



ATOLL ISLANDS HAVE SECRET SUPERPOWERS AGAINST SEA-LEVEL RISE

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YOUNG REVIEWERS:



LEAF

AGE: 12



LORENZO

AGE: 12

When you think of tropical islands, you might imagine palm trees, sandy beaches, and a crystal-blue ocean. But some of the most famous tropical islands—called atoll islands—are often in the news for a scary reason: because atoll islands extend only a few meters above the ocean, many people believe they will soon disappear as sea levels rise due to climate change. But new research tells a different story: atoll islands are not disappearing. These islands have secret superpowers that allow them to move and grow taller with sea-level rise—but only if we let them. This requires keeping atoll islands and the ocean around them healthy. This article is about the secret superpowers that help atoll islands deal with sea-level rise, and how protecting nature can help atoll islands and the people, animals, and plants that live on them.

CORAL REEF

A large underwater structure in the tropical oceans built by tiny coral animals that make hard skeletons. Coral reefs are home to fish, sea turtles, and many other ocean creatures.

ATOLL ISLANDS

Small islands in the tropical ocean that form on top of ring-shaped coral reefs. They are no more than a few meters in elevation above the ocean.

Figure 1

A coral atoll with reefs and islands. (A) The coral reefs form a large ring in the middle of the ocean. (B) Underwater, coral reefs grow. (C) Along this ring-shaped coral reef sit many atoll islands that have dense forest on them. (Image credits: (A) Wikimedia Commons – aerial photograph of Penrhyn, 22/09/2025, CC-BY 3.0 (https://commons.wikimedia.org/wiki/File:Penrhyn_Aerial_EFS_1280.jpg); (B) Rose atoll coral, 22/09/2025, [https://commons.wikimedia.org/wiki/File:Rose_Atoll_coral_\(53588138166\).jpg](https://commons.wikimedia.org/wiki/File:Rose_Atoll_coral_(53588138166).jpg); (C) Atoll island photo taken by S. Steibl).

CLIMATE CHANGE

Changes in the weather and temperature of the Earth caused by humans burning fossil fuels. It leads to hotter air and oceans, stronger storms, melting ice, and rising seas.

WHAT IS THE DEAL WITH ATOLL ISLANDS?

Across the tropical oceans, there are thousands of small sandy islands that sit on top of **coral reefs**. These coral reefs are shaped like rings that can be many kilometers wide, with shallow pools of water, called lagoons, in the middle (Figure 1). On top of the reef rim, waves push sand and rubble into piles, which creates islands called **atoll islands**. Atoll islands are home to many creatures, such as seabirds, sea turtles, and giant coconut crabs [1]. Atoll islands are also home to nearly one million people. In fact, some entire countries, like the Maldives, Kiribati, the Marshall Islands, or Tuvalu, exist only on atoll islands.

