risk profile

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

iDMC internal displacement monitoring centre

Marshall Islands, Majkin Island, Namu Atoll. In the wake of the devastating drought that hit 15 of the northern atolls in the Marshall Islands in early 2013. © IFRC

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Cover image:
The Marshall Islands coping with the effects of climate change and rising sea levels. © Asian Development Bank

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 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. Our analysis considers a wide range of hazard scenarios, their likelihood and their potential to cause housing damage, which serves as a proxy for displacement.

This technical paper presents the initial results of our efforts to assess the risk of displacement associated with disasters in the Marshall Islands. Given our model resolution and the scattered nature of the islands, the analysis could only be conducted for two types of hazards, namely cyclonic winds and tsunamis.

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.

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 people 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.

Cyclonic winds represent the Marshall Islands' highest displacement risk. There is a 64 per cent probability an extreme cyclone winds event will displace about 100 people at some point in the next 50 years.

About five people on average are likely to be displaced by cyclonic winds in any given year. This is the AAD metric. The figure should be considered a significant underestimate, however, given the limitations of the analysis mentioned above.

Looking at displacement risk relative to countries' population size reveals different but equally important information in terms of vulnerability and coping capacity. For example, small island states will experience very different and highly significant consequences in terms of displacement relative to their population size, compared to larger countries.

Our model does not take into account displacements associated with the slow-onset effects of climate change such as drought, coastal erosion and sea-level rise which are believed to be the main triggers of disaster displacement in the archipelago.

This report is divided into four main parts:

1. Background information on the Marshall Islands
2. Baseline for disaster displacement risk in the country
3. 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: Marshall Islands location map

The Marshall Islands lie halfway between Australia and Hawaii, north-east of Kiribati and east of Federated States of Micronesia (FSM). The country is made up of two parallel chains of 29 coral atolls, five low-lying islands and more than 1,000 uninhabited islets.[3] Its average elevation is two metres, and several islands sit just above sea level.[4] The population was 53,158 in 2011 and was predicted to be 54,590 in 2021.[5,6]

The capital, Majuro, is an atoll made up of 64 islets that are home to about half of the population.[7] The economy is based on subsistence agriculture, handicrafts, tuna processing and copra, or dried coconut kernels. GDP per capita was around $3,793 as of 2018.[8] The public sector, which employs 34 per cent of the country's workers, also accounts for a substantial portion of the economy.[9]

The climate of the Marshall Islands is oceanic tropical, with a wet season from May to November and a dry season from December to April. The typhoon season is mainly from September to November. Such storms form further north-west in the Pacific and tend to have degraded by the time they reach the country.[10]

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 7mm a year since 1993 and is expected to rise by another 9cm by 2030, which poses a serious risk of more devastating coastal flooding and storm surges.[11] Such disasters have harmful consequences for employment and food supplies because fishery resources are a generator of government revenue and a foundation for economic development.[12]

The country is also affected by cycles of the El Niño Southern Oscillation (ENSO), which increase the risk of drought and floods and make rainfall high variable from year to year. Rainfall may be reduced by as much as 80 per cent during an El Niño event, and the dry season tends to start earlier and end later than normal.[13]

As in many small island developing states, exposure to hazards in the Marshall Islands is driven by the growing concentration of people and assets in low-lying urban coastal areas. Disasters affect ever more people in these areas, causing increasing harm to employment, housing and critical infrastructure such as roads and power and water networks.[14]

Seventy-five per cent of the country's population live in urban areas, where risk tends to be concentrated. Fifty-two per cent of urban dwellers live in Majuro and the remainder in Kwajalein atoll, mainly on Ebeye island. Urban population growth has been accelerating over the last decade and stood at 1.1 per cent in 2019.[15]

The Marshall Islands has experienced intense cyclones in the past. Typhoon Roy (also referred as Cyclone Anne) destroyed 350 homes, killed one person and left as many as 3,500 homeless in January 1988.[16] Typhoon Zelda also struck the archipelago in 1991, damaging 90 per cent of the buildings on the islands of Ujae and Lae and 60 per cent on Ebeye, where 5,000 people were left homeless. No fatalities were reported.[17]

The most intense disaster of the last 20 years began in 2015 when El Niño triggered a severe drought. By May 2016, 21,000 people, or about half of the population had been affected. There are no official statistics to confirm that displacement took place, but absenteeism rates for elementary schools on Ailinglaplap and Arno suggest families were forced to move to other islands.[18]

