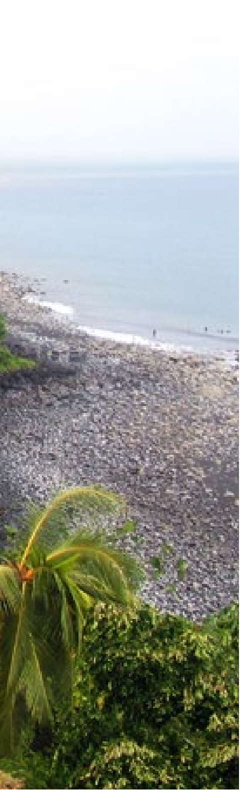
risk profile

Sudden-Onset Hazards and the Risk of Future Displacement in the Solomon Islands

iDMC internal displacement monitoring centre

Solomon Islands tsunami in 2007. Huge landslides cut red slashes into large sections of Ranongga Island's steep west coast. © Rosemarie North/IFRC, April 2007

Damage at Nela Village, Temotu Province, Solomon Islands. A magnitude 7 aftershock occurred off the Santa Cruz Islands in early February 2013– less than three days after the initial magnitude 8 quake and tsunami impacted on 25 communities. © Matt Anderson/ DFAT, 2013



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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 the Solomon Islands. It also recognises that relocation is an appropriate long-term adaptation strategy, as envisaged in the country's national climate change policy for 2012 to 2017.

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.

Cyclone winds represent the Solomon Islands' highest displacement risk. There is a 64 per cent probability that one will displace 68,000 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 4,028 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 the Solomon Islands
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]

Fig 1: Displacement risk: How is it estimated?

Background information

Map 1: Solomon Islands location map

Located to the north-east of Australia, east of Papua New Guinea and north of New Zealand, the country is made up of 992 islands of which a third are inhabited.[3] It has a total land mass of 28,400 square kilometres divided into nine provinces, and as of 2009 it had a population of 515,000 (see box 1).[4] The 2019 census is about to be published. The island of Guadalcanal, which includes the capital, Honiara, is home to about 12 per cent of the population.[5]

The economy is based primarily on the exploitation of natural resources such as timber, palm oil, copra and cacao. GDP per capita is around $2,400. The service sector is also significant, accounting for 39 per cent of GDP, and coastal resources such as marine fisheries and agriculture are vital to people's livelihoods, government revenue and economic development.[6]

The climate is oceanic tropical, with a wet season from November to April and a dry season from May to October. Temperatures are relatively constant throughout the year.[7]

Climate change is expected to affect the country's coastal resources through increased ocean acidification, sea level rise and coral bleaching. The sea level has risen by an average of 8mm a year since 1993.[8] Tropical storms are also becoming more frequent and intense, and the country is prone to El Niño-Southern Oscillation (ENSO) events, which make rainfall high variable from year to year. Associated winds also increase the height of waves, particularly in the Santa Cruz group of islands.[9] The Solomon Islands have the world's fifth-highest climate risk and ninth-highest exposure.[10]

As in many small island developing states, exposure to hazards in the Solomon Islands is driven by the growing concentration of people and assets in urban low-lying coastal areas. Disasters affect ever more people in these areas, causing increasing harm in terms of employment, housing and critical infrastructure such as roads and power and water supplies.[11]

More than 80 per cent of the overall population live in coastal areas where the vast majority of services, infrastructure and agricultural production are located.[12] These areas are also exposed to cyclones and storm surges, which have the potential to cause significant economic as well as human impacts. The archipelago's interior is mountainous, volcanic and ill-suited for human habitation.

Sea level rise in the Solomon Islands is well above the global average, and threatens subsistence agriculture and the viability of human settlements.[13] Coastal infrastructure such as roads and paths are regularly washed away and have to be rebuilt. Twenty-five families on Nuantambu island in Choiseul province were relocated to other islands in 2011 as rising seawater overwhelmed their villages (see box 2).[14]

The 2009 census also reveals that 20 per cent of the country's population live in urban areas, where risk tends to be concentrated. Seventy-eight per cent or urban dwellers live in Honiara, and the remainder in provincial centres such as Auki in Malaita province and Gizo and Noro in Western province. Urban population growth is higher than in rural areas, but it has been decreasing since 2013 and stood at 4.5 per cent in 2019. [15]

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.[16]

