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SANDMINING ON OUR COASTS LEAVES NO SAND FOR SANDCASTLES

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YOUNG REVIEWERS:

ANTONIO
AGE: 11

CALEB
AGE: 11

MOMO
AGE: 13

Beaches and coastal dunes have always been a source of sand for various purposes. People used to take only small amounts of sand for personal needs, like building sandcastles or making a volleyball court, but now sand is being taken for big construction projects, too. However, as the sea level rises and storms get stronger, beaches and dunes are more important than ever for protecting our coasts, and each grain of sand should stay there. Removing large amounts of sand for construction projects is called coastal sand mining, and it damages coastal ecosystems, including beaches, dunes, mangroves, and rivers. We must work together to protect the beautiful places we love to visit along the coasts! You can help by raising awareness about sand mining and sharing the solutions described in this article with others.

UNDERSTANDING SAND AND THE COASTAL ENVIRONMENT

SEDIMENT

Particulate material, such as sand, silt, and clay, transported and deposited by water, wind, or ice, forming layers on the Earth's surface.

COASTAL SAND MINING

Removing sand from beaches for construction, which damages ecosystems and shorelines.

EROSION

The process by which natural forces, such as water, wind, or waves, wear away and remove soil, rock, or sediment from one location to another.

The coast is a special place where land and sea meet. Coastal areas are home to many animals and plants that live together in a delicate balance. Coasts are shaped by natural forces like waves, currents, winds, and tides, creating a unique and beautiful environment [1]. Coasts provide vital environmental services such as filtering water, storing **sediment**, and offering habitats for a wide range of species. People also visit coasts for recreational activities like swimming, surfing, and enjoying the scenery. Coastal regions can offer peace and tranquility, drawing many to visit for personal and spiritual reasons.

However, as more people move to live near the coasts, problems arise. Space is becoming limited, and human activities are harming the fragile coastal environment. One significant problem is **coastal sand mining**, which involves removing sand and gravel from beaches, dunes, and riverbeds (Figure 1) [2]. Sand mining is done to meet the growing demand for sand used in construction, but it comes at a high environmental cost. By taking too much sand, we damage the habitats of coastal plants and animals, disrupt the natural landscape, and increase the vulnerability of the coast to **erosion**.

Figure 1

Figure 1

Coastal sand mining involves taking big scoops of sand from beaches, rivers, and cliffs. People do this to get sand for building things like houses and roads. But removing too much sand can hurt the beaches and the animals that live there. Coastal sand mining is a growing problem all around the world, and it is not good for our planet because it makes the beaches smaller, meaning less fun for us and fewer places for coastal animals to live.

Sand forms over thousands or even millions of years from the breakdown of rocks, shells, and other materials. Natural forces like wind, water, and waves grind these materials into smaller grains, creating sand. Interestingly, bacteria and fungi also play a role by releasing chemicals that help break down rocks into sand. Sand is found on beaches, dunes, and riverbeds, and its properties vary depending on where it comes from [3].

WHY IS SAND MINING A PROBLEM?

Taking sand from coastal areas can significantly harm the environment. You might wonder, "Why is this such a big problem if sand is everywhere?". The truth is that not all sand is the same. Sand is categorized based on its shape, size, and composition, and these qualities determine whether it can be used in different industries. For instance, mineral sand contains metals and minerals like magnetite and zircon, which are used in various industries like ceramics production, aerospace and electronics. Aggregate sand, on the other hand, is crucial for construction and is used to make concrete for buildings, roads, and other infrastructure. Sand for construction needs to be angular and rough so that it binds well with cement to form concrete. Desert sand, which has been rounded by the wind over thousands of years, is not suitable for construction because its grains are too smooth, which makes it hard for them to stick together. In contrast, river sand and ocean-beach sand are more angular and better suited for construction.

However, these types of sand are becoming scarce because they are mined extensively for building purposes. Coastal sand is mined not only for use in construction but also for activities like **beach nourishment**, where sand is added to eroding beaches to make them wider. Beach nourishment might sound like a positive solution to erosion, but it is not always **sustainable**. The sand used for nourishment is usually taken from other locations, such as offshore sites or riverbeds, damaging those environments as well.