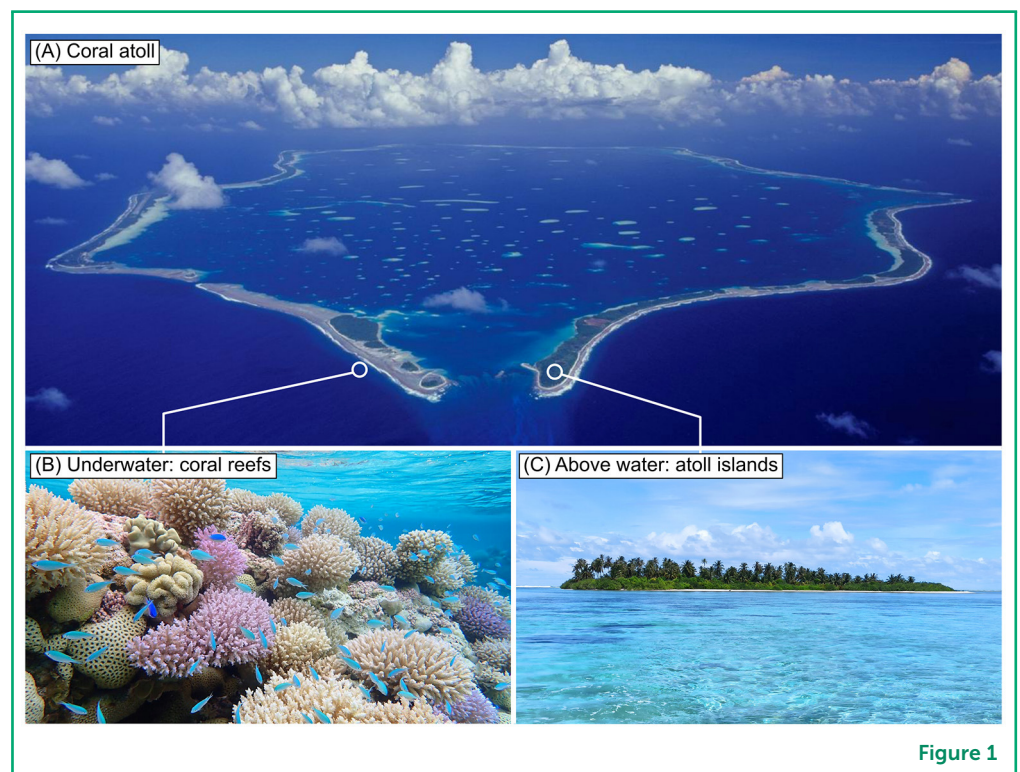


Figure 1

Because atoll islands are small and only rise a few meters above the ocean, many people think they are among the most fragile places in the world, especially in the face of **climate change**. A common belief is that **sea-level rise** makes atoll islands smaller and will drown them in the near future. This would wipe out all the plants and animals on these islands and make the people who live there homeless. But these beliefs of disappearing atoll islands are not what science shows.

WHAT IS SCIENCE ACTUALLY TELLING US?

New scientific studies tell the real story of how atoll islands are dealing with sea-level rise. Scientists compared old photos of hundreds of islands with new satellite photos. They found that almost nine out of 10 atoll islands (88%) had not become smaller [2]! In fact, many had grown

SEA-LEVEL RISE

The increase in height of the world's oceans. It happens because ice melts with warmer temperatures from climate change. Sea levels are currently rising at 3–5 mm per year.

Figure 2

Scientists compared photos of atoll islands from different years to measure how these islands are changing with sea-level rise. They found that atoll islands are moving over time, but they are not shrinking or disappearing.

even larger in the last 50 years, even though sea levels have risen by more than 30 cm during that time (Figure 2). When scientists looked closer at why atoll islands are not disappearing and many are getting larger, they discovered that atoll islands have two secret superpowers: they can move, and they can grow taller [3].

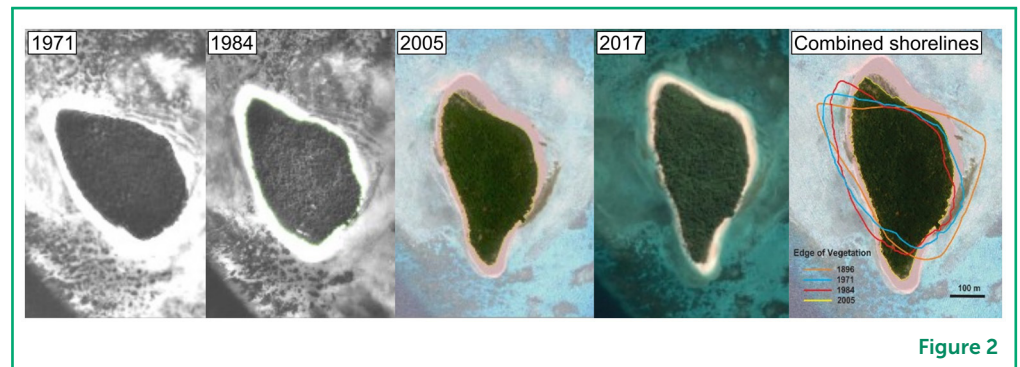


Figure 2

HOW DO ATOLL ISLANDS FORM?

To understand the two secret superpowers of atoll islands against sea-level rise, we first need to explain how atoll islands actually work. Atoll islands are not fixed blocks of rock. They are part of a larger natural system that depends on three connected steps (Figure 3A).

The first step happens underwater, in the coral reefs around the atoll islands. The coral reef is like a factory that produces **sediment** (sand and rubble) from which the atoll island is built. The sediment comes from broken down corals, shells, and skeletons of creatures like crabs, snails, and sea urchins that live on the reef. There is also a unique type of fish called parrotfish that eats corals and poops out sand. Sediment production is natural and happens in every healthy coral reef.

The second step happens when waves and currents carry the sediment from the coral reef to the atoll island. You can think of this like a conveyor belt that transports the sediment from the coral reef sediment factory to the shoreline of the atoll island. Waves reaching and breaking on the atoll island are not a problem—this is the natural and necessary way for atoll islands to get their island-building sediment.

The third step is when the sediment piles up on the atoll island itself. You can think of the atoll island as a warehouse for storing sediment. Fresh sediment from the coral reef sediment factory arrives through the wave conveyor belt and gets stored and moved around

SEDIMENT

Small pieces of broken-up corals, shells, and other material. Sediments can be fine sand or large pieces of gravel.