The country also lies on the so-called Ring of Fire, an active seismic area in the Pacific that accounts for 75% of the world's volcanoes and over 90% of its earthquakes. [17]

The Solomon Islands has experienced many disasters in recent decades. The worst was in 1986, when tropical cyclone Namu killed 101 people and left as many as 90,000 homeless.[18] The deadliest event of this century occurred in 2007, when an 8.1-magnitude earthquake and tsunami killed 52 people and displaced 5,500 in Western and Choiseul provinces. The epicentre of the quake was just off the coast of the main island of Gizo province.[19] The waves reached heights of about ten metres on nearby Simbo island.[20]

Six years later, an 8.0-magnitude earthquake that occurred 33 km West-Southwest of the Santa Cruz Islands, Temotu province, have generated tsunami waves on the Island that was estimated to be about three meters in the worst affected villages meters and inundated areas up to one kilometre inland.[21]

Box 1: Law and policy on relocations

The 2009 census shows that many people are left landless after being displaced by disasters.[22]

The **National Adaptation Programme of Action** of 2008 includes provisions for communities to be able to plan for relocation as a potential adaptation strategy, and acknowledges the importance of land tenure when considering such schemes. To ensure tenure security, it suggests bringing customary land, which accounts for 87% of all land in the Solomon Islands, "onto the mainstream market under a new law that balances traditional institutions with government administration".[23] Such a law has yet to be enacted.

The **National Climate Change Policy** for 2012 to 2017, the latest to date, mentions relocation as a long-term adaptation measure of last resort to be undertaken following relocation guidelines and assessment tools.[24] **The National Development Strategies** for 2011 to 2020 and 2016 to 2035 recognise as one of their primary objectives to respond effectively to climate change by managing the environment and risks of disasters putting a greater emphasis on mitigation to reduce the scale of necessary response to a disaster".[25]

Box 2: Relocated communities

Relocation was used in the Solomon Islands in the 20th century as a coping strategy to escape inundation, overcrowding and land disputes. Planned relocation has since been used as an adaptation strategy for communities in low-lying areas affected by sea level rise, saltwater intrusion, earthquakes and extreme weather events. Such preventive measures are essential to avoid displacement toward risk-prone areas and have helped to save lives. Coastal erosion tends not to trigger relocations, but rather occurs once an area is abandoned.[26]

Rising sea levels have submerged five of the archipelago's islands in the last 50 years.[27] These include Nuantambu in Choiseul province, from where 25 families were relocated in 2011. In addition, the provincial authorities of Choiseul township decided to relocate most of Taro coral atoll and Choiseul's main town of 1,000 inhabitants in 2014. The decision was taken following a request for help from its residents as the atoll was less than two metres above sea level. A local planning scheme for a new township was approved in 2016, but the relocation is likely to take decades to complete.[28] Taro could become the first provincial capital in the country to relocate in its entirety as a result of sea level rise.[29]

Other coping mechanisms have also taken place. Whole communities on the artificial island of Walande in Malaita Province relocated to other islands between 1987 and 2017 for fear of cyclones and tsunamis.[30] In January and February 2009, exceptionally high tides destroyed numerous homes on Walande. While the relocation of process started in the 1980s after a cyclone, the community was permanently relocated after these disaster events in 2009. Walande's church was deconsecrated in May 2009.[31]

Some provinces, such as Malaita and Temotu, are also made up of sinking low-lying islands and artificial islands built on sandbars in the 1900s in part to absorb the growing population.[32] After a 7.8-magnitude earthquake in 2016, many people living on artificial islands in Malaita progressively relocated to the mainland as tides started to flood their villages.[33] Some, however, have refused to relocate: "We are salt-water people and we have a very close bond to the beach and island environment … Relocating to the mainland might be a better idea for others, but not us."[34]

Besides the disastrous consequences of poor adaptation, displacement may lead to tensions with host communities and usually constitutes a trauma for those forced to flee.[35] Families from Nuatambu were spread out over different areas, breaking up communities as a result.

Some communities have come up with ways to cope with negative relocation outcomes. This includes the hill-dwelling Asisiki ethnic group, also known as a "bush" community, who developed a "relocation package" that includes a proposal to subdivide land into plots for families who would acquire registered titles. Such titles would encourage families to relocate and ensure tenure security for future generations.[36] On Malaita island, the community took a collective decision to relocate together to a site 20 metres above sea level.[37]

Disaster displacement in Solomon Islands: historical trends (2008-2020)

Disasters have triggered around 26,000 displacements in the Solomon Islands since IDMC began systematically monitoring data on the phenomenon in 2008. IDMC has detected 16 displacement events triggered by weather-related hazards such as storms and floods, and geophysical hazards.

