Title
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Journal
Electronic Green Journal, 1(47)

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Publication Date
2022

DOI
10.5070/G314756548

Electronic Green Journal
Volume 1, Issue 47

Reality Check on a Purported Global Sand Shortage
Sensationalism Extrapolated From Isolated Occurrences to Global Phenomena

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Abstract

This essay presents how an almost sidebar reference in the back pages of a book, became the topic of a highly promoted documentary on the alleged shortage of a certain type of sand and grew into "conventional wisdom" that the world is confronted with a general sand shortage. Research for this article demonstrates how a story can be blindly repeated until it becomes considered conventional wisdom and how sensationalism about what is commonly believed to be ubiquitous facilitated the spread of a false narrative. The sand that is the topic of the stories, articles, papers on the global sand shortage topic is not the same "industrial sand" that is used by the fiberglass industry. Relating the alleged global sand shortage, as purported in obscure and seemingly credible media outlets, to the fiberglass insulation manufacturing industry is inappropriate, misaligned and inconsistent with very basic and easy to find facts. While there is an abundance of articles and stories that purport global sand shortages, there are no scholarly articles or scientific facts reported that relate the isolated sand shortages acknowledged in the stories to the use of industrial sand for the manufacture of fiberglass insulation or any other fiberglass product.

Background

Due to the author's education and 35 years' experience as a geologist and knowledge of the nonmetallic mining world, during the past nine years the author received articles or internet links from colleagues that pertain to a purported global shortage of sand. In the years prior to these stories being shared the author performed significant research on the presence of industrial sand resources across North America, South America, Australia and China, so had an in depth understanding of the virtually inexhaustible supply of sand on this planet. The author has also been involved for several years in permitting construction aggregate and industrial sand mines in the United States.

Sand is a mineral grain size as discussed in greater detail in the Sand Technicalities section below. For years, the author brushed off the articles as simply absurd and did not consider the various authors as serious or the stories as science-based. Over the years, the author noticed some of the stories were reported in *The New York Times*, *Smithsonian Magazine*, International Monetary Fund, Public Radio International (PRI), *The Economist*, National Public Radio (NPR), British Broadcast Company (BBC), *Forbes*, ABC Radio, CNBC, and others. There is now a sufficient volume of information available on the internet that the story is taken as fact and conventional wisdom and is used against industries that use sand to create the products relied upon in our everyday lives.

As a direct result of the stories and the implications they represent, fiberglass insulation manufacturers have been told they should not be allowed to operate or obtain permits to open new or expand operations at the expense of the earth's dwindling supply of sand. Because of the direct challenge to the fiberglass insulation industry, the North American Insulation Manufacturers Association (NAIMA) requested that the author address this issue in a technical paper.

Fiberglass has widespread application beyond insulation but nearly all fiberglass is manufactured from a common raw material; silica sand, and to an increasing degree from recycled glass and blast furnace slag and other silicon containing minerals, and the attack on one fiberglass industry affects many other industries. Fiberglass is used in automobile body panels, door skins, and tonneau covers; wind turbine blades; boat hulls and accessories; electrical housings and insulation; building components such as concrete, gypsum boards, bathtubs and shower stalls and mats for ceiling tile, carpet, roofing panels and decks; deep cycle batteries and many other specialized uses.

The author reviewed more than 35 internet posted articles addressing the purported global sand shortage and could have reviewed more. An interesting observation about the articles is that they each basically told the same story. Despite the seemingly credible reporting outlets, and the large number of them across the world that reported on the issue, none included actual citations to the sources of the information presented. As discussed in the following section, the author's research identified what appears to be the genesis of these stories.

The Cause

During the past 20-plus years, we have become both blessed and cursed by the instant access to information. Prior to the internet, research was done in libraries and only academics, scientists and devoted individuals took the time necessary for proper research and vetting of information. With access to the world's libraries on our computers and in our pockets, research can be done thoroughly or in a woefully incomplete manner by anyone with a topic of interest to research. In the case of the purported global sand shortage, the prevalence of the same story by dozens of authors appears to be more associated with sensationalized headlines rather than scientific reporting. Clearly there are genuine challenges with sand sources in some parts of the world, but that in no way translates to a global sand shortage.

