risk profile

Sudden-Onset Hazards and the Risk of Future Displacement in Vanuatu

iDMC internal displacement monitoring centre

Families building a new kitchen beside the damaged house. Vunavose, South Santo, Vanuatu, April 2020, © UNICEF/UNI324720/Shing

Table of Contents

Cover image: Drying up school books that got wet during the cyclone. April 2020, © UNICEF/UNI324740/Shing

Summary

Disaster displacement is one of the world's biggest humanitarian and sustainable development challenges, and climate change and urbanisation serve to aggravate the phenomenon.

IDMC has built upon the risk analysis developed by the United Nations Office for Disaster Risk Reduction to look at future displacement risk associated with sudden-onset hazards such as earthquakes, tsunamis, cyclonic winds and storm surges. The analysis considered a wide range of hazard scenarios, their likelihood and their potential to cause housing damage, which serves as a proxy for displacement. At this stage, our model's current resolution, however, did not enable us to assess the risk associated with riverine floods in small island states.

This technical paper presents the initial results of our efforts to assess the risk of displacement associated with disasters and climate change in Vanuatu. It also recognises that relocation is an appropriate long-term adaptation strategy.

It examines risk levels and uncertainties for sudden-onset hazards by type to produce a baseline country risk profile via two national-level metrics:

- **Probable Maximum Displacement (PMD)** is the maximum displacement expected within a given time period, and determines outlier events that could occur during it.
- **Average Annual Displacement (AAD)** is a compact metric that represents the annualised accumulated effect of small to medium and extreme events and predicts the likely displacement associated with them on a yearly basis.

Storm surge represent Vanuatu's highest displacement risk. There is a 64 per cent probability that one will displace 10,900 people in the next 50 years. This is the country's PMD.

Sudden-onset hazards such as earthquakes, tsunamis, cyclones and storm surges are likely to displace an average of around 3,680 people during any given future year. This is the archipelago's AAD.

Displacement risk is determined by three factors:

1. **Hazard:** the likelihood of different hazards and their intensity
2. **Exposure:** the number of people and assets exposed to hazards
3. **Vulnerability**: the likelihood of exposed houses and buildings being damaged or destroyed

Our global disaster displacement risk model does not consider people's economic and social vulnerability.

It covers only the physical aspect by looking at the extent of damage and destruction that hazards of different intensities are likely to cause.

The results it generates provide insight into future disaster scenarios, informing decision-makers in their efforts to reduce the risk of displacement and with it the number of people forced to flee their homes when hazards strike.

The inhabitants of small island developing states in the Pacific are among the world's most exposed to disasters relative to population size. At least 50,000 are at risk of being displaced each year. Almost all human settlements, major services and tourism infrastructure are located in coastal areas, and sudden-onset hazards such as cyclones and flooding pose severe social and economic risks.

This report is divided into four main parts:

1. Background information on Vanuatu
2. A baseline for disaster displacement risk in the country
3. Moves toward risk-informed decision-making
4. Information on how our risk model was constructed, caveats and future improvements

What are disaster displacement and its associated risk?

Disaster displacement refers to "situations where people are forced to leave their homes or places of habitual residence as a result of a disaster or in order to avoid the impact of an immediate and foreseeable natural hazard. Such displacement results from the fact that affected persons are (i) exposed to (ii) a natural hazard in a situation where (iii) they are too vulnerable and lack the resilience to withstand the impacts of that hazard".[1]

Disaster risk refers to "the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity".[2]

Figure 1: Displacement risk: How is it estimated?

Background information

Map 1: Vanuatu location map

Located to the north-east of Australia, to the north of New Zealand, and between New Caledonia and Fiji, Vanuatu is a remote archipelago nation, consisting of a chain of 82 volcanic islands, including 13 principal islands, extending 850km from north to south.[3] Many of those islands sit just 0.9 metres (three feet) above sea level.[4] Home to almost 300,000 residents, Vanuatu concentrates a large share of its population, or about 36 per cent, in the capital, Port Vila, in Shefa province.[5]

The economy is based primarily on the exploitation of natural resources such as copra, beef, timber, kava and coconut oil. About 80 per cent of the population works in subsistence or small-scale agriculture, which makes up around ten per cent of Vanuatu's gross domestic product (GDP).[6] The GDP per capita is around $3,115. Vanuatu is among the last places in the world where the subsistence economy or "traditional economy" still outweighs the cash economy in terms of providing livelihoods for the population.[7]

Some agricultural crops are already showing signs of stress under current climatic conditions. Water- scarce areas and small islands that depend entirely on rainwater and underground water sources are also experiencing severe water shortages. Coastal erosion and flooding affect coastal communities, and fish poisoning has emerged as a danger in recent years. These problems will be aggravated by any further changes in climatic conditions.[8]

The tropical oceanic climate has two different seasons: a wet, hot season which runs from November to April and a dry, colder one that runs from May to October.[9] Vanuatu's latitude places it in the path of tropical cyclones, and it is subject to cycles of El Niño/La Niña-Southern Oscillation (ENSO), which respectively, increase the risks of droughts and floods, and make rainfall highly variable from year to year, with either very dry or very wet conditions.[10] Along with extreme events like cyclones, these conditions can significantly affect water quality, food security, infrastructure, livelihoods and health.[11]

Climate change is expected to affect the country's coastal resources through increased ocean acidification, sea

level rise and coral bleaching.[12] The sea level has risen by an average of six millimetres a year since 1993.[13] Vanuatu is the country with the highest disaster risk according to the World Risk Report.[14]

As in many small island developing states, exposure to hazards in Vanuatu is driven by the growing concentration of people and assets in urban, low-lying coastal areas. Disasters affect ever more people in these areas, inflicting increasing harm in terms of employment, housing, and critical infrastructure, such as roads, power and water supplies.[15]

More than 94 per cent of the population live in coastal areas where the vast majority of services, infrastructure and agricultural production can be found.[16] In addition to sea-level rise, these areas are exposed to cyclones and storm surges, which have the potential to cause significant economic as well as human harm. The archipelago's interior is mountainous, volcanic and ill-suited for human habitation. Larger islands are characterised by rugged volcanic peaks and tropical rainforests. The highest peak, Mount Tabwemasana on Espiritu Santo, is 1,877 meters above mean sea level.[17]

Sea level rise in Vanuatu is well above the global average and threatens subsistence agriculture and the viability of human settlements.[18] Coastal infrastructure such as roads and paths are regularly washed away and have to be rebuilt. A case in point is what happened to the residents of Tegua island in Torba province. They were inundated by high tides and relocated to higher ground in the village of Lirak in 2004 (see box 2).[19]

The 2016 census, carried out after Tropical Cyclone Pam, reveals that 25 per cent of the country's population live in urban areas, where risks tend to be concentrated. Port Vila, which holds about 51,500 people and accounts for nearly 20 per cent of the country's population, experienced rapid growth between 1999 and 2009 when the population increased by more than 50 per cent. Recent estimates indicate a slightly reduced growth rate during the past decade. This trend is believed to stem, at least in part, from economic effects following the global financial crises of 2008.[20]

Many Pacific cities have expanded in recent years with the establishment of informal settlements on riverbanks and estuaries, and in peri-urban areas, waste disposal sites and mangrove swamps. These factors drive up the risk and potential impacts of disaster displacement.[21]