The data in table 1 below 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 necessarily not equal the number of people displaced.

Weather-related events triggered 18,000 new displacements, or almost 70 per cent of the total new displacements recorded over the last decade. Floods, particularly flash floods, were the main triggers. Almost three times the average rainfall for the month fell in April 2014, triggering severe flash floods in Honiara that caused significant damage. They were declared the worst flash floods in the country's history (see box 3).

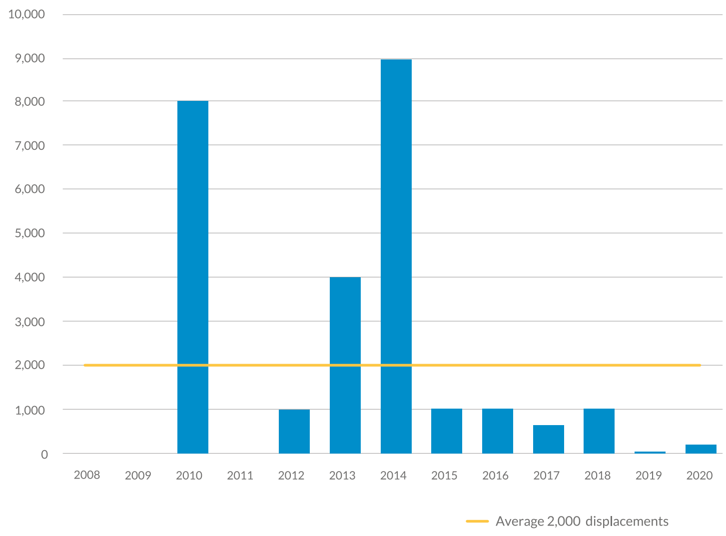
Geophysical events triggered almost 8,000 movements representing almost a third of the displacement recorded between 2008 and 2020. A magnitude 8.0 earthquake struck off the Santa Cruz islands in Temotu province in February 2013. The tsunami that followed had a severe impact on residents' livelihoods, most of whom were subsistence farmers, because seawater contaminated water sources.[38] The earthquake and the cascading events it triggered, which also included landslides, directly affected around 37 per cent of the Santa Cruz islands, displaced 3,500 people and destroyed 588 homes.[39]

Box 3: The 2014 flash flooding in Honiara

Torrential rain associated with cyclone Ita fell continuously over the Solomon Islands for the first four days of April 2014, triggering the worst flash floods in the country's history. The White river burst its banks, heavily inundating Honiara, and the whole of Guadalcanal island was declared a disaster area.[40] Around 52,000 people, or 10 per cent of the country's population were affected, 22 were killed and infrastructure was badly damaged.[41] Around 10,000 people were displaced to 30 evacuation centres in the capital and 4,000 were still living in emergency shelters a month after the disaster.[42]

The flooding caused economic losses put at $107.8 million, or 9.2 per cent of GDP. Housing accounted for 56% of the damage caused, and 675 homes were destroyed. Much of the damage in Honiara was the result of unregulated urbanisation in at-risk areas along the river.[43] Thirty-five per cent of the capital's population was living in informal settlements as of 2012, but such areas accounted for almost half of the housing the floods rendered uninhabitable.[44] Many of those displaced said they would not consider rebuilding in the same place because it would be too dangerous.[45, 46]

Figure 2: New disaster displacements in the Solomon Islands (2008-2020)



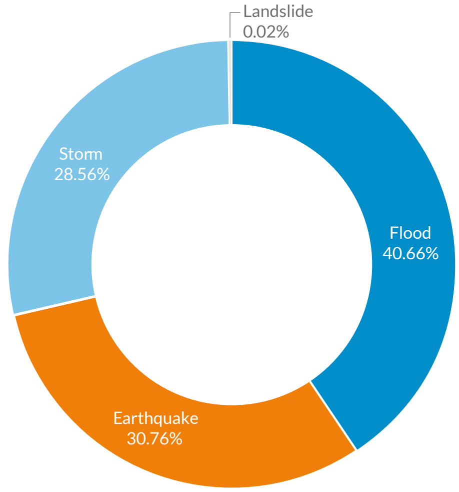


Table 1: Historical displacement events in the Solomon Islands (2008-2020)