We cannot blame scientists for the purported claims and reporting of global sand shortages to the point where some may argue that fiberglass manufacturing should not be allowed. It is reasonable to accept that any geologist can easily verify that the earth will not run out of sand. Individual authors and media companies spread these stories as sensationalized headlines presumably because they make good copy and get shared, retweeted, liked, and whatever other recognition and accolades the spreading of a story benefits an author on social media.

The Sand Story Problem

A search for scholarly articles on the shortage of sand using multiple keywords in more than 50 technical journals, summarized in Appendix 1, identified more than three dozen journal articles potentially relative to the topic. While each of the articles includes sand as the subject matter, none include the discussion on the shortage of the industrial sand used by insulation manufacturers. Keywords used in the scholarly and popular internet search engines included: sand shortage, silica sand shortage, silica sand abundance, fiberglass sand, silica sand endangered resource, bountiful sand, renewable sand, sand genesis, and what is sand.

An internet search using popular search engines using the same keywords referenced above identified an almost endless number of stories, articles, blogs, and papers on the use and shortage of sand. More than three dozen of the opinion pieces were reviewed for this essay. Each of the stories identified were initiated since 2013. Evident in the review is that the genesis of the popular sand shortage story can be traced to the documentary, *Sand Wars* (Delestrac, 2013). The documentary, the auteur's subsequent presentations on the topic, and internet search results referenced above each address construction aggregate and beach sand, and none pertain to the industrial sand used by fiberglass manufacturers. There has never been a claimed shortage of industrial sand or that "the world" was "running out" of industrial sand. The differences between construction sand and beach sand on one hand, and industrial sand on the other, are critical and explained in detail below.

While the origin of the media stories on sand shortage can be attributed to the Delstrac documentary and subsequent 2013 TEDx Barcelona talk, it seems that some of the foundational basis for the issue was derived from a short discussion on international trading and island building in the book: *Sand, the never-ending story* (Welland, 2009). In the book, the author mentions, in less than one page (page 255) of more than 340, many of the claims elaborated by Delestrac and subsequent authors to be a global sand shortage problem. The book states that "the construction boom in China has stimulated massive illegal sand dredging, damaging river systems and increasing flood risk; beaches have all but disappeared from some Hong Kong islands." The book mentions, without citations, the illegal nocturnal smuggling of Indonesian sand into Singapore as the cause for the near disappearance of one Indonesian island. The brief discussion closes with, "Regrettably, illegal sand mining is a criminal, economic, and environmental problem in many parts of the world." The book is a valuable technical resource and, apparently, an unintentional source of information that has been extrapolated from isolated occurrences to global phenomena.

Most of the stories reviewed, including the *Sand Wars* documentary, were clearly written to be alarming without citing the sources of information. It is apparent that the sand shortage story "fits all too conveniently into a chronic obsession we have with the idea that the world is running out of stuff" (Kirby, 2016). While the stories may be intended to bring a legitimate concern to the public conversation, they do nothing to focus on facts or offer resolution of the problem alarmingly being reported. Renewed searches for sand shortage stories identify a dozen stories and a CNBC news video from 2021 that recycle the same information presented in *Sand Wars* as if it was new. Although billed as a documentary, without citations that can be verified, *Sand Wars* does not necessarily meet the definition found in the Oxford dictionary as “a movie or a television or radio program that provides a factual record or report.”

The documentary and many stories also focus on the irony of importing sand to places like Dubai and Saudi Arabia and cite that as a reason for concern, as if the abuse and misuse of sand have created a controversy worth reporting. Nearly every country imports and/or exports sand, including those in the Middle East and Persian Gulf. There are many specialty sands that are not found everywhere but are used universally. Although sand is commonly traded, the Observatory of Economic Complexity (OEC) reports that in 2019, sand represented 0.011% of total world trade and was the world's 740th most traded product, with a total trade of $1.91B (Observatory of Economic Complexity, 2019).

