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A SINKING FEELING

The floods are getting worse in Tuvalu. As scientists argue over climate change and struggle to measure rising seas, **Samir S. Patel** meets the locals of this tiny island nation.

On a Friday afternoon in late January, the phone rings in the Filamona Guest House, one of the few places to stay in the Pacific archipelago of Tuvalu. Hilia Vavae, the director of the Meteorological Office, sounds excited in her modest, laid-back way. "There is a…" she struggles for the right word "…flooding!"

The floods on Funafuti, the main atoll of Tuvalu, are caused by 'king tides' — the highest high tides of the year. They percolate up through the porous limestone, soaking the islets from the inside out. And they draw journalists, scientists and environmental advocates from around the world, all keen to see what is happening on the front line of climate change. If global sea levels rise as predicted, the 11,000 Tuvaluans will be among the first to see things go awry. Yet even here, attitudes and responses to the impending catastrophe vary in complex and sometimes surprising ways.

Next to the guest house is the country's sole airstrip, built by the US military in the Second World War. Being the only open space on Funafuti, the airstrip provides a breezy place to sleep on muggy nights, not to mention a pitch for football and *te ano*, a volleyball-like game. Following Vavae's directions, I walk across the airstrip and, rolling up my trousers, on into a clear tidal lake. Two kids run over to sail toy boats made of green Victoria Bitter beer cans pounded flat. The salt water creeps steadily along the dirt track next to the runway and surrounds the nearby buildings, including the diesel power station, a handful of pungent concrete pigpens, and the office where Vavae and her staff collect data on sea level and beam them to the Australian Bureau of Meteorology's National Tidal Centre (NTC), thousands of kilometres away in Adelaide.

In January and February, Tuvalu experienced some of the highest tides ever recorded there, nearly 1.5 metres above mean sea level. They were caused in part by the convergence of natural short- and long-term tidal cycles, but were boosted, perhaps, by the effects of global warming. Although the tides are not especially high compared with Newfoundland's Bay of Fundy or even the English Channel, they are pretty alarming in a country where the highest ground is just 5 metres above sea level and most is much less than that.

A mean sea-level rise in Tuvalu of just 20 to 40 cm in the next hundred years would significantly increase the frequency and depth of saltwater flooding and accelerate coastal erosion. It would threaten the Tuvaluans' food and housing, poisoning the pits where they grow giant swamp taro plants and undermining buildings. It could make the country simply uninhabitable.

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Water, water everywhere: Tuvaluans think the floods are getting worse, but it is hard to measure changes in sea level accurately.

Rising damp

There are two tide gauges in Tuvalu. One, operated by the University of Hawaii until 1999, sits on a small concrete wharf behind the three-storey Taiwanese-built government building. In 1993, the NTC installed a more modern and accurate gauge a few kilometres north at the country's only deepwater wharf. One of twelve in the South Pacific, this gauge should in theory provide quantitative confirmation that Tuvalu is being engulfed, as the king tides and the wet cuffs of my trousers suggest.

But in 2000 an NTC analysis reported a negligible increase of 0.07 mm a year over the past two decades from the University of Hawaii gauge, and a drop in sea level from the seven years of NTC data[1]. It was clear that the El Niño/Southern Oscillation (ENSO), which drives down sea level in the western Pacific, affected both of these records. And the international environmental group Greenpeace asked John Hunter, a climatologist at the University of Tasmania, to have another look at the data. When he adjusted for ENSO and the vertical movement of the Hawaii gauge, which is thought to be sinking, Hunter found a sea-level rise of around 1.2 mm a year[2].

M. PALEY/CORBIS; SATELLITE IMAGE BY GEOEYE

"Because we love the sea, we need a place close to the sea. We know these are expensive places."
— Maatia Toafa

Shore thing: the snaky islet of Fogafale is Tuvalu's capital and hosts the country's airstrip (inset).

Hunter's figure is consistent with the global estimate of the Intergovernmental Panel on Climate Change (IPCC): 1 to 2 mm a year for the twentieth century[3]. But the Tuvalu estimates are based on a couple of gauges and a reasonably short record, points out John Church of the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Hobart, Tasmania, who was one of the lead authors of the chapter on sea level in the IPCC's most recent assessment.