Year	Event Name	Hazard Type	New Displacements
2010		Earthquake	3,000
2010	Cyclone 'Ului'	Storm	5,000
2012		Storm	1,000
2012		Flood	47
2013	Solomon Islands Tsunami	Earthquake	4,000
2014	Honiara floods	Flood	9,000
2015	Cyclone Pam	Storm	1,000
2016	Makira Earthquake	Earthquake	1,000
2017	Solomon Islands: Floods, Guadalcanal Province - 05/12/2018	Flood	600
2018	Solomon Islands: Floods - Honiara - 1/3/2018	Flood	15
2018	Solomon Islands: Floods / Tropical Cyclone Penny - Malaita, Western, Guadalcanal - 27/12/2018	Flood	900
2018	Solomon Islands: Tropical Depression - 24/1/2018	Storm	100
2019	Solomon Islands: Landslide - Gizo - 10/9/2019	Landslide	4
2019	Solomon Islands: Storm - Kwai and Ngongosila islands (East Malaita) - 11/2/2019	Storm	27
2020	Solomon Islands: Floods - Guadalcanal - 10/03/2020	Flood	11
2020	Vanuatu, Solomon Islands, Fiji, Tonga: Tropical Cyclone Harold - 01/04/2020	Storm	300

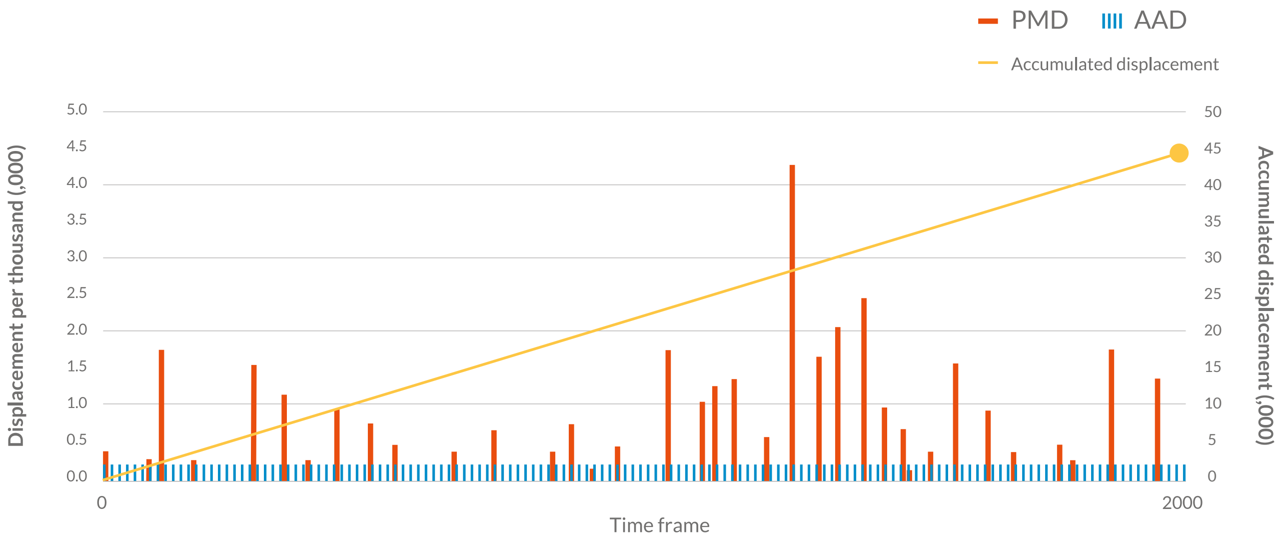
Disaster displacement risk in Solomon Islands

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.

Fig 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.[47]

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.[48]

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 4,000 people could be displaced by disasters in the Solomon Islands in any given future year. This is its AAD (see table 3).