Fiberglass manufacturers are not contributing to the issue described by the non-scientific opinion pieces initiated by the *Sand Wars* documentary. The sand shortage issue, as purported in *Sand Wars* and picked up by others, has no relevance to the industrial sand sources mined and/or used in North America. Ironically, none of the “sand” occurrences or types discussed in *Sand Wars*, the media stories, or other related articles are the same “sand” used by the fiberglass industry and insulation manufacturers in North America. As described below, it is truly as simple as that. Similarly, *The Time of Sands, Quartz-rich Sand Deposits as a Renewable Resource,* (Shaffer, 2006), provides fact-based reporting on the genesis, abundance and use of sand that effectively counters the shortage purported by others.

Construction Aggregate

The purported sand shortage issue presented in the *Sand Wars* documentary and subsequent articles pertains to isolated areas of coastal erosion, removal and relocation of sand from the oceans and rivers, the blocking of river sediment by the world’s dams; and the use of sand for construction aggregate to build islands, expand coastlines, replenish beaches, and construct roads and buildings. In each instance, the “sand” that is the subject of the story is construction aggregate, again, not the “industrial sand” used to manufacture fiberglass in the United States.

Construction aggregate is the most common of all the minerals removed from the ground and manipulated to establish a higher quality of life and standard of living. Human history and the formation of civilization and society evolved by utilizing the locally available natural resources to create infrastructure to improve and sustain the quality of life. A key trademark of the earliest civilizations, and every subsequent civilization, is the presence of roads created from local construction aggregate. The rationale for the construction of those roads thousands of years ago was no different than today - to build the foundation for a sustainable society. Our modern society travels, works, lives on, and is surrounded by construction aggregate. Modern life would be impossible without reliance upon construction aggregate and other minerals mined from the earth. Many people go about their daily lives and rarely step beyond construction aggregate that was extracted, processed, transported, and placed beneath their feet. The local sand, gravel, and rock, and the land where they are extracted are not destroyed or consumed, they are merely transformed sustainably for the benefit of the community and remain available for use and, if necessary, reuse.

Construction aggregate has not changed much since the ancient Sumerians built their first roads; they are primarily clay, sand, gravel, and stone. Construction aggregates also include sand dredged from the ground, ocean and rivers; seashells; and caliche. Additionally, construction aggregate includes byproducts of our modern industrial society such as steel slag, coal ash, foundry sand, and a wide variety of recycled materials such as concrete, asphalt pavement, ceramic, brick, and roofing shingles.

The production of construction aggregate involves the quarrying of sand and gravel broken by natural forces of water and/or glaciers over eons, or a process of making little rocks from big rocks by quarrying bedrock through drilling, blasting, and crushing. The ultimate sources of most construction aggregate are the oldest bedrock on the planet, the 1- to 2-billion-year-old igneous rock that cooled deep in the earth, and metamorphic rock. Eventually, the bedrock was exposed to climate and weathered into gravel, sand, and finer-grained minerals that settled in the oceans and transformed into sandstone, limestone, dolostone, siltstone and mudstone.

Quality construction aggregate is not present everywhere. Many areas benefit from widespread aggregate reserves relative to other parts of the world where quality aggregate is rare or nonexistent. The mountainous regions benefit from exposed bedrock uplifted into mountains of solid rock. Other areas benefit from river and glacial deposits of sand and gravel. Other areas have limited supplies of aggregate and must make do with what is available or pay significantly higher prices to import aggregate in large volumes using ships, trains, trucks or mules, or excavate deep underground.

Many areas are “aggregate rich,” with different types of low-cost sand, gravel, and bedrock accessible. The availability of locally sourced construction aggregate has a major impact on the cost of all construction, compared to locations where quality construction aggregate may need to be transported hundreds or thousands of miles to construction projects. The articles on the shortage of sand pertain to challenging areas of the planet where some view mining practices as questionable and have social and economic impacts on the population by mining beaches, mining streams, stealing from neighbors, illegal dredging, smuggling, sand mafias, etc. The stories have no relevance to North America and no relevance to fiberglass insulation manufacturers that use industrial sand.