Figure 3

The working of atoll islands. **(A)** The coral reef produces the material to build an island (1); wind and waves transport the sediments to the island (2); and the island stores the sediments with the help of plant roots (3). **(B)** When waves get stronger and bigger with sea-level rise, they transport the sediment from one side of the atoll island to the other, and the whole island moves away from the strongest waves. **(C)** When sea levels rise and waves get stronger, sediment is thrown higher up on the atoll island, making the island grow upward.

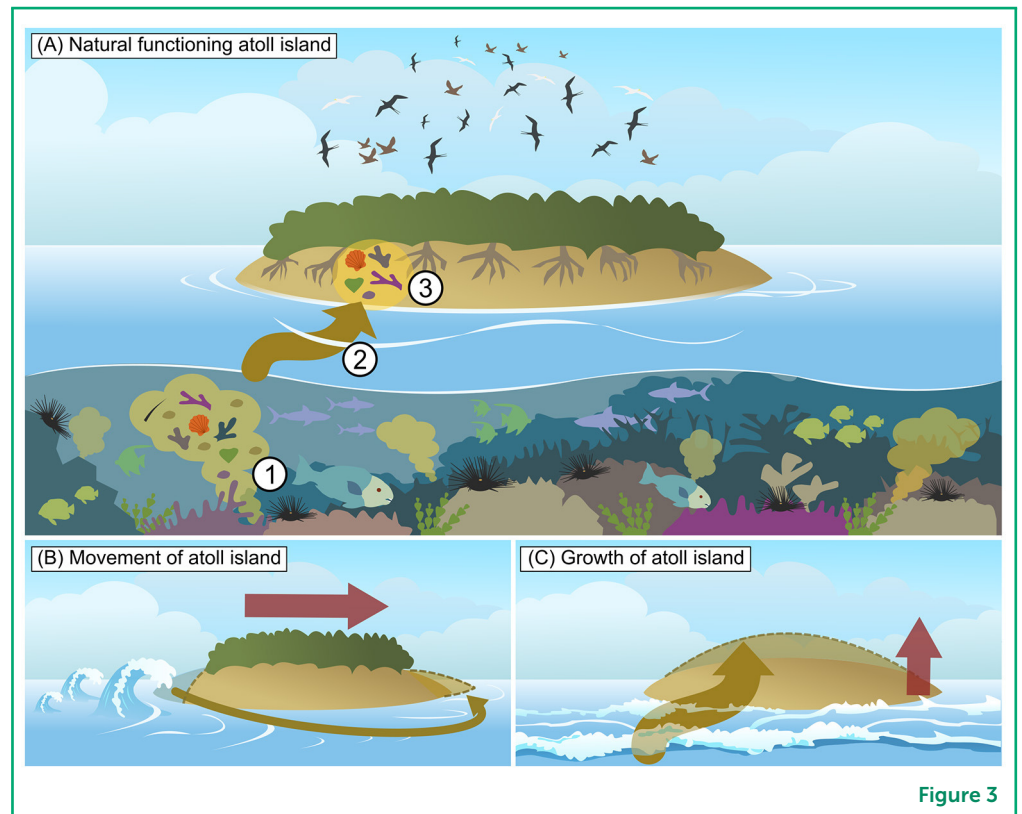


Figure 3

on the island. This storage of sediment is what allows atoll islands to exist.

HOW DO ATOLL ISLANDS REACT TO SEA-LEVEL RISE?

So, how do these three steps help atoll islands deal with sea-level rise? When sea levels rise, increased water depths mean that more powerful waves can travel across the reef and reach the atoll island. These powerful waves pick up sediment from one side of the island and move it around the atoll island to the sheltered side—like moving things around in a warehouse. As a result, the whole atoll island is moving to protect itself from the biggest and most powerful waves. This is its first superpower (Figure 3B). More powerful waves also mean that the sediment conveyor belt runs faster and throws sediments higher up to the top of the atoll island surface, which increases the **elevation** of the atoll island. This allows the atoll island to grow in elevation with sea-level rise—its second superpower (Figure 3C). Researchers have measured atoll islands moving as far as 30 m in just 1 year [4]. They have also shown that atoll islands can grow taller at the same speed that scientists expect that sea level is rising with climate change [5].

ELEVATION

Elevation is how tall an island is compared to the water level of the ocean.

DO THEIR SUPERPOWERS MAKE ATOLL ISLANDS INVINCIBLE?

Unfortunately, these superpowers do not make atoll islands invincible. But the threat to atoll islands is not simply because they are low in elevation, as most people believe. The real risk for atoll islands is when one of the three connected steps (coral reef sediment factory, wave conveyor belt, or island sediment warehouse) is damaged or broken.

In some places, the connection between coral reefs and atoll islands has been damaged by the actions of people. Where the health of the coral reef has been damaged by pollution, overfishing, or construction activity, the reef no longer produces enough sediment for the atoll island to grow—the sediment factory is broken.