Total: 4,028

EARTHQUAKE
278

STORM SURGE
1,368

TSUNAMI
11

CYCLONIC WIND
2,371

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 the Solomon Islands

Return Period in years

Hazard	ADD	PMD 10	25	50	100	250	500	1,000
Storm Surge	1,368	1,100	8,000	31,000	41,000			60,000
Cyclonic Wind	2,371	150	1,800	68,000	91,000			200,000
Earthquake	278	450	1,300	2,500	4,100	7,500	12,300	17,000
Tsunami	11			15	110	600	1,400	3,000

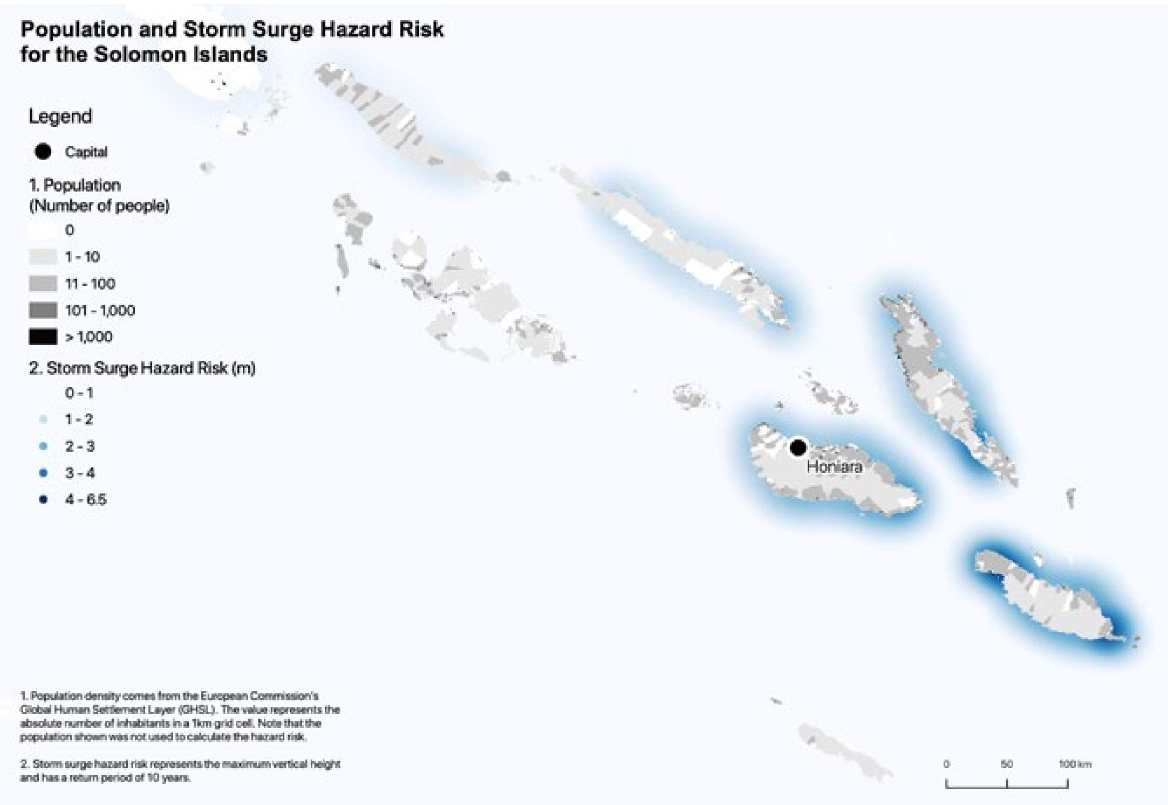
AAD is useful for providing a sense of the scale of the annual risk of displacement, but it tends to hide potential outliers. High-intensity but low-frequency events that trigger mass displacement could take place over extremely long time spans. A category 5 cyclone or a 7-magnitude earthquake, for instance, could strike Solomon Islands unexpectedly and cause significant displacement. While such extreme events may not have occurred since record keeping began, they can still take place, and it is important that the country be prepared for them. Cyclones Namu in 1986 and Nina in 1992 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.[49]

Map 2: Storm surge risk map



The displacement risk associated with storm surges in the Solomon Islands is high. On average 1,368 people can be expected to be displaced per year considering all the events that could occur over the return period.

In terms of PMD, there is a 56 per cent probability that a storm surge will displace about 8,000 people at some point in the next 20 years. There is a 33 per cent probability that Honiara and the east and west coasts of Malaita island will experience storm surges of around a metre during the same time period.