Rapid urbanisation in Port Vila has resulted in high population density in exposed and vulnerable areas of the city. The peri-urban areas of the city are growing at twice the rate of Port Vila. So are nearby villages outside the city limits, such as Erakor, Eratap, Ifira, Mele and Pango.[22] Combined with poor housing quality and deficits in critical services and infrastructure, this population density makes the people in these places highly vulnerable to displacement. [23] The situation is exacerbated by the failure of the urban housing and land markets and the related shortage of affordable housing in urban areas. A recent assessment of the rapidly growing informal settlements of the city have identified up to 21 unauthorized settlements with a combined population of as many as 43,000 people, or about 40 per cent of the urban population.[24] These settlements are located on lands that have been deemed unsuitable for urban development, as they are subject to one or more climate hazard risks.[25]

Box 1: Law and policy on disasters in Vanuatu

The government of Vanuatu in 2012 established a National Advisory Board (NAB) on Climate Change and Disaster Risk Reduction Project Management Unit within the Vanuatu Meteorology and Geo-Hazards Department. The NAB is a committee made up of government and non-government members. It is Vanuatu's supreme policymaking and advisory body for all disaster risk reduction and climate change programs, projects, initiatives and activities.[26] After the widespread damage caused by Cyclone Pam when it hit Vanuatu in March 2015, the government sought to further strengthen the country's ability to mitigate climate change and disaster risk.

Launched in 2015, the National Policy on Climate Change and Disaster Risk Reduction 2016 – 2030, highlights Vanuatu's government renewed commitment to increase the country's resilience to climate change impacts and disaster risks provides a framework for mainstreaming climate change and disaster risk reduction into sustainable development processes. The policy takes a practical approach, taking into consideration Vanuatu's resources, exposure to risks and demographic situation. By promoting cooperation between local and national authorities and organisations, as well as between national, regional and international ones, it makes the country one of the global leaders in disaster prevention and recovery.[27]

One of its most important initiatives was the development of a national policy on resettlement and internal displacement enacted in 2018.[28] In doing so, Vanuatu became the first country in the Pacific with a specific policy on displacement. This policy adopts a broad concept of "disaster" so that it encompasses both natural hazards and a wide range of "man-made" displacements, such as evictions, land conflicts and those caused by development. It approaches these holistically in order to provide assistance to affected communities through a common set of principles and standards across a range of different scenarios.[29]

The national policy stresses durability, or the importance of finding "durable solutions" for people who are unable to return to their place of origin. It is in line with the Guiding Principles on Internal Displacement.[30] System- and sector-level interventions cover a range of areas, including governance, data, protection and capacity building and integrate consultation and participation mechanisms. This innovative approach combines policy areas such as land, housing, health, education, livelihoods, indigenous knowledge, security and access to justice with the effective application of the policy, through guidance on implementation, financing and monitoring.[31]

These policies linked to disaster and displacement are incorporated into Vanuatu's National Sustainable Development Plan (NSDP) for 2030. The policy framework creates an inclusive plan for a stable, sustainable and prosperous country. Enhancing resilience and adaptation to climate change and disasters are core priorities of the plan.[32]

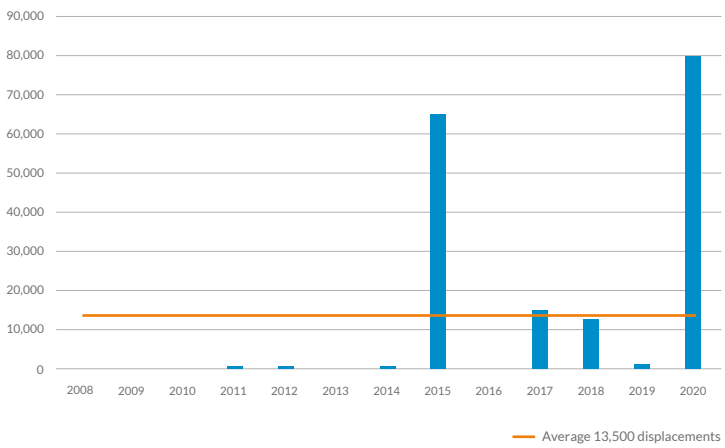
Vanuatu has experienced many disasters in recent history. The deadliest occurred in late December 1951 when a tropical cyclone killed 100 people.[33] Tropical Cyclone Uma killed 48 people in 1987 and left about 5,000 people homeless around Port-Vila on Efate Island.[34]

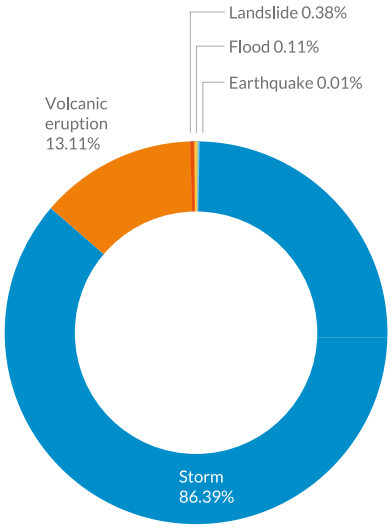
The country lies on the so-called Ring of Fire, a seismically active area of the Pacific that accounts for 75 per cent of the world's volcanoes and more than 90 per cent of its earthquakes.[35] The most significant geophysical event occurred in 1999, when a 7.4-magnitude earthquake followed by a tsunami and landslides killed 12 people and destroyed numerous buildings. The epicentre of the quake was just off the east coast of Ambrym Island.[36] The waves reached heights of about 6.6 metres on Pentecost Island in Baie Martelli. Large numbers of people were evacuated pre-emptively and fled inland and to higher ground before the waves struck. Many lives were saved as a result.[37]

Disaster displacement in Vanuatu: historical trends (2008-2020)

Disasters have triggered almost 175,000 displacements in Vanuatu since 2008 when IDMC began systematically monitoring data on the phenomenon. Cyclone Pam, which struck the country in March 2015, represents more than 37 per cent of the total displacement. Tropical Cyclone Harold, which devastated Sanma and Penama provinces in 2020 and which our preliminary analysis shows displaced a quarter of the population, and represents 46 per cent of the total displacement (See box 3). Since 2008, IDMC has detected 19 displacement events triggered by weather-related hazards, such as storms and floods, and geophysical hazards.

Figure 2: New disaster displacements in Vanuatu (2008-2020)





BOX 2: Temporary and permanent community relocations

Whole communities have been displaced and then relocated through state-led initiatives in Vanuatu. The 2018 policy on disaster displacement recognises that planned relocation is an option of last resort. Where communities need to move away from hazards, either temporarily or permanently, the policy highlights the need to mitigate relocations' potential negative effects. It also calls for safeguarding and protecting human rights and full social and economic recovery.[38] This includes the development of sustainable livelihoods to ensure that displaced and relocated households can earn an income and reduce their risk of poverty.[39] The policy also recognises that more guidance is needed from the national and provincial governments with regards to managing relocations with customary land holders.