Often, people build walls and barriers around atoll islands. These cut off the transport of sediment from the coral reef sediment factory onto the island. In this case, the atoll island no longer receives the sediment that it needs to grow and move with sea-level rise—the wave conveyor belt is broken.

People also remove the forests on atoll islands. Trees and their roots hold the sediment together, but without forests the island cannot hold the sediment—like removing the shelves from a warehouse. When these natural connections are damaged, atoll islands lose their superpowers to move and grow. That is when they truly become vulnerable.

GOOD NEWS!

The good news is that most atoll islands in the world are still healthy and have their superpowers to move and grow with sea-level rise. Making sure that these islands remain healthy is important to protect the millions of birds, crabs, and other animals and plants that live on them, and the people too! This means we always need to protect all three steps of the system at the same time: the coral reef sediment factory, the wave conveyor belt, and the island sediment warehouse [6]. Just protecting the coral reef while not caring about the islands is not enough for atoll islands to keep their superpowers.

For atoll islands that are damaged or broken by the actions of people, we can give them back their superpowers. We can restore the coral reefs by removing pollution, fishing sustainably, and stopping reef destruction so that the sediment factory works again. We need to restore the connections between atoll islands and their coral reefs so that sediment can reach the islands again. We can also re-plant forests on the atoll islands so that the roots hold the sediment in place. All these actions can be done locally for every atoll island, by the people

who live on them. People on atoll islands have the power to restore and protect the superpowers of their own atoll island. When coral reefs and the atoll islands are healthy and connected, atoll islands have the best chance to survive sea-level rise and climate change. Atoll islands are not doomed to disappear with climate change; they can be natural survivors—if we give them the chance.

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ORIGINAL SOURCE ARTICLE

Steibl, S., Kench, P. S., Young, H. S., Wegmann, A. S., Holmes, N. D., Bunbury, N., et al. 2024. Rethinking atoll futures: local resilience to global challenges. *Trends Ecol. Evol.* 39:258–66. doi: 10.1016/j.tree.2023.11.004

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SUBMITTED: 28 November 2025; **ACCEPTED:** 11 May 2026;
REVISED: 11 March 2026; **PUBLISHED ONLINE:** 26 June 2026.

EDITOR: [Idan Segev](#), Hebrew University of Jerusalem, Israel

SCIENCE MENTORS: [Xiaoming Wan](#) and [Janifer Raj Xavier](#)

CITATION: Steibl S, Kench P, Wegmann A and Russell JC (2026) Atoll Islands Have Secret Superpowers Against Sea-Level Rise. *Front. Young Minds* 14:1756248.
doi: 10.3389/frym.2026.1756248

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YOUNG REVIEWERS

LEAF, AGE: 12

I am in sixth grade, and my favorite subject is art and science. I love observing changes in the world. I like to work as a Young Reviewer as I can observe many more changes using scientist's equipment. In my spare time, I like hiking, swimming, and riding bikes with my friends.

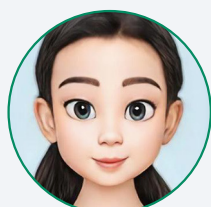
LORENZO, AGE: 12

I am interested in discovering the natural world around us. I want to use science to help preserve nature.

AUTHORS

SEBASTIAN STEIBL

Sebastian is a scientist at the University of Auckland, New Zealand. He is deeply fascinated by atolls and has specialized in studying them. In his work, Sebastian investigates the plants and animals living on atoll islands (biodiversity), the reasons why certain species exist on atoll islands and others do not (biogeography), and how these plants and animals support the atoll islands' superpowers to become stronger against climate change (resilience). *sebastian.steibl@naturalis.nl





PAUL KENCH

Paul is a professor of coastal change at the University of Waikato, New Zealand. His work has focused on understanding the evolution and processes that cause physical change on atoll islands, and he discovered the superpowers of islands in response to sea-level rise. His findings are based on extensive fieldwork in atoll nations throughout the Pacific and Indian Oceans, examination of satellite imagery over the past century, and the first physical laboratory experiments in which models of islands were subjected to increased sea levels in wave basins.



ALEX WEGMANN

Alex is a scientist who helps protect islands and the ocean. He studies atolls and works with local communities and governments to keep atoll ecosystems healthy. Alex uses nature-based solutions, like restoring seabird colonies. Why seabirds? Their poop (called guano) is packed with nutrients that help plants and coral reefs grow. By protecting seabirds and other species, Alex helps atoll islands stay strong against climate change.



JAMES C. RUSSELL

James is a professor of island conservation at the University of Auckland, New Zealand. He studies the animals found only on islands, using natural science to understand why the animals found on islands are different than those found elsewhere, and social science to help motivate people to want to save them. Together, this helps find the best ways to protect animals on islands.