In the Dark of Monday Morning: Coastal flooding on Majuro in March 2014

In the early hours of Monday, March 3, 2014, officers from the local police on the low-lying atoll of Majuro, capitol of the Republic of the Marshall Islands (RMI), began knocking on doors to alert residents to the large waves now overtopping seawalls and flooding their properties.

"I was in bed at home, as most people were, because it was 3 am," said Angela Saunders, head of the Majuro sub-office of the International Organization for Migration (IOM), which was one of the groups, alongside the RMI government, active in responding to the coastal flooding. A phone call from a colleague woke Saunders, telling her about the high swells flooding the atoll.

High tide came at 5:30, allowing the swell to higher and farther inland. Source: Alison Kelen.

Families were evacuated from their homes in the dark of Monday morning. High tide, which would exacerbate the already significant flooding from high swells, was a few hours away. The impacts of coastal flooding on atolls can be far reaching. Private property damage can displace residents, requiring temporary shelters that are often ill-equipped. Public infrastructure can be damaged or destroyed, inhibiting transportation and the logistics for emergency response. Saltwater intrusion can diminish the availability and quality of fresh groundwater supply. Coastal flooding can also ruin crops and threaten public health through water-borne diseases and increased insect infestations. Over the radio, the government warned residents that the high seas could last for the next 2 days, becoming especially dangerous around high tide.

Later that morning, Saunders left her house, where there was some standing water in the yard, to assess the more stricken areas of the atoll. High tide had come and gone at 5:30 am, allowing flooding to subside for the time being. "There was still a fair amount of water on some parts of the road, so we were driving through maybe a foot of water in some places. And lots of people were out and already cleaning up by the time we got there." Debris had been washed onto the roads and Majuro local government was working to clear it away.

Majuro, like many atolls, is composed of several land segments with elevation less than 10 feet above sea level, connected by shallow reef encircling a large lagoon. This coastal flooding event was particularly impactful to the atoll because waves entered the lagoon through a northern passage and flooded the land from both the lagoon and ocean sides. Multiple ocean and atmosphere phenomena can cause coastal flooding on atolls, including typhoons, tsunamis, large swells, and king tides – the highest tide of the year, also called the perigean spring tide. Many attributed this event to a king tide but the flooding actually began during a mid-tide – and peaked at a high tide a foot or so lower than the king tide of 2014, which happened

later in the year. The coastal flooding was caused by exceptionally large waves formed by distant storms located north of RMI near Japan and exacerbated by high tide. The frequency and magnitude of coastal flooding events on Majuro and other nearby atolls have increased significantly over the last decade, with several taking place in the last 5 years. Accelerated sea level rise due to climate change will likely increase both the frequency and magnitude of these coastal floods.

The Chief Secretary of the RMI called a meeting of the National Disaster Committee at 8 am, which Saunders attended along with representatives from the various departments and organizations that respond during an emergency. “Each of those representatives gave an update of the situation from their perspective,” said Victoria Bannon, the Representative to the North Pacific Region for the International Federation of Red Cross and Red Crescent Societies (IFRC) in Majuro.

At the conclusion of the meeting, Bannon and Saunders joined assessment teams that were dispatched to monitor conditions in the shelters and assess needs. Schools had been canceled across Majuro and those schools – along with the College of the Marshall Islands, churches and other facilities – were used as emergency shelters. Some shelters were officially designated; others were spontaneous. “The classrooms had been cleared out, and people were sleeping on the floors, mostly in bedding that we provided but also with bedding that they brought themselves from their own homes and they were using the shared bathroom facilities,” said Bannon. “Families who could afford it booked hotel rooms or stayed with relatives.”

Almost 1,000 people relocated to shelters on Majuro, along with around 250 on Arno, Majuro’s less populous neighboring atoll. Meals were served in these shelters and bottles were filled with desalinated water in case the flooding further compromised Majuro’s fresh water resources. Other supplies – such as bedding, clothing and personal hygiene materials – were donated through local businesses, the Red Cross, Salvation Army and other organizations, coordinated through the Ministry of Internal Affairs and the Marshall Islands Red Cross.

Teams were sent out to assess the impact of the past day and more than 100 homes were found damaged on Majuro and Arno – many with doors and windows broken and debris washed inside. Source: Karl Fellenius.

As high tide approached early that evening, radio announcements warned residents to stay clear of the shore. The large swells had not completely subsided and they became more dangerous as the rising tide again brought them closer to coastal homes. “People were still relocating to shelters, just to be safe,” said Saunders. “The next two sets of high tides weren’t as bad.”