The best known state-led relocation in Vanuatu involved the inhabitants of the Lateu community, located on Tegua Island in the Torres Islands chain.[40] This garnered international attention when a press release from the UN Environment Programme called the villagers the first climate change refugees.[41] Since an earthquake in 1997, the village had been increasingly affected by sea water entering with the high tides. Its leaders began to ponder the possibility of moving the village to Lirak. After years of discussions, assessments of potential new locations, and the involvement of the national authorities, the community formally decided to relocate in 2004.[42] Eventually about 50 people from 10 households were relocated to the new community, which though lacking a school for older children, had a kindergarten as well as a church, community hall and a station for delivering aid. Post-relocation assessments emphasised that the relocated inhabitants were happy with the decision. They also highlighted, however, that the new site was prone to flooding.[43]

In anticipation of the possible eruption of the Manaro Voui volcano, a state of emergency was declared on the island of Ambae in late September 2017. The entire population of around 11,600 people was then pre-emptively evacuated by the National Disaster Management Office in early October.[44] The state of emergency was lifted in the latter part of that month when the government decided that conditions allowed for their return. Most of the evacuees did so within three days. Manaro Voui continued to be active, however. Given the increasing risk of future eruptions, the government initiated a "second home" programme involving, with their approval, the relocation of about 300 families.[45] Some of these families relocated permanently and only returned to Ambae for special occasions. Others chose to return and only use the new site as a refuge during disaster events.[46]

The data in table 1 above shows the estimated number of new displacements by event. Added up over years or decades, the figures may include people who have been displaced more than once. In this sense, the number of new displacements does not necessarily equal the number of people displaced.

Weather-related events triggered more than 152,000 new displacements, or almost 87 per cent of the total new displacements recorded over the last two decades. Storms, particularly tropical cyclones, were the main triggers. Tropical Cyclone Pam, the most powerful cyclone to hit Vanuatu in recent times, led to widespread destruction after striking on 12 March 2015 and continuing through 14 March 2015, the day of the opening conference of the Third UN World Conference on Disaster Risk Reduction held in Sendai, Japan. It was a Category 5 cyclone and was comparable in intensity to Typhoon Haiyan, which lashed the Philippines in November 2013.[47] Winds from Cyclone Pam were estimated to have reached 250 km per hour with gusts of 320 km per hour.[48] About 166,600 people were estimated to have been affected, more than half the country's population.[49] Around 80 per cent of the national housing stock was damaged or destroyed.[50] More recently, Tropical Cyclone Harold struck Vanuatu in 2020, with severe impacts in Penama Province and even greater ones in Samna Province, home to the country's second biggest city, Luganville (see box 3).

Geophysical events triggered more than 23,000 movements representing almost a quarter of the displacement recorded between 2008 and 2020. Vanuatu in 2018 was preparing for the possible eruption of Manaro Voui, on the island of Ambae. Faced with potential risks to the whole island, the government evacuated its population of around 11,600 people (see box. 2).

Table 1: Historical displacement events in Vanuatu (2008-2020)

Year	Event Name	Hazard Type	New Displacements
2011	Tropical Cyclone Atu	Storm	400
2012		Storm	700
2013	Paama Landslide	Landslide	69
2014	Tropical cyclone Lusi	Storm	100
2014	Efate flash floods	Flood	200
2015	Cyclone Pam	Storm	65,000
2017	Tropical Cyclone Cook	Storm	700
2017	Vanuatu: Volcanic activity - Ambae island - 22/09/2017	Volcanic eruption	11,000
2017	Tropical Cyclone Donna	Storm	3,000
2018	New Caledonia, Vanuatu: Earthquake/Tsunami - 5/12/2018	Earthquake	11
2018	Vanuatu: Volcanic activity - Ambae island - 18/3/2018	Volcanic eruption	600
2018	Vanuatu: Mudflow - Waluwebue, Ambae - 31/3/2018	Landslide	100
2018	Vanuatu: Landslide - Maewo - 12/9/2018	Landslide	500
2018	Vanuatu: Volcanic activity (Ambrym) - Ambrym - 15/12/2018	Volcanic eruption	300
2018	Vanuatu: Tropical Cyclone Hola - 6/3/2018	Storm	100
2018	Vanuatu: Volcanic activity (Manaro) - Ambae island - 19/7/2018	Volcanic eruption	11,000
2019	Papua New Guinea; Vanuatu: Tropical Cyclone Oma - 13/2/2019	Storm	1,000
2020	Vanuatu: Volcanic ashfall - Tafea (Tanna island) - 31/03/2020	Volcanic eruption	8
2020	Vanuatu, Solomon Islands, Fiji, Tonga: Tropical Cyclone Harold - 01/04/2020	Storm	80,000

BOX 3: Two devastating cyclones in five years, cyclones Pam and Harold

Tropical Cyclone Pam hit Vanuatu in March 2015, destroying a significant proportion of the housing stock and displacing more than 65,000 people. Most of the national population was affected, with around 166,000 people on 22 islands in need of emergency assistance, including the entire population of Port Vila.[51]

Around 17,000 buildings were damaged or destroyed, including houses, schools, medical clinics and other medical facilities. The cyclone destroyed crops on a large scale and affected the livelihoods of at least 80 per cent of Vanuatu's rural population.[52]

The economic losses associated with the cyclone were estimated at about $449.4 million, or around 64 per cent of Vanuatu's GDP.[53] Additional negative economic impacts, however, have been felt for several years as a result of lingering production losses and higher production costs.

Cyclone Harold hit the Solomon Islands on 2 April 2020, causing widespread flooding. It gained strength and made landfall in Vanuatu on 6 April as a category 5 cyclone with sustained winds of more than 200 km/h. Harold continued moving south-east to Fiji, where it displaced another 10,000 people before attaining its full strength on Tonga, where it coincided with a king tide phenomenon, displacing 500 people. It was the most violent cyclone to strike the archipelago since Cyclone Pam.

IDMC estimates, based on damages to housing, that more than 80,000 people have been displaced across Vanuatu as a result of Cyclone Herald. This represents almost a quarter of the country's population. In some areas, like Sanma province in Vanuatu, 80 to 90 per cent of the population have lost their homes.[54] As of 6 June 2020, more than 6,200 individuals were still reported as displaced, spread out across 569 host families and 178 evacuation centres.[55] Many communities remained cut off from assistance because of flooded and damaged roads.

Vanuatu has been relatively spared from the effects of the COVID-19 pandemic, but response to the disaster has been slowed by restrictions aimed at preventing the disease's spread. Overseas humanitarian workers, for instance, have not been allowed to enter the country.[56]

Recent assessments suggest that about 16,000 dwellings were damaged and more than 5,000 destroyed by Cyclone Harold.[57] According to the 2016 census, 75 per cent of dwellings in Vanuatu are traditional and semi-permanent structures, making them particularly vulnerable to intense hazards. These houses suffered the heaviest damage when the cyclone struck Sanma province.