Recently, Church and his CSIRO colleague Neil White have moved to a more regional approach. They have combined records from tide gauges around the world, some of which date back as far as 1870, with satellite altimeter data to assess regional variation in sea-level rise. Their results for the South Pacific are in line with the Hunter and IPCC estimates[4], and they are now looking specifically at Tuvalu and other small island nations.

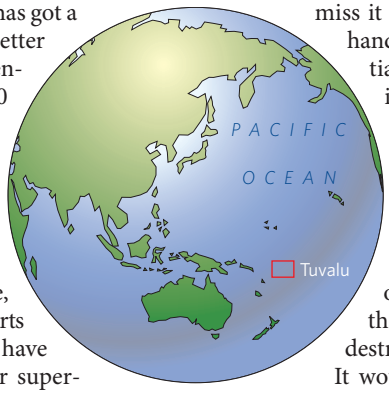
"The thing that really interests me is how you reconcile the relatively low estimates of sea-level rise, which are the same order as what's happening in the rest of the world, with the anecdotal observations from Tuvalu," says Hunter. "It seems that the flooding reported there is bigger than 2 mm a year. The extremes of high tide could be getting bigger relative to the mean sea level, although that's disputed at the moment."

Phil Woodworth of the Proudman Oceanographic Laboratory in Liverpool, UK, has studied high tides in the Pacific to see whether they have changed since the 1970s. He says the peaks seem to be increasing, but by no more than mean sea level[5]. "The extremes at Tuvalu seem determined primarily by the slower changes in the oceans due to ENSO and the long-term changes in mean level," he says.

The disagreements are unlikely to be resolved soon. "We're going to be waiting around for a fair while before our estimates of sea-level rise become statistically meaningful," says Bill Mitchell, manager of the NTC. "Everyone presses you to give a number. We put a vast amount of effort into telling people that you should not be using numbers yet."

Treading water

Vavae has a similar opinion of the numbers, but perhaps for different reasons. "I always tell my people that it's not the data that you look at. You have to actually rely on your eyes," she says, glancing outside to where the salt water is once again creeping across the yard. "A person who experiences it has got a much better feel or much better knowledge of what is happening than someone who is 100 miles away."



When Vavae started working for the Meteorological Office in 1981, the saltwater flooding was no worse than that from heavy rain. Now it is extensive, regularly inundating large parts of the island. The floods have almost reached the *fusi*, or supermarket; seaweed is starting to appear in the more commonly flooded areas, Vavae tells me.

The Tuvaluans have mixed reactions to these changes, and the scrutiny that comes with them. A few days after witnessing the king-tide flood by the airstrip, I talked to Carol Farbotko on the verandah of the Filamona. Farbotko, a cultural geographer from the University of Tasmania, is working on a thesis on cultural responses to climate change on the islands. In her interviews with officials and community leaders, she has found that climate is a vague, long-term concern. People get much more worked up about problems such as waste disposal, a fetid and ubiquitous problem; overpopulation; and the accelerating erosion of traditional culture in the age of the Internet and DVDs. Even frequent workshops on climate and the dangers of accelerating sea-level rise fail to provoke a sense of urgency.

"Oh, it's a very important concern," is the standard and slightly mechanical response to questions on climate change, Farbotko says. In her experience, and in mine, some Tuvaluans refuse even to talk about climate, or dismiss it with a weary wave of the hand. Tuvalu is a deeply Christian country, and some islanders put their faith in the promise God made to Noah in Genesis 9:11: "And I will establish my covenant with you; neither shall all flesh be cut off any more by the waters of a flood; neither shall there any more be a flood to destroy the Earth."

It would not take a very large breach in that covenant to wash Tuvalu away. Fogafale, the largest of the islets that make up the Funafuti atoll, is an elegant snake of land about 10 kilometres long. Even on a borrowed bicycle with a hard seat and half-flat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Where next? If Tuvalu is flooded, its citizens could relocate, but their culture might be lost.

tyres it is easy to get from one end to the other in a morning. The ride is comfortable, because the roads were resurfaced with a windfall from the sale of Tuvalu's appealing Internet country code, '.tv', although the speeding motorcycles and cars no longer have to slow for potholes.

During high tides, waves crash from the lagoon on to stretches of the new tarmac, spreading trash, coral rubble and other detritus across it. There was a time, I'm told, when the road behind the government building was set back a few metres from the lagoon, but now it is right on the sea. In itself this says nothing about sea level, because the islets are constantly changing shape: a spit forming here, an island tip disappearing there. Arthur Webb, a coastal ecologist in the Fiji offices of the South Pacific Applied Geoscience Commission, makes the point to me graphically by flipping through aerial and later satellite photographs from the 1940s on. "These really are quite natural processes," he says. "It's part of living on a soft-shored island."