Industrial Sand

Sand has been mined for industrial processes across North America for more than a century. In contrast to construction aggregate, industrial sand used to manufacture fiberglass is fine grained (and may be ground to a coarse powder) and 98 to 99+ percent quartz, essentially pure silica (silicon dioxide, SiO_2), with strict specifications that limit impurities such as iron. Industrial sand is often present as sandstone bedrock and if derived from sandstone, must be drilled, blasted, and further processed to liberate the individual sand grains. Some industrial sand is mined by excavation or dredging deposits of sand that were eroded from sandstone and is present in loose form that does not need to be drilled or blasted. Referred to as silica sand or industrial sand, it is used for a variety of essential industrial purposes in its pure form or mixed with other minerals, including the manufacture of fiberglass, glassmaking, metal production, cores and molds to make metal castings, paper, medicines, fertilizer, cleansers, cosmetics, and food additives; bedding for livestock; filtering drinking water; and hydraulic fracturing, a technique used in oil and natural gas production. None of the articles on the shortage of sand pertain to industrial sand.

In recent years, the use of silica sand as a proppant for hydraulic fracturing using horizontal drilling techniques has been the largest factor driving growth in the industrial sand market. Industrial sand, commonly referred to as “frac sand” when used as a proppant, is crucial to the process of recovering oil and natural gas from shale, tight sandstones, and other unconventional gas- and oil-containing rock formations. The growing demand for frac sand has led to an increase in volume and value of industrial sand mined and processed in the United States.

Before the rapid growth of hydraulic fracturing, industrial sand was a relatively small market. In 2005, for example, United States Geological Survey (USGS) data indicate 31 million metric tons of industrial sand were mined in 35 states. That sand was valued at $700 million, averaging roughly $22.6 per metric ton. Approximately 35 percent was used for glassmaking, 19 percent at foundries, 12 percent in hydraulic fracturing using vertical drilling techniques, and 10 percent in the construction industry (USGS, 2006). Use of the remaining 24 percent is spread amongst hundreds of industries, including food, consumer products, plastics, and fiberglass manufacturing.

By contrast, in 2018, 121 million metric tons of industrial sand and gravel were mined in the United States, nearly 4 times more than just a few years prior, and the sand was valued at nearly $7 billion (USGS, 2021). Hydraulic fracturing, not the glassmaking industry, is the leading use for industrial sand, as 72 percent of the sand mined in 2018 was used for hydraulic fracturing and well-packing. Based on voluntarily reported data from sand producers and users, 9.7 percent of the industrial sand mined in 2018 (11.7 million metric tons) was used for glassmaking. The amount of sand reported for fiberglass was 0.5 percent, less than 1 million metric tons (USGS, 2021). Some data obtained by the USGS for their Mineral Yearbook reports is withheld by producers and users to avoid disclosing company proprietary data so the data reported is incomplete. Because of the market diversity the USGS data does not distinguish the various fiberglass end uses.

Sand Technicalities

The diversity of sand on earth is because scientifically, sand is defined by its size, not its composition. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) provides a comparison chart of particle gradation scales for earth materials with the following comparisons (USDA, 2012):

1. The Unified Soil Classification System (USCS), generally adopted by the American Society for Testing and Materials (ASTM) in standard D2487 “Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System),” defines fine sand to range from 0.075 millimeters (mm) to 0.425 mm, medium sand to range from 0.425 mm to 2 mm, and coarse sand to range from 2 millimeters (mm) to 4.76 mm.
2. Per ASTM D2487, sand is defined as: “particles of rock that will pass a No. 4 (4.75-mm) sieve and be retained on a No. 200 (75-μm) US standard sieve…” Section 3.1, subsection 3.1.6.