The recent Post-Disaster Needs Assessments (PDNA) conducted by Vanuatu's government estimates combined economic losses from Covid-19 and disasters to be $617 million, or about 61 per cent of GDP, in 2020.[58]

Individual households have their own timeframes for recovery, distinct from the national recovery process. Initially safe temporary housing is a priority. Durable solutions take time, especially because they are linked to the recovery of livelihoods, whether through agriculture or some other income source. As incomes have been particularly affected by Covid-19, displacement and recovery will be protracted. Long-term support may be required.[59]

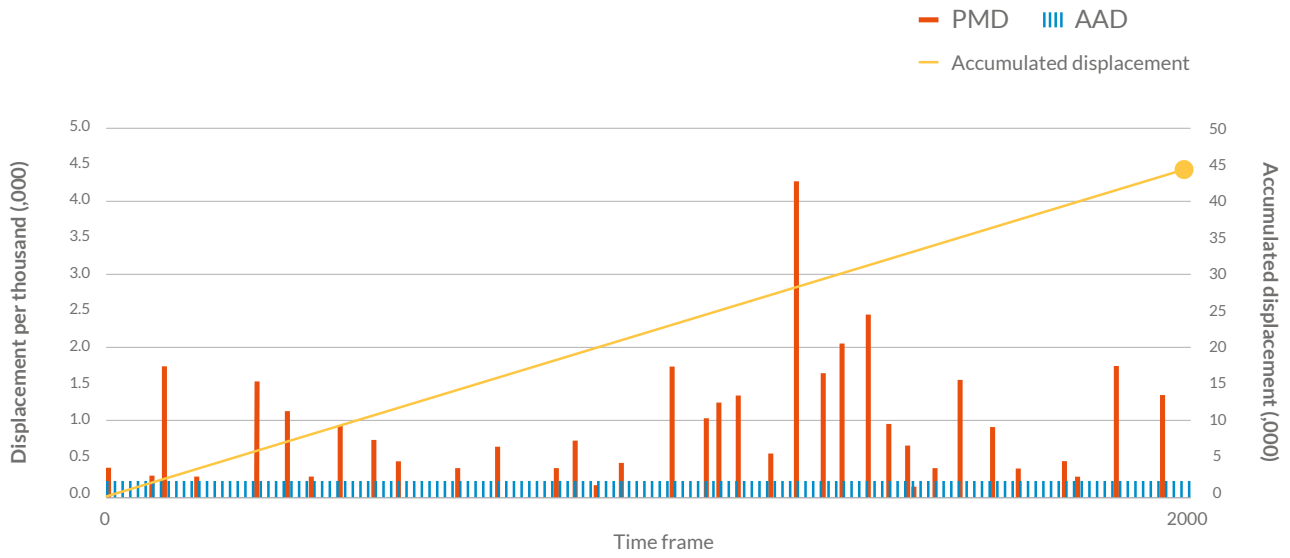
Disaster displacement risk in Vanuatu

The baseline established by our global disaster displacement risk model presents results at the national level and provides insight into future displacement situations. This analysis of future displacement risk associated with sudden-onset hazards, including earthquakes, tsunamis, storm surges and cyclonic winds, considers a large number of possible hazard scenarios, their likelihood, and the potential damages to housing, which is used as a proxy for displacement.

Displacement risk: two key metrics and how to read them

Our multi-hazard Global Disaster Displacement Risk Model provides two metrics at the national level: the **Average Annual Displacement (AAD)** by hazard and the **Probable Maximum Displacement (PMD)** by hazard. Because these metrics are based on a global model, the granularity of the data is low and estimates should be considered conservative.

Figure 3: How we calculate Probable Maximum Displacement (PMD) and Average Annual Displacement (AAD) by hazard



Source: UNDRR, 2015

Box 4: The concept of risk return periods

The concept of return period is often misunderstood. If a disaster or displacement event has a 500-year return period, that does not mean it will only occur once every 500 years. Nor does it mean that if it occurred today, it would not recur for another 500 years. Rather, it means that it happens once every 500 years on average. If there were four extreme events in the space of a century followed by 19 centuries without any, the return period would still be 500 years.[60]

The longer an event's return period, the less likely it is to occur in any single year. It is also possible for an event with a 500-year return period not to occur at all over five centuries. The most common misconception is that a 100-year flood will only occur once per century. That is not true. There is a small probability that such an intense event could happen every year. If a 100-year flood happened last year, it can happen again before the next century, or even this year. It is also possible for such an event to not occur within a 100-year period.

That said, Houston in Texas experienced 500-year floods for three years in a row between 2015 and 2017, the last one caused by hurricane Harvey. This prompted the city's authorities to revise zoning regulations to account for changes in the flood drainage basins around it.

We expect to see many similar revisions as climate change alters the frequency and intensity of extreme events, and rapid urban sprawl shrinks the natural areas available to absorb floodwater.[61]

The model considers the likelihood of different hazards, as well as their intensity, to estimate the number of people that could be forced to flee from their habitual place of residence as a result of severe damage or destruction that could render housing uninhabitable. Many factors, including insurance penetration and coverage, coping capacity, humanitarian responses and recovery efforts, also influence the duration and severity of displacement.

Probable Maximum Displacement (PMD) by hazard

Probable Maximum Displacement (PMD) is the maximum displacement expected within a given time period. It answers the question: What is the maximum expected displacement within a range of X years? It represents the outlier event that could occur during a specific time frame. PMD can be used to determine the size of shelters and other assets that a government needs to provide to cope with the potential magnitude of displacement.

A hundred years does not mean it will occur every 100 years (see Table 2). There is a common misconception that an event with a 100-year return period will only occur once a century, but that is not the case (see Box 4). There is a small probability that such an intense event could happen much more frequently. PMD for different return periods is best expressed as the probability of a given amount of displacement being exceeded over different periods of time.

Even in the case of a 1,000-year return period, there is a five per cent probability of PMD being exceeded over a 50-year time frame. This metric is relevant to planners and designers of infrastructure projects because investments are often made with an expected lifespan of 50 years.

Average Annual Displacement (AAD) per hazard and multi-hazards

AAD is a measure of the magnitude of future displacement by hazard type that a country is likely to experience. It does not reflect the number of displacements it will face each year, but the number it can expect per year considering all the events that could occur over a long timeframe. AAD is a compact metric with low sensitivity to uncertainty.

Multi-hazard AAD is calculated by aggregating the figures of each hazard type. This metric encompasses the probability that cyclonic winds and storm surges could destroy one single house, and could be double "counted" when calculating multi-hazard AAD. The probability that double severe damages occur is not nil.

Results: displacement risk by hazard

As described above, AAD represents the annualized accumulated effect of all the catalogue events. It is a compact metric which accounts for the probable displacement of small-to-medium and extreme events. Our model suggests that around 3,680 people could be displaced by disasters in Vanuatu in any given year of the future . This is its AAD (see table 3).

AAD is useful for providing a sense of the scale of the annual risk of displacement, but it tends to hide potential outliers. High-intensity but low-frequency events that trigger mass displacement could take place over extremely long-time spans. A category 5 cyclone or a 7-magnitude earthquake, for instance, could strike Vanuatu unexpectedly and

Total: 3,677

EARTHQUAKE

417

STORM SURGE

1,125

TSUNAMI

1

CYCLONIC WIND

2,134

Table 2: Concept of probabilities for different return periods

Return period (years)	Probability of displacement exceedance per year	Probability of displacement exceedance in 20-year timeframe	Probability of displacement exceedance in 50-year timeframe
25	4.0%	56%	87%
50	2.0%	33%	64%
100	1.0%	18%	39%
250	0.4%	8%	18%
500	0.2%	4%	10%
1,000	0.1%	2%	5%

Table 3: Displacement risk by hazard in Vanuatu

			Return Period in years					
Hazard	ADD	PMD 10	25	50	100	250	500	1,000
Storm Surge	1,125	3,600	6,200	10,900	12,000			20,000
Cyclonic Wind	2,134	1,100	23,000	32,000	41,000	50,000		60,000
Earthquake	417	850	2,500		6,000	10,200	13,000	17,000
Tsunami	1				1	20		250

cause significant displacement. Such extreme events may not have occurred since record keeping began, but they can still take place, and it is important that the country be prepared for them. Cyclones Eric and Nigel which struck the archipelago within a week in 1985 and Uma in 1987 are examples of disasters at an unprecedented level.

