource-governance> (Accessed: August 9, 2019).

negatively affects underwater vegetation, and can suffocate fish.<sup>44</sup> Furthermore, sand mining can impact hydraulic conditions of river water, influencing the movement of fish and the availability of habitat.<sup>45</sup> The destruction of fish habitat and breeding grounds also directly affects local populations, which rely on fisheries for their livelihoods.

## Risks to Construction

Irresponsible sand mining also affects the construction industry. When large amounts of sand are dredged from riverbanks, the foundations of bridges and other structures are exposed and weakened. Bridges in India have reportedly collapsed due to sand mining. In one of these incidents, a bridge across Savitri river close to Mahad city collapsed in 2016, and in another incident, the Mukkombu regulator dam and a bridge across Kollidam bridge in Tiruchirappalli collapsed due to illegal sand mining in 2018.<sup>46</sup> Such infrastructure damage can pose a financial burden for either businesses, insurance companies, or taxpayers. Therefore, illegal or irresponsible sand mining harms not only the environment but can also result in financial costs when infrastructure becomes unstable and is at an increased risk of collapse.

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<sup>44</sup> Beiser, V. (2017): Sand mining: The global environmental crisis you've probably never heard of, *The Guardian*. Available at: <https://www.theguardian.com/cities/2017/feb/27/sand-mining-global-environmental-crisis-never-heard> (Accessed: August 9, 2019).

<sup>45</sup> Koehnken, L. (2018): Impacts of sand mining on ecosystem structure, process & biodiversity in rivers, *World Wildlife Fund* [WWF]. Available at: [https://d2ouvy59p0dg6k.cloudfront.net/downloads/sand\\_mining\\_impacts\\_on\\_world\\_rivers\\_final.pdf](https://d2ouvy59p0dg6k.cloudfront.net/downloads/sand_mining_impacts_on_world_rivers_final.pdf) (Accessed: August 12, 2019).

<sup>46</sup> Times of India (2016): Illegal sand mining eroded Savitri bridge foundation, led to collapse, *Times of India*. Available at: <https://timesofindia.indiatimes.com/city/mumbai/Illegal-sand-mining-eroded-Savitri-bridge-foundation-led-to-collapse/articleshow/53548289.cms> (Accessed: August 12, 2019); Times of India (2018): Raja: Collapse of regulator, bridge due to sand mining, *Times of India*. Available at: <https://timesofindia.indiatimes.com/city/trichy/raja-collapse-of-regulator-bridge-due-to-sand-mining/articleshow/65546425.cms> (Accessed: August 12, 2019).

## Alternative Materials

In order to reduce current sand and gravel consumption levels, viable solutions must be sought. Firstly, preventing an unnecessary overconsumption of sand is one approach to smart resource management. Secondly, alternative materials to substitute sand should be sought and used in order to reduce associated risks of sand mining and consumption. The UNEP suggests several alternative methods and materials to limit the extraction of sand. These include recycled concrete from waste asphalt, recycled waste composites from construction sites, foamed concrete, geopolymer concrete, and other mixed materials for concrete such as fly ash, steel slag, coconut shells, sawdust, or crushed tiles.<sup>47</sup> Central factors that must be taken into consideration in the search for alternative materials and compounds are their durability, accessibility, safety, carbon dioxide emissions during production, and cost.

## Strategic Summary

### Strengths

- Sand mining constitutes a financially viable business opportunity because extraction is relatively easy and affordable. While large companies use excavators that can extract several thousand tons per day, sand can also be mined with simple equipment such as shovels and carts, granting smaller companies business opportunities in domestic markets.
- The world population and urban areas will continue growing, according to forecasts for the next few decades. This means that countries across the globe will demand increased amounts of sand and gravel aggregates in order to expand infrastructure and drive urbanization forward. Therefore, sand will remain a crucial natural resource around the world and in developing countries in particular. Above all, Asia will become a major sand consumption hub, and China's and India's demand will remain high.

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<sup>47</sup> UNEP (2019): *Sand and sustainability: Finding new solutions for environmental governance of global sand resources*. Available at: <https://www.unenvironment.org/news-and-stories/press-release/rising-demand-sand-calls-resource-governance> (Accessed: August 9, 2019).

- While sand trade is largely a domestic affair because of the volume and bulkiness of sand, which drives up transportation costs, projections forecast a slight increase in international sand trade activities in the future.