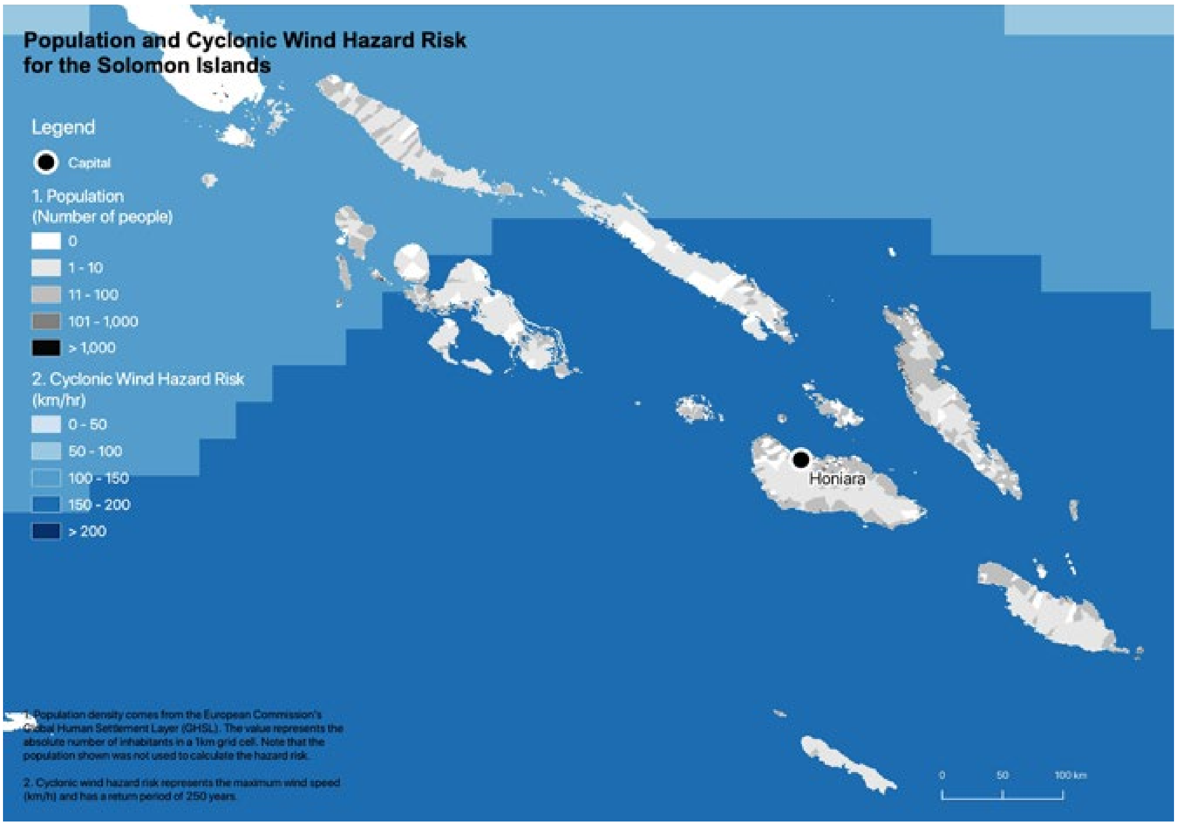
Risk of displacement as a result of cyclonic winds

Cyclonic winds represent the Solomon Islands' highest displacement risk. 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, and they remain 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.[50]

On average 2,371 people are expected to be displaced per year considering all the events that could occur over the return period, and the archipelago could experience wind speeds greater than 180km/h. In terms of PMD, there is a 64 per cent probability that a cyclonic wind will displace about 68,000 people at some point in the next 50 years.