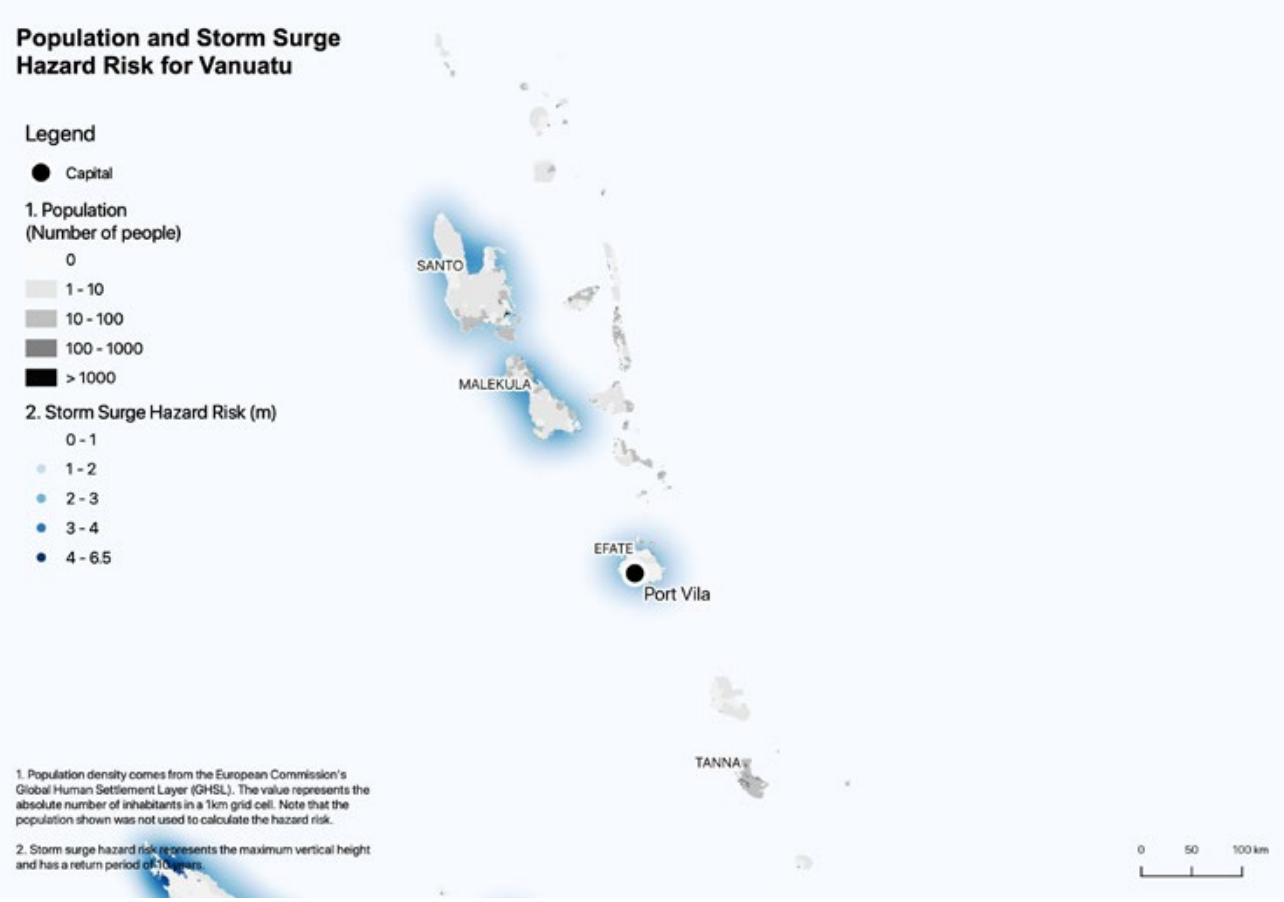
The model considers the likelihood of different hazards and their maximum intensity at different return periods (see table 3). This national-level resolution is based on global-level observations and data. It provides multi-hazard risk metrics and allows risk levels to be compared across countries, regions and hazard types. At this scale, the estimates should therefore be considered conservative.

Risk of displacement as a result of storm surges

As a cyclone moves across an ocean, its winds push the water into a wall as it nears landfall, creating a storm surge. Impacts depend on coastal topography and the tides. The risk of displacement enters uncharted territory with king tides, which occur when extreme weather events coincide with uncommonly high tides caused when the gravitational pull of the moon and the sun are aligned.[62] Storm surges represent Vanuatu's highest displacement risk. On average 1,125 people can be expected to be displaced per year considering all the events that could occur over the return period.

Looking at PMD, there is a 56 per cent probability that a storm surge will displace about 6,200 people at some point in the next 20 years. There is a 33 per cent probability that Efate island will experience storm surges of around two to three metres during the same time period.

Map 2: Storm surge risk map



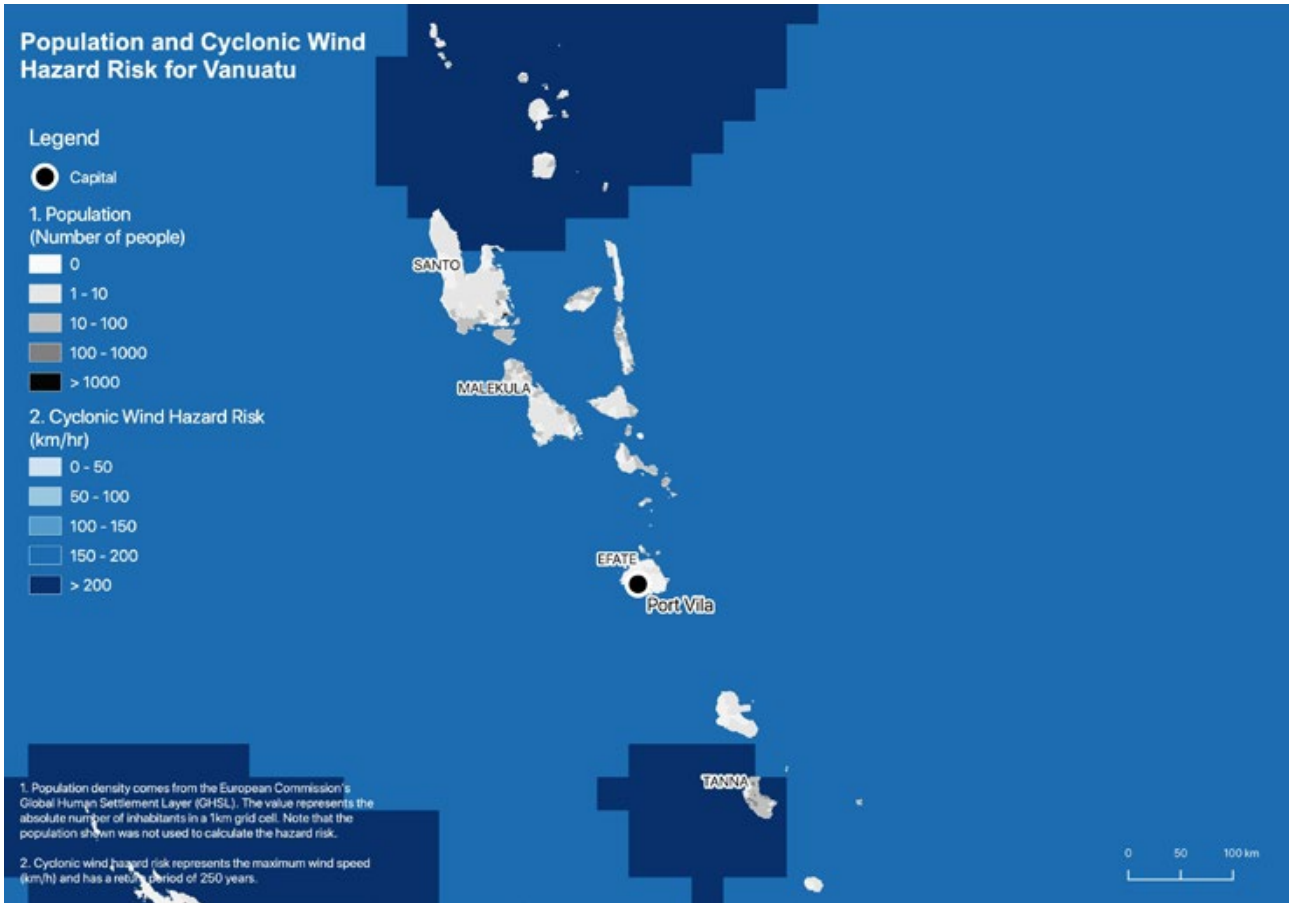
Risk of displacement as a result of cyclonic winds