Swept away

As Webb shows me images with Second World War seaplanes and torpedo boats sitting in the lagoon, he explains how, in 1943, US troops built a makeshift seawall and land-reclamation project along the length of the lagoon foreshore. After the troops left, locals built homes and roads on this 25- to 30-metre-wide stretch of rubble, which then began to erode. Jetties and channels further altered coastal erosion and deposition patterns.

The move from portable, short-lived thatch houses to Western-style concrete-block homes has added to the difficulties. Despite regulations, the shores of Tuvalu have been ransacked for aggregate for construction — an activity that makes the prospect of flooding far worse. "Beach mining is a disaster," says Webb.

Those sceptical about Tuvalu's plight, including amateur scientist Willis Eschenbach, seize on local explanations such as mining to assert that fears about sea-level rise are created by hysterical journalists and environmental groups looking for a *cause célèbre*. Eschenbach, who carried on a spirited debate with Hunter in the journal *Energy and Environment*, has concluded that sea-level rise in Tuvalu is an illusion. He has used that conclusion to support an argument that there is no clear evidence for climate change.

Webb, on the other hand, thinks that poor coastal management and climate change are acting in concert. Oddly, when he presented this sinister synergy to the *falekaupule*, or council of elders, in Fogafale, their reaction was something like relief; a remote and difficult problem became a local and understandable one. They learned there were things they could do to mitigate erosion — they could further regulate beach mining and carefully dredge the lagoon for the island's aggregate needs, for example.

Many scientists and people within the government insist that Tuvalu must step up the implementation of 'no-regrets' policies — activities that make sense whether the seas rise or not. These include introducing salt-tolerant crops and dealing with the island's highly visible trash problem. The process is painfully slow.

"I always tell my people you have to rely on your eyes."
—Hilia Vavae

Distressed that its capacity for action was limited to its own shores, in 2000 Tuvalu joined the United Nations for the express purpose of highlighting climate change. It was a considerable expense for a country that had a GDP at the time of just US$12.2 million. But membership allows Tuvalu to play a role as the most vocal and insistent of the small island developing nations, positioning itself as the conscience — or pest — of climate negotiations. "The current strategy is to continue making noises in the international forums," says Prime Minister Maatia Toafa.

Exit strategy

In addition to championing increased adoption of the Kyoto Protocol, which aims to curb greenhouse-gas emissions, Tuvalu also wants to discuss immigration policies with Australia and New Zealand. More open policies would provide both economic opportunities and the possibility of a new home if, or when, the islands become uninhabitable. Critics charge Tuvalu with using the sympathy generated by its position to increase the number of Tuvaluans living abroad and the remittances they send home. Toafa, a casual and jovial fellow who kicks off his sandals and props his feet on the table as we speak, is candid about their intentions. "It will work both ways," he says. "One, as an opportunity for people to go and develop their lives there, and secondly as a way of easing this resettlement problem."

Ideally, Toafa would like to buy land in New Zealand or Fiji to resettle the entire nation. "Because we love the sea, we need a place close to the sea. And we know these are very expensive places," Toafa says. But relocation is more than a logistical and economic problem. It threatens their national and cultural identity — "unless we can develop an underwater Tuvalu," he adds with a high-pitched laugh.

So far, New Zealand has offered to accept more Tuvaluans, but that brings the total to just 75 a year, and even then it is as part of a labour programme, not resettlement. Despite reports in the press that the evacuation of Tuvalu is already under way, very few are going. "I don't know if anyone wants to leave," says Pepetua Latasi, climate-change coordinator for the environment department. "People are saying Tuvalu will be gone in 50 years' time, but I doubt it." Still, even Latasi, who is optimistic about both local efforts and international mitigation, concedes that if the expected rises in sea level coincide with increases in cyclone activity, the prospects are bleak.

On another day of king tides, I walk down to the end of the airstrip, where floods overflow the edge of a trash-filled pit. Three boys are trying to turn over a half-submerged rowing boat. It capsizes, but they paddle back and have another go. ■

Samir S. Patel is a freelance science journalist and photographer based in New York City.

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