In anticipation of the evening high tide and others to follow, the local government and the Ministry of Public Works started building berms with bulldozers in an attempt to protect the coastline. The combination of high tides and large swells promptly eroded most of these berms because of the poorly consolidated and fine material, such as sand, used to build them. Some berms made of coarser aggregate material – made from mixed grains sizes including sand, gravel, and rock – fared better.

"The idea behind berms is that they're migratory. So they're going to move as the island moves over time – whether via natural process or accelerated via climate variability and climate change," said Karl Fellenius, RMI Coastal Management Extension Agent for the University of Hawai'i Sea Grant College Program based in Majuro. Berms are part of the natural topography of atoll islands, but they have been highly modified or removed through development. Coastlines across the world are constantly changing shape under the powerful influence of ocean tides and currents – and atoll islands are particularly soft, and easily molded. "So there is a significant rationale for re-building berms using mixed grain-sized materials, compacting and vegetating them, and allowing them move with the island as the island moves. And then when the storms happen, they would provide some protective barrier but they're not intended to stop the island topography from changing."

KEY MESSAGE

Tailor information to the needs of the user – commitment to an iterative process involving the 'co-production of knowledge' at multiple levels will ensure that products and services are specific to sector and locale as well as the nature and timing of decision-making.

Given that the shorelines will, in the end, draw their own contours, berms cannot be the only solution to coastal flooding. "We need to find that good balance between a reasonable level of prevention coupled with a more effective early warning preparedness and response system," said Bannon.

This coastal flooding event particularly illustrated the need for a more robust early warning system. Most of the residents of Majuro did not realize the swell was approaching until the waves reached their homes at 3 am. "It didn't give people any time to protect their homes, remove or secure their property, or find alternative places to stay," Bannon said.

More time could have afforded people in affected areas to take those precautions – but it's not only the timing that must be improved. "It's also the content of the warning. Because if the content doesn't lead people to action, then there's no point," said Bannon. "An early warning, ideally, needs to be issued hand-in-hand with some recommendations for how communities can actually use that information. For people in certain areas – is it recommended for them to protect their property or to sandbag their doors – or evacuate?"

Recognizing the lack of accessible early warning prior to the flooding, IFRC is working with the Marshall Islands Red Cross, SPREP, and the National Weather Service on a pilot project, supported by FINPAC, an initiative of the Finnish government, commencing in January 2015 to address this need for a comprehensive early warning system. "The project will look into the kinds of weather and climate-related services that already exist, how they could be better used and communicated to the community and then work with the national disaster response framework to set up a community-based early warning system where people are notified and also have a plan in place for responding to different types of hazards," said Bannon. This is only

one of several efforts to address early warning, such as the High Sea Level and Inundation Forecast Tools for Majuro developed by Pacific Islands Ocean Observing System (PacIOOS) – for which Fellenius is the local liaison – and other work by regional groups such as NOAA, SPREP, SOPAC, SPC and PEAC. Building new partnerships –and leveraging existing ones – within these organizations will be important to maximizing the capacity of the Weather Service Office in Majuro to develop effective early warning systems for coastal flooding and other hazards, from early detection to widespread communication.

KEY MESSAGE

Direct attention to the alignment and coordination of activities – integrated program planning and product development will maximize efficiency and effectiveness – by minimizing gaps and overlaps and maximizing consistency of information and messaging – as well as enrich potential for local to regional capacity development.

Some areas were still flooded the next day, Wednesday March 4, but most of the roads were cleared of debris. Teams were sent out to assess the impact of the past day and more than 100 homes were found damaged on Majuro and Arno – many with doors and windows broken and debris washed inside. The foliage on breadfruit trees were turning yellow – distressed by the saltwater saturating their soil. A national state of emergency was announced that night. No coastal flooding was reported after that time, and by Wednesday evening most families had returned to their homes, with the exception of about 200 people who remained for about a week.

Local co-authors, Victoria Bannon, the Representative to the North Pacific Region for the International Federation of Red Cross and Red Crescent Societies (IFRC) in Majuro (left) and Karl Fellenius, RMI Coastal Management Extension Agent for the University of Hawai'i Sea Grant College Program based in Majuro

The Pacific Islands Climate Storybook can be found at: http://pacificislandsclimate.org/csdialogs/
Climate Stories can be found at: http://www.pacificislandsclimate.org/csstories/

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