The risk from cyclonic winds in Vanuatu is very high. The country is located to the south of the equator in the South Pacific convergence zone, which is known for frequent cyclones.

Cyclones use warm, moist ocean air as fuel to gather force. They stay strong for longer periods in the South Pacific convergence zone because they are not obstructed by large land masses that would deprive them of their fuel and slow them down with greater friction than exists on the sea surface.[63]

On average 2,134 people are expected to be displaced per year considering all the events that could occur over the return period. Winds with speeds greater than 190km/h could strike Vanuatu. They could reach speeds of more than 200km/h in the north and the south of the archipelago. Looking again at PMD, there is a 64 per cent probability that a cyclonic wind will displace about 32,000 people at some point in the next 50 years.

Map 3: Cyclonic wind risk map

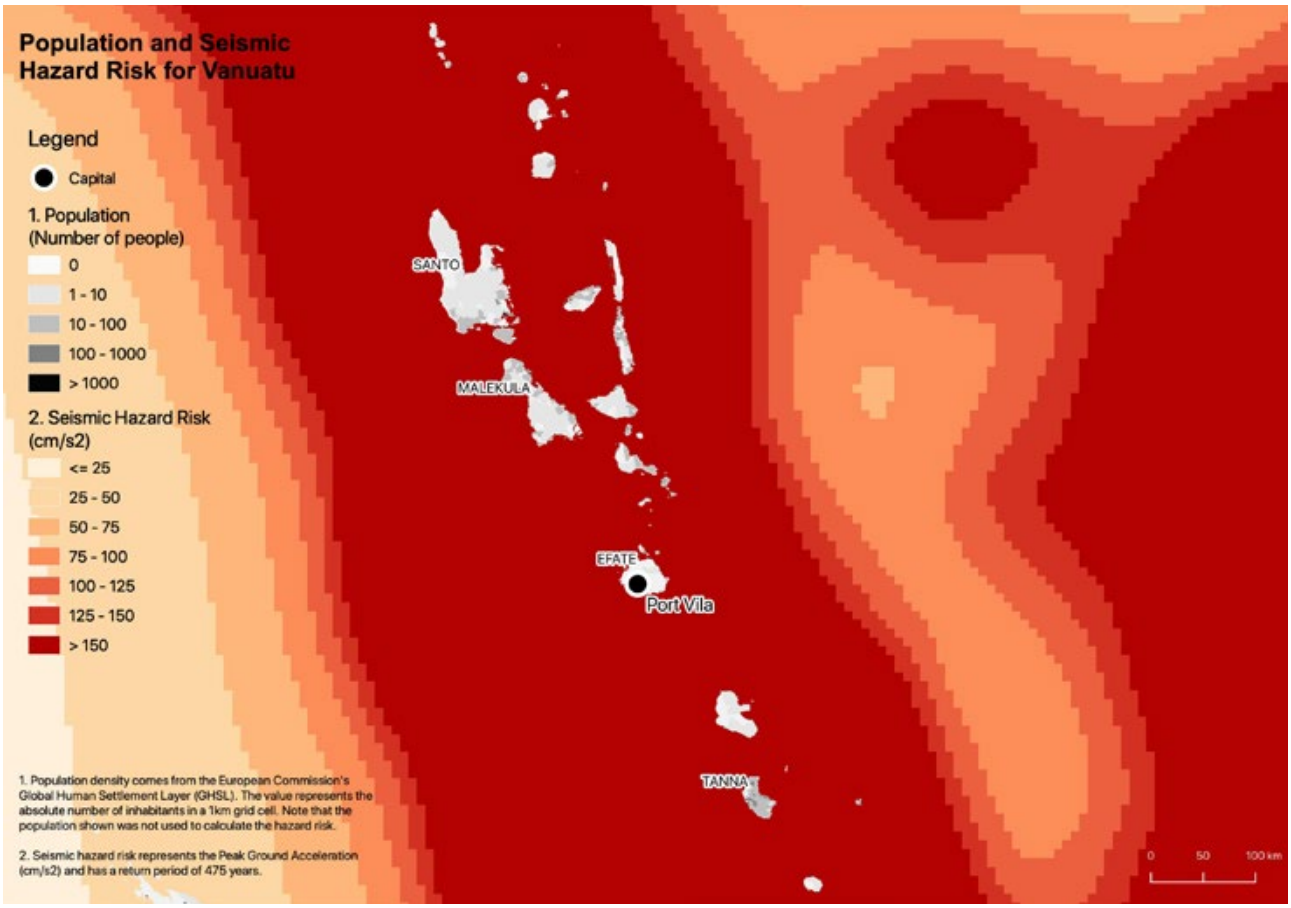


Risk of displacement as a result of earthquakes

The archipelago of Vanuatu is in a seismically active area above the collision between the Australia and Pacific tectonic plates. The displacement risk associated with earthquakes is high. On average, 417 people are expected to be displaced per year given all the events that could occur over the return period.

In terms of PMD, there is a 39 per cent probability that an earthquake will displace about 6,000 people at some point in the next 50 years. The map below shows earthquake intensity zones and indicates where there is a 10 per cent probability that degrees of intensity will be exceeded in the next 50 years.