### Weaknesses

- Sand is a mostly nationally traded commodity and breaking into national markets can prove difficult because of rigorous regulations. In the U.S., for instance, national legislation permits only domestic companies to extract marine sand. Similarly, the United Kingdom procures its sand from only a small number of businesses to control its market.
- Even if licenses must be officially obtained in order to start mining operations, compliance can be low in some countries, and companies may extract more sand than they are in fact permitted. This fosters illegal mining activity and creates unregulated competitiveness.
- Sand trade can produce international tension among states and result in trade restrictions, particularly between those with a strong demand for the natural resource such as China, India, Singapore, or Dubai and those that deliver the resource such as Indonesia, Malaysia, Vietnam, Cambodia, or Thailand. Strategic land reclamation to assert power in a disputed sea also adds to political tension between states, as the case of China's building of artificial islands in the South China Sea for military purposes demonstrates.

## Tactical Breakdown

### Strategic

- Sand is a global key resource, but weak regulations or enforcement foster illegal mining activity. Furthermore, there are fewer international trading opportunities as compared to other natural resources like oil and gas.
- Sand mining is at a risk of overconsumption. While sand is available in abundance, it is a finite resource. Therefore, sand use should be managed accordingly, particularly since not all sand is suitable for construction. Conflicts and competition over sand as a diminishing resource can be a likely future scenario.

- Overconsumption of sand can negatively affect ecosystems, particularly regarding rivers, lakes, and oceans, as well as fisheries, and the livelihoods of local people.

### Operational

- Interference from sand mafias and illegal sand mining can disrupt the operation of businesses that adhere to legal regulations on sand extraction, processing, and trading.
- Sand mining companies may struggle with maintaining business as sand reserves diminish. In order to prevent risks of business failure, sand mining companies may seek alternative materials to keep selling products to construction companies.
- If sand mining on beaches is so excessive that state governments acknowledge the negative impact this has on the national tourism industry, then businesses may anticipate more rigorous sand mining regulations as governments seek to protect revenue coming from tourism.

### Financial

- Since sand is ubiquitous in modern society, global sand mining and trade is a relatively lucrative USD 60 billion business and will remain so in the coming years.
- If sea sand is not processed adequately through desalination, constructed buildings are at risk of collapse. This will result in a financial loss for related construction businesses, insurance companies, or taxpayers.
- Irresponsible mining activities can also risk the collapse of bridges and other buildings if foundations are exposed and become unstable.

### Compliance

- Establishing legal regulations and control of sand markets globally constitutes a considerable challenge. Countries may have adopted national legislations on sand mining, but they may require improvement.
- Particularly, adequate enforcement and accountability are major stumbling blocks for numerous countries such as India or Morocco, where illegal sand mining is distorting revenues for national economies. Ensuring enforcement and adherence to the law at the

national as well as the local level must be a focus since bribery and violence can be a common practice among sand mafias.

- Awareness for the importance of improving legal frameworks must be raised globally. Sand may be underestimated in its economic value and its susceptibility to risk. Implications for the environment, the construction industry, local communities, and global population growth must be taken into consideration to create suitable regulatory frameworks for sand mining.

## Conclusion

The value of sand as a finite resource may be often ignored or overlooked. Nonetheless, however abundant the resource may appear, the natural corrosion of stone into gravel and fine grain takes thousands of years. At current consumption levels, sand reserves are at risk of depletion in the long-term future. As an indispensable commodity for the construction industry, conflict and tension over remaining sand resources may become a central risk if viable alternatives for sand and gravel aggregates are not available in the future. As the global population growth continues to strain cities and drive urbanization across the world, diminishing sand resources carry devastating implications. However, considering that innovators are already looking for alternative solutions for the construction industry, future outlooks may appear less bleak.

Vital components in managing global sand resources are strengthening legal frameworks, standards, and regulations; guaranteeing the enforcement of such laws; and supporting accountability mechanisms to combat illegal sand mining. Monitoring sand extraction volumes and recording consumption levels can further facilitate sustainable sand management. Finally, good sand governance also requires that all stakeholders in the sand supply chain gain an adequate understanding of the various risks of sand mining, sand utilization, and overconsumption. Finally, legal safety nets, improved monitoring, and resourceful alternatives for sand can alleviate the silently but gradually mounting sand crisis.



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