CONSEQUENCES OF COASTAL SAND MINING

Mining sand from coastal and river areas causes significant damage to the environment. Sand plays an essential role in protecting coastlines. Sand dunes act as barriers against **storm surges**, absorbing the impact of waves and preventing flooding. Beach sand helps dissipate wave energy, reducing the risk of erosion. The removal of sand disrupts beaches, dunes, and riverbanks (Figure 2). By taking sand, we destroy these protective landforms, making coastal areas more vulnerable to natural hazards such as storm waves and rising sea levels.

Additionally, sand mining destroys the habitats of coastal plants and animals. For example, dunes are home to specialized plants that help stabilize the sand, and they also provide shelter for animals like crabs, birds, and turtles. When sand is removed, dune plants lose their habitat, leading to a chain reaction that affects the entire **food web**. Sand removal also impacts underground water systems because sand helps rainwater seep through the ground and recharge **aquifers**. Without this natural filtration system, the water level decreases, making it harder for plants and animals to access the water they need.

BEACH NOURISHMENT

Adding sand to eroding shores to restore beach width.

SUSTAINABLE

Practices that meet present needs without compromising the ability of future generations to meet their own needs, focusing on environmental, social, and economic balance.

STORM SURGE

A temporary rise in sea level caused by strong winds and low atmospheric pressure during a storm, leading to coastal flooding and erosion.

FOOD WEB

The interconnected feeding relationships within an ecosystem, essential for biodiversity and ecological stability.

AQUIFERS

Underground layers of permeable rock or sediment that store and transmit groundwater, supplying wells and springs.

Figure 2

(A) There was a beautiful beach with soft sand and tall dunes. **(B)** But then, people started to mine the sand, digging it up with big machines. **(C)** Sand mining changed the beach, causing significant damage to the dunes. **(D)** Sand mining also affected the underground water, by hydrogeological disruption. **(E)** Mining also destroyed the homes of coastal plants and animals.

The impact of sand mining goes beyond environmental damage. It also causes air pollution due to the dust and emissions from the heavy machinery used in mining. This air pollution not only affects plants and animals but also poses health risks to people living nearby. Moreover, the high value of sand has led to illegal sand mining, which often results in conflicts, law violations, and sometimes even violence, further worsening the problem.

THE SAND JOURNEY

The story of sand starts with rocks (Figure 3). Over time, rocks deep within the Earth can break down into smaller pieces, eventually becoming the sand we find on beaches. This sand can travel a long way, being carried by rivers and wind, until it reaches the coast.

But humans started to interfere with this natural process by taking too much sand from the beaches and rivers. They use large machines, such as excavators and dump trucks, to remove the sand [4]. Even small-scale sand collectors take sand from places where they should not, and this makes things worse.

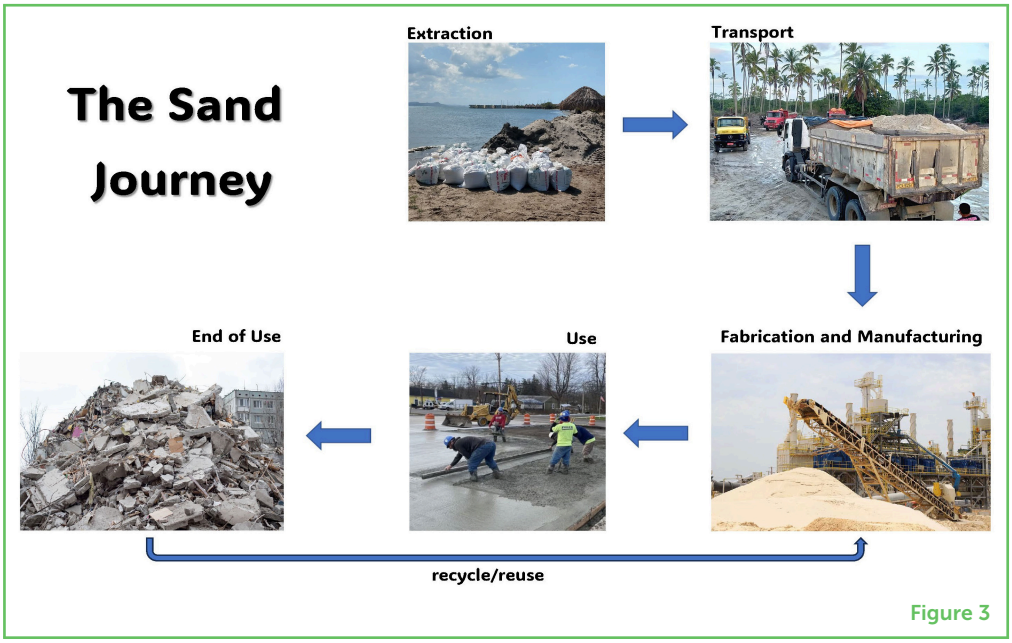

Figure 3

The sand journey begins with rocks, which can break down into smaller pieces over many years, eventually becoming sand. Sand is carried by rivers and wind and ends up on beaches. When people extract (remove) sand from beaches, the sand often gets transported to areas where it is used to make things like roads and buildings. Eventually, it ends up as waste, which can be recycled or reused—although this is expensive.