Map 4: Seismic hazard risk map



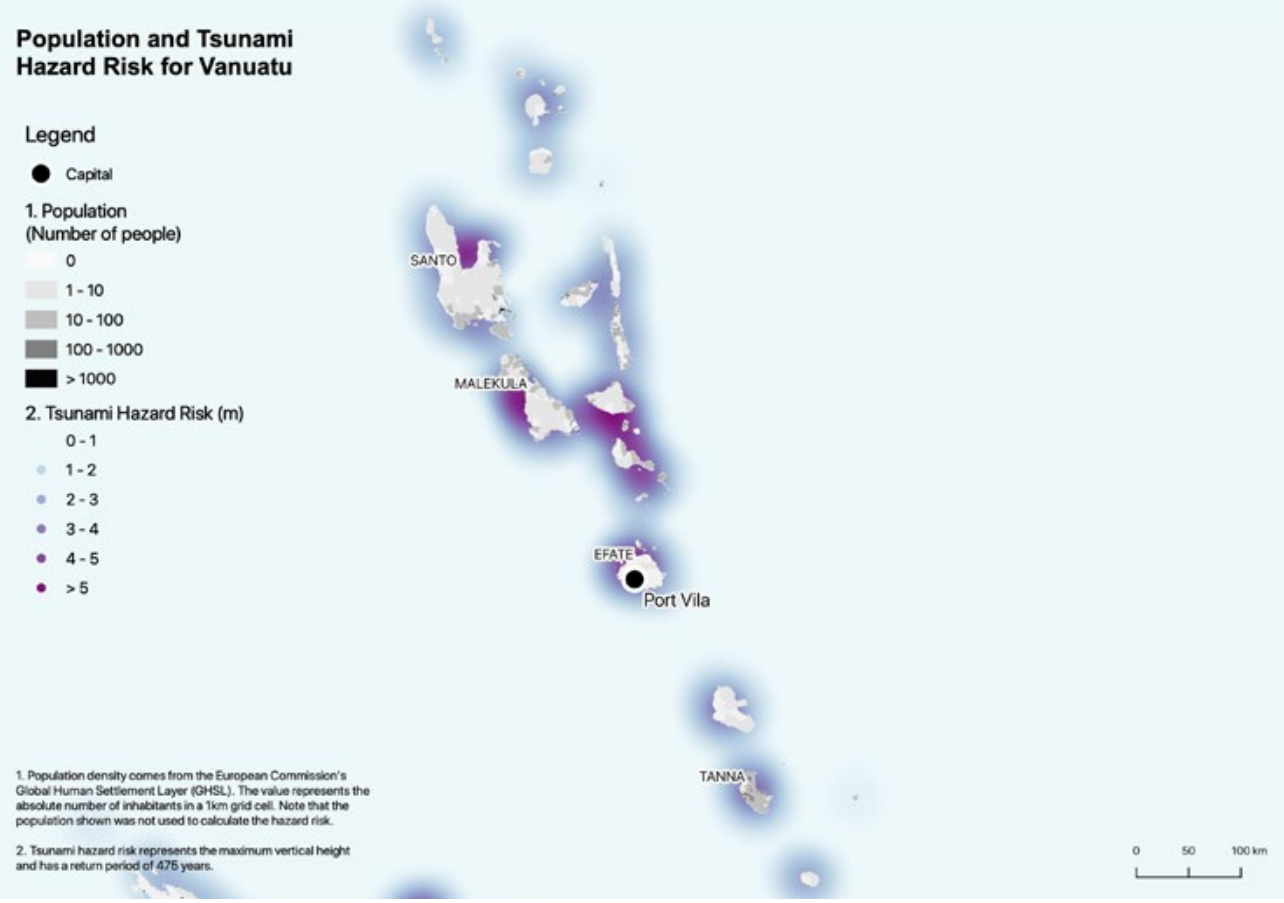
Risk of displacement as a result of tsunamis

Vanuatu is particularly vulnerable to tsunamis. During a tsunami, waves push a large amount of water above sea level onto the shore. This is known as the run-up. The maximum vertical height above sea level reached by a tsunami onshore is estimated to be around three to four metres for most of the coastal areas at risk. It could be higher than 15 to 20 metres, however, on the west coast of Santo and Malekula islands.

The archipelago is somewhat protected by coral reefs that could dissipate wave energy, but the islands are still vulnerable to significant damage from tsunamis, the effects of which are greatly amplified if they coincide with high or king tides.

On average, one person is expected to become displaced per year considering all the events that could occur over the return period. In terms of PMD, there is a five per cent probability that a tsunami will displace about 80 people at some point in the next 50 years.

Map 5: Tsunami risk map



Toward risk-informed decision making

Disasters have triggered about 290 million displacements around the world since we began collecting data on the phenomenon in 2008. This is more than three times the figure for conflict and violence displacements. Given its scale, the need to address the risk of disaster displacement has been explicitly recognised in global policy agendas on disaster risk reduction and climate change. The UNFCCC's Warsaw International Mechanism on Loss and Damage associated with Climate Change Impacts has established a task force on displacement, which recognises the need to "avert, minimise and address displacement related to the adverse impacts of climate change.[64]

Global agreements on disaster risk reduction, such as the Hyogo Framework for Action 2005–2015 and the Sendai Framework for Disaster Risk Reduction 2015–2030, have promoted and significantly increased efforts to reduce disaster risk in general. The Sendai framework recognises the importance of addressing displacement risk in particular.[65]

Despite these advances, the number of disaster displacements is likely to increase in the future. Weather-related hazards account for more than 87 per cent of all those recorded to date, and climate change and the increasing concentration of populations in exposed areas mean that ever more people are at risk.

People displaced by disasters face similar challenges to those who flee conflict and violence. Many lose their homes, assets and income. They face insecurity, reduced access to water, food and services such as healthcare and education, and disrupted social networks.

Our data shows that internal displacement is on the rise globally. Addressing the phenomenon will require significant humanitarian and development measures, but resources are becoming increasingly stretched to service a growing number of priorities. This calls for a new and more comprehensive approach to mitigate and reduce the risk of medium and long-term displacement.

Why do we need to understand risks?

Monitoring disaster displacement typically means accounting for the number of people displaced or homes destroyed after a disaster occurs. This information provides a baseline to inform emergency responses and disaster management. Retrospective analysis, however, is only one element of informed planning and decision making, particularly when it comes to mitigation and prevention. It should be complemented with probabilistic analyses and metrics, such as those presented in this report.

As the UN Office for Disaster Risk Reduction (UNDRR) has emphasised: "Catastrophic earthquakes or tsunamis may only happen every 500 or 1,000 years in any given place. As such, even though records may go back centuries, most of the extreme events that could potentially occur have not happened yet. And, although data on disaster loss provides a guide to the past, it is insufficient to predict and estimate damages that may occur at present and in the future."

The risk of future displacement is determined by the way in which policies and processes influence peoples' exposure and vulnerability to hazards, and many governments and operational stakeholders recognise the need to understand the issue. Demand for models and tools to estimate its potential scale and severity is growing, but developing and improving them takes time.

Estimating displacement risk using probabilistic approaches requires highly localised and detailed information. Many governments, however, lack the data needed to validate models and conduct comprehensive quantitative assessments. More capacity building is needed before they will be able to adapt models to their own needs and apply the results to policy development and investment planning.

Investments should be made in understanding disaster risk in all its dimensions: the exposure and vulnerability of people and assets, hazard characteristics, response capacity and environmental factors. Such understanding would also inform preparedness measures and effective responses that build back better.

The initial results from our probabilistic model provide useful baselines for policymakers working to implement the Sendai framework, the Paris Agreement of the UN Framework Convention on Climate Change (UNFCCC), the Warsaw International Mechanism and the Agenda for Humanity.

