Climate Notes: Is Sand Running between Our Fingers?

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Sand seems to be the epitome of a plentiful resource. On closer examination, however, this highly important raw material turns out to be limited and precious; and must be handled carefully and in a sustainable manner. The results of excessive sand depletion range from a loss of biodiversity to a negative impact on the climate and geopolitical implications, to name just a few outcomes. In other words, sand is a far more exciting study subject than it appears at first glance.

Sand is created by the erosion of rock, which is broken down into particles by wind, water and ice and transported, sorted and deposited again. Sand is defined geologically and mineralogically as being composed of particles of naturally formed loose rock with a grain size diameter of between 0.063 and 2 mm. By contrast, particles that are more or less round and have a diameter of between 2 and 63 mm, are described as gravel. For simplicity's sake both categories are referred to as 'sand' below (HLUG 2006).

Sand and gravel are key commodities that have been industrially extracted for almost 200 years. They are used in a very wide range of areas such as, for instance, the glass and electronics sector and the chemical industry, but over 90 percent of sand is used in construction. Sand is mostly removed from river beds and sandpits, but since such resources are becoming increasingly scarce, extraction activities are increasingly shifting to the sea bed and coasts. Interestingly, the most obvious reservoirs of sand, namely deserts, are not considered as stocks of raw material since the shape of sand grains in deserts make them unsuitable for the construction sector (the sand grains are already too round and do not give rise to a sufficiently stable structure when used in cement production). Sand from the sea, by contrast, is very good for making cement, despite the fact that it has to be thoroughly purified of salt to prevent corrosion if steel is set in the cement.

Although sand and gravel are the world's most widely used commodities after water, there is an astonishing lack of detailed statistical data on their extraction and use. Estimates by the United Nations Environmental Programme (UNEP) attempt to come close to the magnitude of worldwide sand use *via* data on global cement production, and produce astonishing figures. Based on statistics on the volumes of cement produced worldwide in 2012 – the 150 countries taken into consideration produced 3.7 billion tonnes of cement in 2012 – UNEP infers that sand consumption in that year must have totalled around 26 to 30 billion tonnes, since the amount of sand required to produce cement is six to seven times as high as the final volume. The amount of cement produced in a single year would therefore be enough to build a cement wall of 27 metres in width and height all the way around the earth's equator (UNEP 2012). Sand consumption is also growing very rapidly, especially due to the growing consumption in booming emerging economies (Figure 1). These developments are illustrated by an astounding trend: China's cement consumption during the period of 2011-2013 was around 40 percent higher than consumption in the United States in the entire 20th century (The Washington Post 2015).

However, we are not only consuming a huge and growing amount of sand, we are also negatively impacting its creation and the transport of sand in rivers with our major interference in countryside structures, whether this be *via* agriculture, land clearance or the construction of large reservoirs. The construction of dams in particular has proven an increasingly important factor in lower sand transport over the last 50 years: dams form sediment traps where large quantities of sand collect. The sediment flows of large Chinese rivers have fallen over the last 50 years as a result of dam construction from around 1,800 million tonnes (Mt) to just 370 Mt of sediment (Gupta *et al.* 2012). The Nile can be cited as another well-known