Map 3: Cyclonic wind risk map

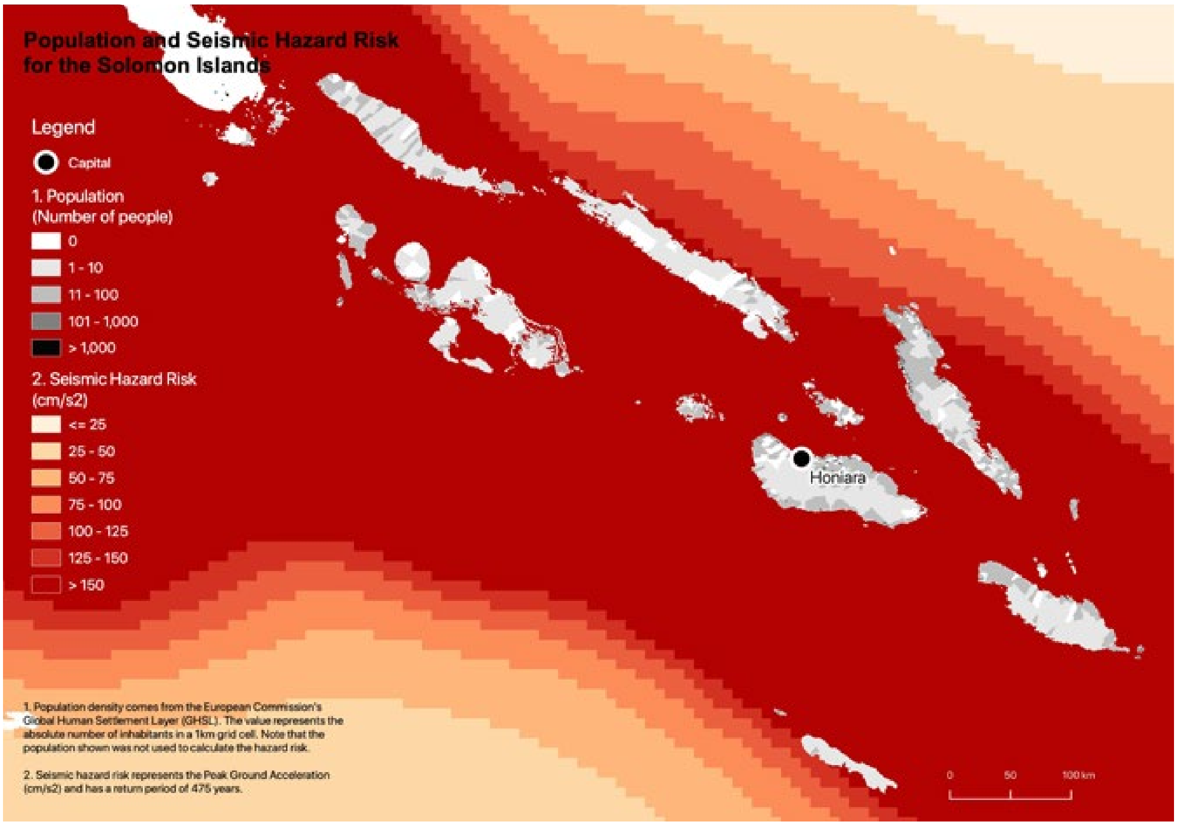


Risk of displacement as a result of earthquakes

The Solomon Islands are in a seismically active area above the collision between the Australia and Pacific tectonic plates, and the displacement risk associated with earthquakes is high. On average 278 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 4,100 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

