Paradise lost: Islanders prepare for the flood

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The Maldives may look idyllic, but in reality they are on the frontline of climate change (Image: Alexis Rosenfeld / SPL)

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TWO years ago, the Maldives became the first nation in the world to open an embassy on a virtual island in Second Life. What started as a gimmick could become a tragic reality in coming decades, as sea level rise reduces the entire country to a virtual state. Global greenhouse gas emissions have already committed the residents of the Maldives to a watery future: ocean expansion due to warming has raised sea levels enough to regularly deluge the islands, and melting glaciers will only make matters worse.

The Maldives are not about to give up without a fight, however. As leading climate models predict that sea level rise will make the islands uninhabitable by 2070, 2050 or even as early as 2030, the country is striking back with an ambitious programme of island restoration. But will it be enough to keep the ocean at bay? I visited the archipelago earlier this year to find out.

The islands that make up the Maldives have always led a precarious existence. According to Charles Darwin's theory of island formation, published in 1842, the islands started out as a string of volcanoes, fringed by coral reefs. As the volcanoes subsided and sea levels rose at the end of the last ice age, they were gradually submerged, leaving only the reefs behind. These began growing upwards to remain in warm, sunlit water, eventually forming circular reefs, or atolls, encircling shallow lagoons. Over time, coral debris and sand accumulated on and around the reefs to form low-lying islands. Today, 26 such atolls

house the 1196 islands of the Maldives. Of these, 200 are permanently inhabited.

Many of these islands are mere sandbars that come and go with the changing currents. In fact, local people call their country "Woden adhi Girun", which roughly translates as "the nation of appearances and disappearances".

In the past 15 years, though, coastal erosion and rising sea level have meant that more and more of the islands are disappearing permanently. Rising waters, combined with coral growing more slowly or dying as warmer temperatures lead to bleaching, has left the reefs less able to shelter the islands. As a result, waves and storms are rapidly eroding away the coastline of the islands.

These changes are already having devastating effects on the population. Roads and houses are crumbling into the sea, coconut palms are being washed away, and groundwater has become so polluted with seawater that on many islands it is undrinkable. The resort islands, which bring in a third of the nation's income, have also been affected. "Some resort bungalows have been abandoned because they kept getting flooded. And the beach where we used to sunbathe has completely gone," says Sue Gregory from Bath in the UK, who has holidayed in the Maldives since 1999.

So far 20 islands have been abandoned, some of them after the 2004 tsunami gave residents a shocking taste of what higher waters mean for the islands. On one of the worst-hit islands, Kandholhudhoo, the highest tsunami wave was just 2.5 metres, but when it receded minutes later, three people were dead, not a single house was habitable, and residents had to leave the island for good. With rising sea levels and more frequent storms forecast, it may not take a tsunami to inflict similar damage in future.

Ironically, earlier attempts to solve some of the Maldives' problems may only have made them worse. In the 1990s, the then-president, Maumoon Gayoom, set about building artificial sea walls outside the reefs on some islands as a barricade against the rising tide and storms. But while the sea walls have been effective against storms in many places, including protecting the capital Malé from the tsunami, they have also reduced currents flowing over the reefs. Without a flow rate of around 10 metres per second the corals die, removing the islands' natural barrier to coastal erosion. The construction of a dozen or so new harbours during Gayoom's presidency have had similar effects, as did the dredging of the lagoons to build them.

The current president, Mohamed Nasheed, who was elected in November 2008, has other plans. He is focusing on bolstering the islands' natural defences by restoring coral reefs and coastal vegetation. The question is, is it too little too late?

There are some indications that coral can be saved - at least from the effects of warming. In experiments, Robert Tomasetti, a marine biologist employed by the Banyan Tree Resort on Vabbinfaru Island, has found that heat-tolerant corals grafted onto concrete frames or a low-voltage electrical carapace that stimulates growth are better able to endure temporary warming, and can survive when other corals bleach. Done on a larger scale, this

could keep enough of the reef alive to delay erosion and buy the islanders some more time.

So far, though, progress has been frustratingly slow. "I would like to be able to find out whether we can transplant heat-tolerant ones to parts of the reef where it is more exposed and so build coverage there," says Tomasetti. "We don't have that level of equipment, so at the moment we're really just growing pretty reefs for the tourists."