Box 1: Law and policy on disaster displacement

The Marshall Islands does not have a specific policy or legislation on internal displacement, but the government recognises the issue and the need to prepare for it.[19]

The vision and goals of the National Strategic Plan 2020-2030 are underpinned by key adaptation principles and approaches relevant to displacement associated with climate change and disasters. They include people's inalienable "right to remain" on their islands; "integrated adaptation", which recognises the complex and multidimensional reality the country faces; "knowledge first", which embraces a scientific and evidence-based approach; "consensus and inclusion", which emphasises the need for more participatory consultation; and "security", which recognises the importance of people's wellbeing, identity, self-determination, human rights and survival. The plan's policy objective 3, goal 5.5 also aims to facilitate orderly, safe, regular and responsible migration and human mobility.

The government's 2018 Adaptation Proclamation sets out its intention not to "allow our people to become climate refugees", but rather to "strengthen international and domestic efforts and international cooperation to plan, finance and implement resilience and adaptation measures to protect the rights of our people to remain on these islands"[20].

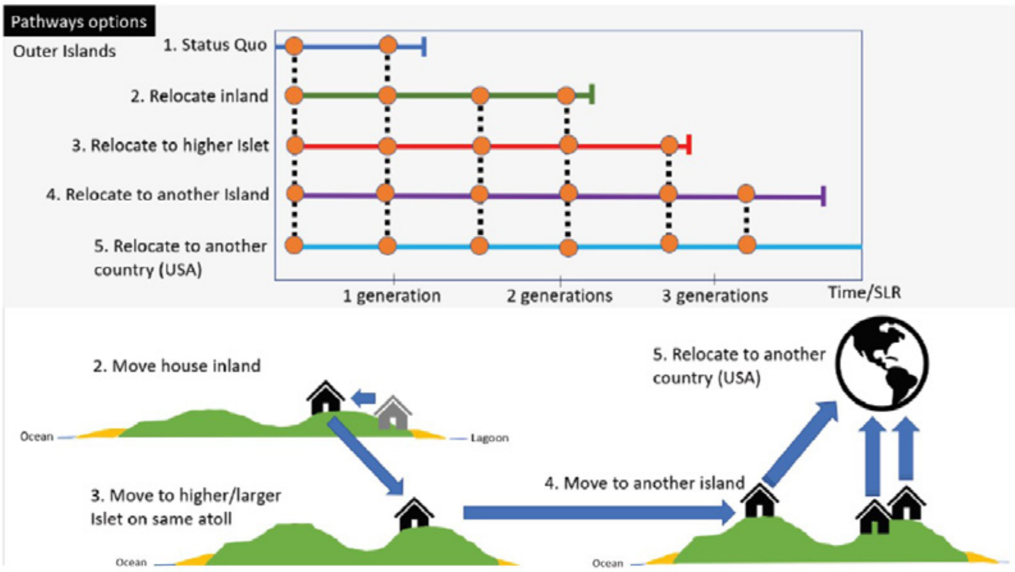
The country's response to disaster displacement is based on the Joint National Action Plan for Climate Change Adaptation and Disaster Risk Management of 2014. There is no direct reference to the phenomenon, but goals 1 to 6 reflect the government's intention to address the forced movement of people. Goal 6, for example, refers to integrating the impacts of climate change and disasters in land use and resettlement planning processes.[21]

The Marshall Islands has a National Climate Change Policy Framework, endorsed in 2011, which provides overarching guidance and identifies priorities in tackling the challenges involved.[22] The country has also bolstered its capacity to address climate change impacts by establishing a Climate Change Directorate, strengthening other agencies and improving national coordination between planning and implementing partners.

At the time of writing, the government was undertaking extensive consultations to inform the development of a National Adaptation Plan, in which relocation is regarded as an adaptation mechanism. The plan is envisioned to outline a number of adaptation pathways as per the example below based on sea-level rise.[23]

Under the Compact of Free Association, a 1986 agreement between the Marshall Islands and the US, the United States Agency for International Development (USAID) and the US Federal Emergency Management Agency (FEMA) provide the islands with free services including air safety support, weather forecasting and health and other assistance in the event of disasters.