3. The American Association of State Highway and Transportation Officials (AASHTO) defines fine sand to range from 0.074 mm to 0.425 mm and coarse sand to range from 0.425 mm to 4.76 mm.
4. The American Geophysical Union (AGU) and USDA define very fine sand to range from 0.0625 mm to 0.125 mm; fine sand to range from 0.125 mm to 0.25 mm, medium sand to range from 0.25 mm to 0.5 mm; and coarse sand to range from 0.5 mm to 2 mm.
5. Udden-Wentworth Classification system (Udden, 1914; Wentworth, 1922), define very fine sand to range from 0.0625 mm to 0.125 mm; fine sand to range from 0.125 mm to 0.25 mm; medium sand to range from 0.25 mm to 0.5 mm; and coarse sand to range from 0.5 mm to 2 mm.

In addition, the Burmister soil classification system (Burmister, 1941), developed in the 1940s, defines fine sand to range from 0.074 mm to 0.25 mm; medium sand to range from 0.25 mm to 0.6 mm; and coarse sand to range from 0.6 mm to 2.0 mm. Some modifications to the system are utilized by certain entities (government or private firms) to increase the size of sand to include particles smaller than 4.75 mm. Additionally, some changes to internal divisions are commonly used in practice.

Particles larger than the ranges provided above are called gravel, cobbles then boulders; and sometimes “stones”. ASTM and the USCS define coarse-grained soils as gravel or sand. Particles smaller than the ranges provided above are generally referred to as silt and clay-sized particles.

In the ASTM and USCS soil classification, “sands” or sand soil are characterized as having 50 percent (by weight) or more of soil particles retained on the No. 200 US standard sieve (referred to as the coarse fraction) and 50 percent or more of the coarse fraction is smaller than 4.756 mm.

The engineering and geologic use of the term “sand” refers to sizes consistent with the general range of sand particle sizes summarized above, as reported by the USDA, ASTM, AASHTO, AGU, Uden-Wentworth and Burmister.

The geologic use of the term “sand” may further characterize sand by its composition, such as silica sand, olivine sand, shell sand, chlorite sand, gypsum sand (White Dunes National Monument is gypsum sand), etc. The geologic use of the term “sand” may be further characterized by its depositional environment or genesis, such as beach sand, dune sand, lacustrine sand, eolian sand, glacial sand, manufactured sand, etc.

Sand can be found across the earth from the mountains to the sea and is so abundant that resources and reserves cannot be quantified. It is washed out of the mountains by streams and deposited along the way in river valleys, lakes and beaches. Historical beaches and adjacent sand dunes along ancient seas 500 million years ago accumulated hundreds, if not thousands, of feet of sand later compressed into sandstone found around the globe. In the Midwestern United States, such ancient beaches are present beneath more than 50,000 square miles of small portions of Wisconsin, Illinois, Minnesota, Iowa, Missouri and Arkansas, in general order of predominance. This sand is generally pure silica, at least 98 to 99 percent, and is the premier industrial sand in the world.

It would be impossible to estimate the volume of sand and beyond comprehension to believe that there is or ever will be a shortage of industrial sand. The only real potential threat to any theoretical industrial sand shortage pertains to the ever-expanding residential encroachment on supplies and challenges associated with permitting new quarries or expansions. In 2014, the Wisconsin Department of Natural Resources reported that there were more than 100 industrial sand operations in Wisconsin, and more than 60 of those were quarries. Railroads transported millions of tons of nonmetallic minerals from Wisconsin, primarily industrial sand. The amount of sand transported from Wisconsin and other Midwest states increased through 2016, then decreased in response due to the use of regionally mined sand in Texas, Oklahoma and elsewhere where much of the imported industrial sand is used for hydraulic fracturing.

The significance of the volume of industrial sand has and can be produced in the Midwest is staggering when compared to the relatively trivial amount of sand used by the North American insulation manufacturers. The annual consumption of industrial sand for insulation manufacturing in the United States is equivalent to or less than the annual production of an average Midwest industrial sand mine.

Recycled glass

Although the amount of industrial sand used annually to make fiberglass insulation is relatively small, increased focus on glass recycling is further reducing sand use. As an alternative to industrial sand, all fiberglass insulation manufacturers are using recycled glass (referred to as cullet) that is crushed, washed and sorted to size and color specifications. Waste 360 reported in 2007, that the majority of recovered glass is made into new glass bottles and that fiberglass is the second largest market (Miller, 2007). In 2016, a single North American fiberglass insulation manufacturer, Owens Corning, reported that they use ½-million tons of cullet annually as a substitute for industrial sand (Karidis, 2016).