Resources aren't the only issue. According to Bruce Hatcher, a marine ecologist at Cape Breton University in Sydney, Nova Scotia, Canada, who has studied the Maldivian reefs, large-scale coral rehabilitation is not feasible. "There is no current technology that allows thousands of kilometres of reef to be regrown, so in terms of mitigating sea-level rise in the Maldives, it is of very limited value," he says.

Restoring coastal vegetation, however, could make more of an impact. Part of the reason that Kandholhudhoo suffered so badly during the tsunami was that the reef had been dredged for building materials, and mangrove swamps had been plundered for timber, exposing the coast to the elements. With no tree roots to bind the topsoil it washed away. Properly managed mangrove plantations could restore this barrier, and since some species can mature in five to 10 years, it could have relatively immediate benefits.

With time running out, though, some feel restoration will not be enough to save the Maldives. Local NGO Bluepeace believes that the nation needs to think bigger. Much bigger. It argues that what is really needed is a series of raised artificial islands, dotted around the archipelago. Bluepeace suggests that seven islands, perhaps paid for by the international community by way of compensation for causing the climate to change, could allow the entire Maldivian population to stay ahead of the rising waters.

The idea is not entirely far-fetched. One artificial island, called Hulhumalé, has already been built to the north-west of the capital, and was officially opened in 2004. While it was designed mainly as a commercial port and to reduce pressure on the overcrowded capital, it was built 3 metres above sea level, enough to ensure it lasts the century, at least by conservative estimates.

Nasheed's government has no plans to build more islands like Hulhumalé, though, arguing that raised islands "cost a fortune to build" and that Hulhumalé has actually increased erosion in adjacent islands by disrupting natural currents. Nevertheless, it does admit that sooner or later the waters will get too high, too often, for the population to stay (see "How long have they got?"). To this end, Nasheed has pledged to divert much of the annual tourist revenue into a "sovereign fund", to enable the country to buy land elsewhere in the world when the time comes. It is an idea that some say is impractical, but one that he believes will be necessary if they are to avoid becoming climate refugees.

Whatever the ultimate solution, the fate of the Maldives lies in the hands of the rest of the world. The emissions we pump out and where we choose to spend our hard-earned cash

could make or break the fate of the lowest, and perhaps most beautiful, nation on Earth.

Higher ground

As well as restoring the islands' natural defences, the Maldivian government is relocating vulnerable populations to houses built further inland on previously uninhabited islands. The first such "designer island", Dhuvaafaru Island in Raa Atoll, was unveiled in March this year. Formerly an uninhabited forest, the entire island was razed, and a new village built from scratch for 4000 survivors from Kandholhudhoo, an island left uninhabitable by the 2004 tsunami.

Along with new, spacious homes, the island also features a community centre built on stilts that is large enough to shelter its entire population during high tides, storms or future tsunamis (see photo, left).

The Maldives' current president, Mohamed Nasheed, has plans to build more of these kinds of communities. "We need to bring some of the more isolated villages into the 21st century so that they are better able to deal with the challenges ahead," he says.

How long have they got?

The Maldives is the lowest lying country in the world: 80 per cent of the islands are less than 1 metre above sea level, and the highest point is just 2.3 metres.

Clearly, even a small rise in sea level is bad news for such low-lying land. But predicting when the islands will become uninhabitable is far from simple.

Sea level has risen 52 millimetres on average in the past 15 years. Much of this can be put down to thermal expansion of the water, in which the molecules become agitated and move further apart as temperature rises. We know this is happening because sea level rise has so far been directly proportional to global warming. Some scientists, however, are concerned that melting ice may now have overtaken thermal expansion as the leading cause of sea-level rise. "How these factors will influence regional sea rise over the century is the great unknown," says Steve Nerem at the University of Colorado in Boulder, who monitors sea-level rise.

While we wait for data, we are left with an array of models that vary widely in when they estimate sea level rise will swamp the Maldives. In its latest assessment, the Intergovernmental Panel on Climate Change predicted a rise of up to 59 centimetres by the end of 2100 - a figure that does not include glacial melting. At the other end of the scale, James Hansen's group at NASA Goddard predicts a global sea-level rise of up to 25 metres by 2100, assuming that feedback mechanisms will accelerate melting in Greenland and Antarctica. More conservative models without feedback scenarios, such as that by Stefan Rahmstorf at the Potsdam Institute in Germany, put it at 1.4 metres by 2100.

None of these estimates are comforting for the Maldives. "Even a 1-metre rise would be

devastating," says Nerem.

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