Box 5: The definition of disaster risk

/rɪsk/
The potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity (*UNDRR – 2017*). Risk is the possibility of something bad happening.

Families who moved to Santo during the evacuation of their home island, Ambae due to the Manaro eruptions, waiting for their roofs being repaired after TC Harold. April 2020, © UNICEF/ UNI324730/Shing

Methodological considerations and caveats

IDMC's global disaster displacement risk model

We began a unique probabilistic modelling exercise in 2017 with our global disaster displacement risk model, which assesses the likelihood of such population movements in the future.

Since 2011 the UN Office for Disaster Risk Reduction (UNDRR), has rigorously analysed the risk of economic losses due to disasters risks in its Global Assessment Report (GAR).[66] One critical gap, however, concerns evidence and analysis of the risk of disaster-related displacement, a problem which hinders the effective reduction of both displacement and disaster risk.

This risk profile for Vanuatu lays the groundwork for addressing this gap. It presents the first results generated by IDMC's global disaster displacement risk model in 2017, which builds upon and extends the analysis presented in the GARs.[67]

The model's results can be used to inform national and sub-national disaster risk reduction (DRR) measures, identify areas where large numbers of people could be made homelessness by disasters, and calculate evacuation-centre capacities and the amount of investment needed to support displaced people.

In short, they allow decision makers to make risk-informed efforts to prevent displacement happening in the first place and reduce its impacts when it does occur.

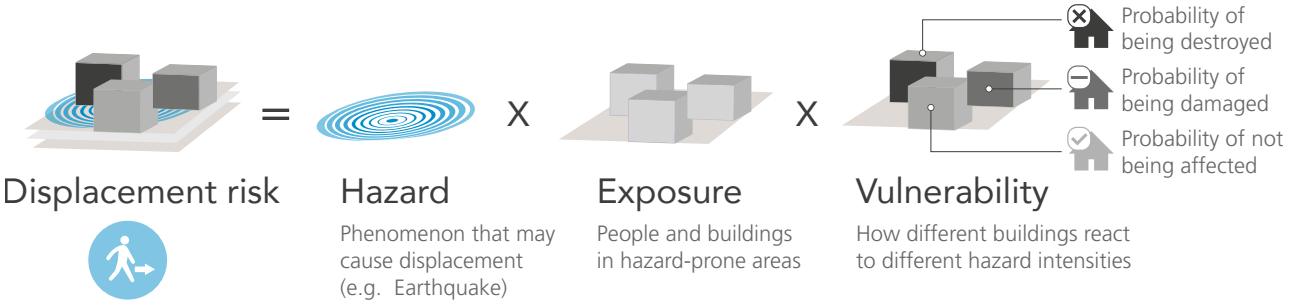
The model can be adapted to support operations in real time by indicating the number and location of homes severely damaged or destroyed by observed and forecasted hazards. This has the potential to make responses more timely and better targeted and ultimately save lives. It also provides a benchmark for measuring progress toward DRR and climate change policy objectives.

Our Displacement risk model is determined by three factors:

1. **Hazard:** the likelihood of different hazards and their intensity
2. **Exposure:** the number of people and assets exposed to hazards
3. **Vulnerability**: the likelihood of exposed buildings being damaged or destroyed

The model does not consider people's economic and social vulnerability. It covers only the physical aspect by looking at the extent of damage and destruction that hazards of different intensities are likely to cause (see figure 4).

Figure 4: Displacement risk: How is it estimated?



The model does not account for pre-emptive evacuations, which means its estimates are inherently conservative. In countries with strong disaster preparedness capacity where such evacuations occur, such as Bangladesh, China, Cuba, Japan and Viet Nam, it underestimates the number of reported displacements significantly. In countries with weaker capacity, and for hazards such as earthquakes for which early warning systems are limited, historical data and the model's estimates are a closer fit.

What about displacement risk associated with slow-onset hazards?

Our global model only considers displacement risk associated with sudden-onset hazards. It is also possible to consider slow-onset phenomena such as drought, desertification, sea level rise and coastal erosion. We have, for example, modelled drought displacement risk in the Horn of Africa.[68]

Such complex exercises, however, need to take many human factors into consideration. They are time-consuming and require historical data on various indicators to validate and generate confidence in the results. We do not yet have such a model for countries in the Pacific, but we would be willing to develop one if there were interest and the resources to do so.

Caveats and future improvements

This risk assessment considers a large number of possible scenarios, their likelihood, and associated damages to housing. Our risk model is informed by and relates to medium to large-scale events, but small and recurrent events still require the daily monitoring of empirical information to understand the true historical scale of displacement.

The results are a probabilistic indication of the potential impact of events, but underlying limitations and simplifications mean the figures for individual events and the calculated impacts on particular assets are unlikely to be precise.

Our global model, presenting results at a national level, aims to provide insight into future displacement situations. It allows decision-makers to take risk-informed decisions that can help prevent and reduce the risk of displacement before it happens. The model calculates how many people will be displaced on average every year by sudden-onset hazards, (earthquakes, tsunamis, floods, cyclonic winds and storm surges). Results are based on the likelihood of housing destruction and show that, globally, 14 million people on average could be displaced in any given year. The model also calculates the probable maximum displacement (PMD) that could be expected within a given return period. (See section Two key metrics and how to read them).

The displacement risk metrics were developed at the global level and so have low granularity, but they are still a useful baseline and guide. The model has analysed more the 4.5 million cells containing proxies for exposed assets and people at a resolution of five square kilometres, and one square kilometre along the coast. Millions of hazard scenarios have also been compiled. The resolution used in 2017, however, did not allow us to run a proper risk assessment for riverine floods in small island states. Nor is its current resolution suitable for informing land use and urban planning decisions.

The model excludes displacements associated with pre-emptive evacuations. This information must be collected in the aftermath of disasters. Where no specific indicators exist to monitor disaster displacement, states could report on other indicators established by the Sendai framework and the Sustainable Development Goals (SDGs) without duplication of effort. Target B of the Sendai framework, for example, includes the "number of directly affected people attributed to disasters". It is linked to SDG targets 1.5, 11.5 and 13.1, which refer to monitoring and reporting on the "number of people whose destroyed dwellings were attributed to disasters". Sendai's target G and particularly G-6 could be also monitored using data on pre-emptive evacuations. These indicators could help to calibrate the next improvements of displacement risk models.

We are working closely with the Swiss Federal Institute of Technology in Zurich (ETHZ), Oxford University and other partners to improve the model's ability to predict displacement risk for sudden-onset hazards, including floods in small island states. Increasing the resolution of the exposure layer from five square kilometres to one allows for a more granular assessment of the people and assets exposed. [69]

This, coupled with a rerun of hazard scenarios using the latest technologies, has produced a more accurate estimate that suggests the number of people at risk of displacement from all hazards is significantly higher than previously thought. Better resolution also allowed the disaggregation of displacement risk figures by urban and rural locations.

In the aftermath of TC Harold, April 2020, © UNICEF/UNI324714/ Shing

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69 for more information or to collaborate with IDMC on this, please contact info@idmc.ch

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Every day, people flee conflict and disasters and become displaced inside their own countries. IDMC provides data and analysis and supports partners to identify and implement solutions to internal displacement.

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