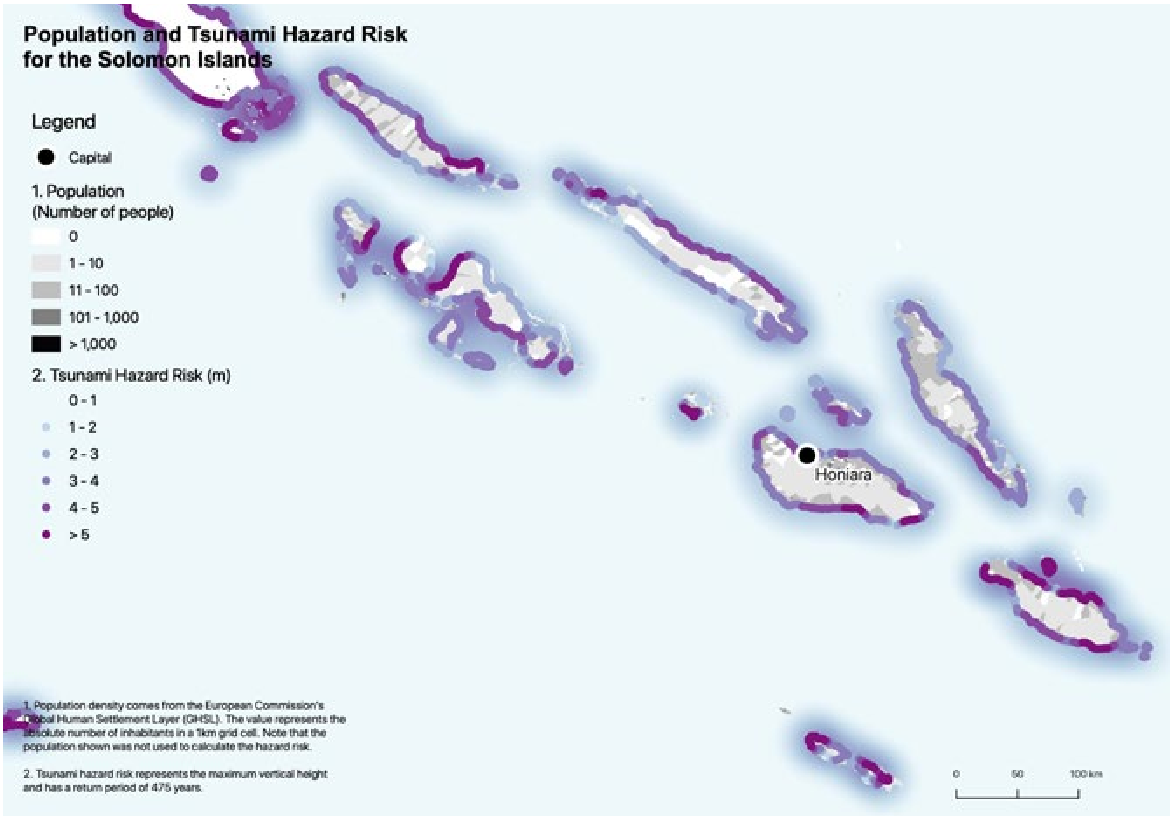


Risk of displacement as a result of tsunamis

The Solomon Islands are 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 metres for most of the coastal areas at risk. But it could be over eight metres on the north-west coast of San Cristobal island. The archipelago is somewhat protected by coral reefs that 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, 11 people are 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 3,000 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".[51]

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.[52]

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

Flooded villages in Guadalcanal, Solomon Islands. © Australian Government/
OdinsChildPhotography, April 2014

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.

The sea has now replaced what used to be the beach of Kolombranga island, Solomon Islands. © Benoit Matsha-Carpentier/IFRC, May 2013

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.

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).[53] 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 Solomon Islands 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.[54]

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

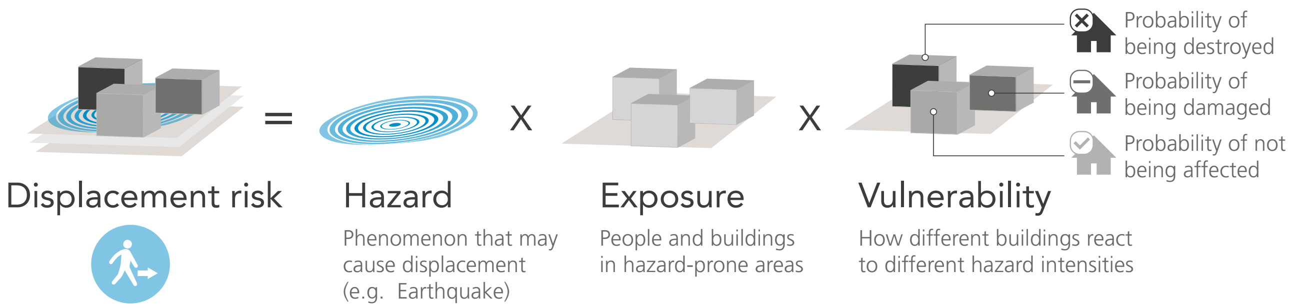
The model does not consider people's economic and social vulnerability. It covers only the physical aspect by looking at the extent of damage and destruction that hazards of different intensities are likely to cause (see figure 4).

The model does not account for pre-emptive evacuations, which means its estimates are inherently conservative.

A house washed right off its foundation by the 2 April 2007 tsunami in the Solomon Islands. © Scientology VM Disaster Response Team, 2007

To adapt to the increasing issues linked to climate change, the community has introduced new methods of gardening such as the basket gardens, or rising up the gardens to avoid them to be in contact with the sea water. Ghatere village, Kolombranga Island. © Benoit Matsha-Carpentier/ IFRC, 2013

Fig 4: Displacement risk: How is it estimated?



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.[55]

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.[56]

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.

Tsunami damage, Solomon Islands. © AusAID/Department of Foreign Affairs and Trade, 2007

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ON DISASTER
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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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