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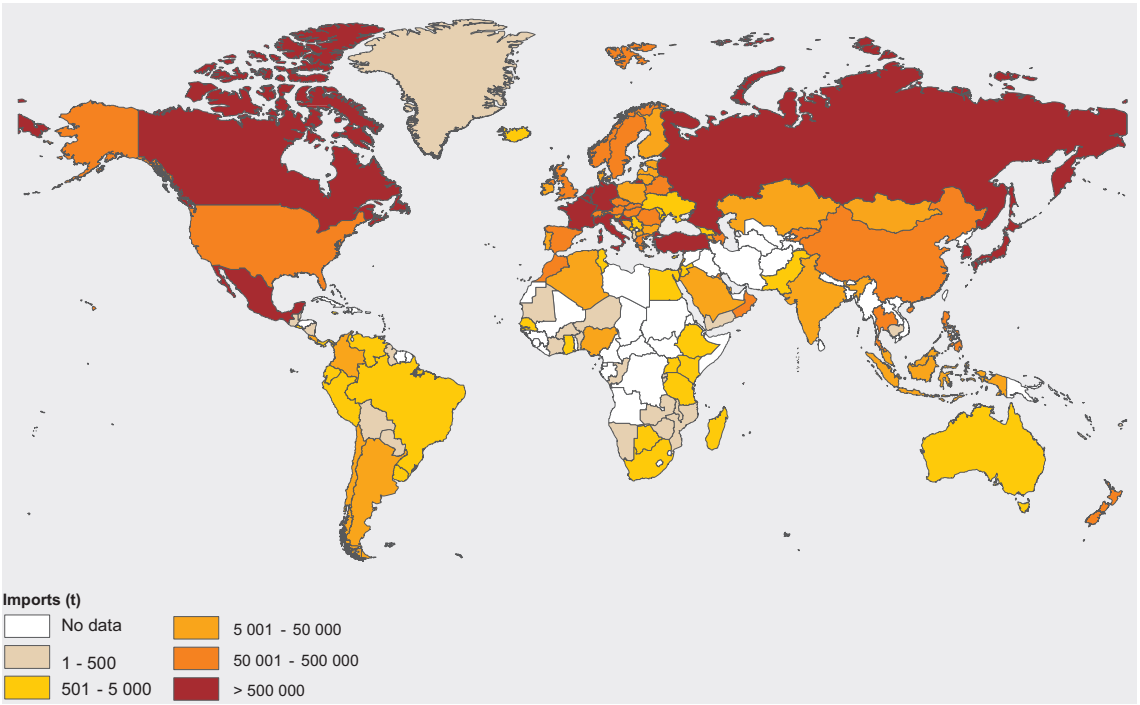
Figure 1

Imports of Sand 2013



Source: UN Database 2015.

example, whose sediment load fell from around 100 million tonnes per year to almost zero due to the construction of the Assuan reservoir (UNESCO 2009). Such extensive and far-reaching interventions in sand circulation cannot be without ecological consequences. Such excessive sand depletion can have a negative impact on water circulation, for example, since ground water formation may fall as a result of riverbed dredging. Moreover, contamination often occurs through oil or the penetration of salt water from nearby coastal waters. Thanks to changed streams and sediment patterns, interventions in riverbeds and/or the sea bed can also lead to changes in the composition of ecosystems, as well as to the destruction of the habitats for many species (Mattamana *et al*. 2013). Moreover, the extraction, transportation and use of such huge volumes of sand is also linked to high energy use and CO_2 emissions.

Another key point is the potential threat through erosion from excessive sand depletion, which is particularly acute for coasts and islands; and the progressive loss of land, as well as dwindling protection against natural catastrophes like floods and storms. Indonesia provides a particularly impressive example of the serious consequences that unchecked sand depletion, and the land losses that accompany it, can have. Indonesia – a large archipelago consisting of 17,500 islands – is highly vulnerable to both natural catastrophes, which are having a stronger impact due to climate change, and to human ecological interventions with serious consequences. For a long time Indonesia was a major supplier of sand and gravel for Singapore, whose construction boom absorbed huge volumes of landfill and construction material. Singapore, which is small in terms of its area, but very strong economically and densely populated, has put a great deal of effort into expanding its surface area with land reclamation; and has gained an additional 20 percent in surface area over the past 40 years thanks to this technique. The extensive removal of sand from the Indonesian coast has led to the disappearance of at least 24 small islands over the last ten years, and to changes in the state borders between Indonesia and Singapore, resulting in border disputes (New York Times 2010). Indonesia attempted to stop the sand removal with an export ban, which it even tried to reinforce by deploying its navy. However, with global demand for sand remaining high, illegal sand removal continued and organisations, in some cases criminal, formed in Indonesia – and in other countries like Cambodia, India or Morocco for example – which are prepared to satisfy this demand at almost any cost. Whole beaches regularly disappear in short periods of time, transported off in trucks and baskets to building sites worldwide.

In view of the problems outlined above, what measures can be called for? Firstly, efforts must be made to

raise awareness of the problem, which could partly be achieved by creating a far better database. In addition, sand must be treated more rationally as a resource *via*, for example, the recycling of old cement and the use of sedimentary deposition near reservoirs as a commodity resource. A scientifically-based, transparent regulation of sand use is also needed, along with suitable pricing mechanisms for sand and its management as a resource.

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