In 2021, NAIMA announced (NAIMA, 2021) the results of a survey of members' use of pre- and post-consumer recycled materials in insulation and acoustical products. In 2019 and 2020, NAIMA members used 2.4 million tons of recycled glass and 0.7 million tons of blast furnace slag. Since 1992, NAIMA members have diverted more than 20 million tons of recycled glass and more than 10 million tons of slag from the waste stream. Reliance on recycled glass as a primary ingredient for the manufacture of fiberglass insulation means that there is an essentially endless supply of sustainably sourced glass.

Recycle Across America (RAA) is a 501(c)(3) nonprofit organization dedicated to expediting environmental progress and society-wide standardized labeling system for recycling bins (Galecki, n.d.). RAA reports that more than 28 billion glass bottles and jars end up in landfills every year and equate that as the equivalent of filling up two Empire State Buildings every three weeks, which is 17 times per year - and that is just the waste. If one considers the number of bottles recycled each year (about 30% per USEPA) the Empire State Building equivalent of bottles produced would be more than 25. The volume of the Empire State Building is 37 million cubic feet (Empire State Realty Trust, n.d.). If filled with industrial sand, an average unit weight of 100 pounds per cubic foot would require about 1.9 million tons to fill the building. The equivalent volume of sand used to manufacture fiberglass would fill the Empire State Building once per year, but the amount of waste glass bottles generated annually would fill the building more than 25 times.

Conclusions

In the author's opinion, this essay debunks what the popular internet, news outlets and sensationalizing authors have promoted to become conventional wisdom that the world is confronted with a general sand shortage. The story has gained such widespread acceptance that seemingly reputable news sources blindly promote the story as if it were based on factual research. Relating the alleged global sand shortage to the industrial sand used by the fiberglass insulation manufacturing industry is inappropriate, misaligned and inconsistent with very basic and easy to find facts.

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Appendix 1

The following journals were accessed in late 2021 and searched for scholarly articles, papers and reports on the global shortage of sand.

1. Advances in Civil Engineering
2. Applied Earth Science
3. Building and Environment
4. Canadian Journal of Earth Sciences
5. Cement & Concrete Composition
6. Computers & Industrial Engineering
7. Construction and Building Materials
8. Earth Science, Systems and Society
9. Earth Surface Processes and Landforms
10. Ecological Economics
11. Ecological Engineering
12. Electronic Green Journal
13. Environmental Development
14. Environmental Earth Sciences
15. Environmental Geology
16. Environmental Management
17. Estuarine, Coastal and Shelf Science
18. Facilities
19. Geological Magazine
20. Geography Compass
21. Geological Society of America Bulletin

22. Global Environmental Change
23. Global Research and Development Journal for Engineering
24. International Journal of Advances in Engineering and Management
25. International journal of cement composites and Lightweight concrete
26. International Journal of Earth Sciences
27. International Journal of Earth Science and Geology
28. International Journal of Pavement Engineering
29. International Journal of Science, Environment and Technology
30. International Journal of Sediment Research
31. International Journal of Structural and Civil Engineering Research
32. IOSR Journal of Mechanical and Civil Engineering
33. Journal of Basic and Applied Biology
34. Journal of Cleaner Production
35. Journal of Coastal Research
36. Journal of Earth Sciences and Engineering
37. Journal of Economic Integration
38. Journal of engineering research and studies
39. Journal of Environmental Planning and Management
40. Journal of Geology & Geophysics
41. The Journal of the Geological Society
42. Journal of Industrial Ecology
43. Journal of Infrastructure Systems
44. Journal of Materials Science
45. Journal of multidisciplinary engineering science and technology
46. Journal of Sedimentary Research
47. Journal of Sustainable Development
48. Minerals
49. Nature Sustainability
50. Quarterly Journal of Engineering Geology and Hydrogeology
51. Resources, Conservation and Recycling
52. Sedimentary Geology
53. Sustainability Science
54. Waste Management