People need sand for building things, like houses and roads, so they transport it in many ways like ships, trucks, ferries, and carts. They even process the sand to make it better for construction. But the more sand people use, the more they need, and the demand keeps growing. This makes sand very valuable, and countries now export and import it like any other commodity. But the sand cycle does not end when people use it. The sand turns into waste, which can be recycled or reused, but this is hard to do and costs a lot of money.

RIVER SAND FACES SIMILAR THREATS

While coastal sand mining is well known, rivers are also heavily affected. River sand is highly sought after for construction because of its high quality, but riverbeds are often mined unsustainably, causing severe erosion [5]. Rivers play a key role in delivering sediment to the coasts, helping maintain beaches and deltas. However, sand mining, along with the construction of dams that block sediment flow, reduces the amount of sand that reaches coastal areas. This not only affects the rivers but also leads to coastal erosion, as beaches are no longer replenished by river sediments.

Sea-level rise due to climate change also contributes to the erosion of both river and coastal sands. As sea levels rise, the force of waves on the shore increases, speeding up erosion. In response, people often build seawalls and other hard structures to protect their properties, but these barriers can make erosion worse in other areas, potentially worsening the overall situation. Without enough sand, the coastline becomes more exposed to wave action, leading to more significant erosion and loss of land. This is why maintaining healthy sand levels is crucial for the long-term stability of coastal environments.

HOW CAN WE HELP SAVE OUR BEACHES AND DUNES?

With more than 8 billion people in the world, the demand for construction materials is constantly increasing. To protect the environment, we need to find ways to reduce our dependence on natural sand. One way is to use alternative materials in construction. For example, recycled glass can be used as a substitute for sand in concrete. Additionally, crushed rock can be used in some construction applications, reducing the need for natural sand.

Scientists are also exploring creative solutions like using bacteria and fungi to create sand. These microorganisms can break down rocks and minerals, slowly turning them into sand. Although this process is still being researched, it may someday provide a sustainable alternative to sand mining.

By adopting these new methods, we can protect our beaches, dunes, and riverbanks, preserving them for the plants, animals, and people who rely on them. It is crucial to remember that sand is more than just a building material—it is a fundamental part of our environment that plays a critical role in keeping ecosystems healthy. Protecting our sand resources means protecting our coasts and ensuring a better future for all of us. Remember that beaches are where we express our dreams in sandcastles.

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CONFLICT OF INTEREST: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

YOUNG REVIEWERS

ANTONIO, AGE: 11

Antonio is 11 years old, though insists he is almost 12. He enjoys bird watching, recess, lunch, and snack time. Also science and math. In his spare time he likes to draw and watch Naruto.

CALEB, AGE: 11

Caleb enjoys all things science, animals, reading, exploring the outdoors, playing the violin, and curling. When he grows up, Caleb wants to be an architect focusing on eco-friendly and animal oriented buildings. He has tried four sports and is always up for trying something new. Caleb's favorite foods are macaroni and cheese or lasagna. He enjoys traveling and would like to go to an animal reserve.

MOMO, AGE: 13

Momo loves to travel the world and see new places. Even so, she is a self-proclaimed couch potato when she is at home. The two extremes can coexist in one person! Her favorite couchmate is her fuzzy and affectionate dog, Lita.

AUTHORS

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Nelson is a geology professor (like an Earth explorer). He teaches about rocks, coasts, and the ocean at the Universidad del Atlántico in Barranquilla, a city on the Caribbean coast of Colombia. He also writes lots of cool stories about the beach and the coast. Plus, he is an editor for a special journal that talks all about coastal issues. You can find him at Programa de Física, Facultad de Ciencias Básicas, Universidad del Atlántico, Km 7 Via Puerto Colombia, Barranquilla, Atlántico, Colombia. *nelsonrangel@mail.uniatlantico.edu.co

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