Figure 2: Potential Adaptation Pathways for for the Republic of the Marshall Islands (outer-islands or rural/semi-rural areas)



Government of the Republic of Marshall Islands - Adaptation Communication - 2020

Disaster displacement in the Marshall Islands: historical trends (2008-2021)

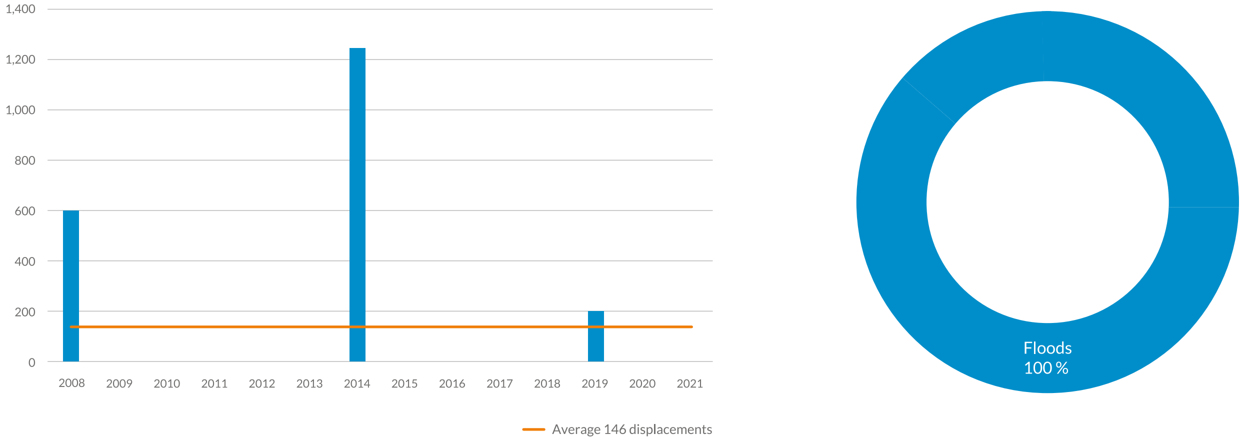
Disasters have triggered about 2,046 displacements in the Marshall Islands since IDMC began collecting data on the phenomenon in 2008. They were the result of three weather-related events – high tides impacts aggravated by storms and floods.

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.

Most of the displacement recorded has been the result of king tides impacts aggravated by storms. King tides are higher-than-normal tides following a new or full moon or coinciding with perigean spring tides.[24]

The biggest displacement event of this king tide took place in March 2014, when tidal surges inundated communities on low-lying atolls. Seventy homes were damaged in Majuro, some of which were completely destroyed. The number of people displaced peaked at around 1,000, many of whom sheltered in churches in Uliga and Rita.[25] Four days later, 160 people were still displaced and had been moved to safer places. Thirty-six homes were also damaged and 246 people displaced on Arno atoll. Around 80 per cent of its sanitation facilities were affected with sewage leaks reported in some areas.[26]

Figure 3: New disaster displacements in the Marshall Islands (2008-2021)



All flooding from unusually high tides in coastal areas are registered as "flood" hazard in IDMC database.

Table 1: Historical displacement events in the Marshall Islands (2008-2021)

Year	Event Name	Hazard Type	New Displacements
2008		Flood	600
2014	King tides in the atolls	Flood	1,246
2019	Marshall Islands: Flood (swell) - Majuro - 27/11/2019	Flood	200

The highest tides of 2008 coincided with a large storm, producing waves of up to three metres that flooded the urban centres of Majuro and Ebeye and displaced around 600 people, and a large swell coincided with high tides in 2019 to trigger the evacuation of more than 200 residents in Majuro to two schools and three other shelters.[27]

The government has recognised that sea-level rise and recurrent flooding could contaminate the country's water and make it undrinkable by 2030.[28] These same phenomena also increase the spread of dengue fever.

Displacement associated with drought is much more complicated to monitor than that triggered by sudden-onset hazards such as storms and floods, because the latter occur over shorter timeframes and their impacts can be measured more immediately and directly.[29] Whether this type of displacement has taken place in the Marshall Islands or not, it is true to say that drought has had a severe impact on the population because most freshwater supplies and subsidence agriculture depend on rainfall.

Months of drought in 2013 depleted water storage tanks and rendered groundwater unsafe for human consumption because of increased salinity. The drought also damaged food crops such as banana, taro root and breadfruit, leaving people to rely on fish, crustacea and other coastal food resources for nutrition.[30] Several months of normal rainfall were needed to replenish groundwater, dilute salty aquifers and restore food crops.[31]

Another severe drought took place from 2015 to 2016. Linked to ENSO cycles, it affected more than 21,000 people as lack of rainfall decimated drinking water supplies. The archipelago depends on rainfall for more than 90 per cent of its freshwater, but it received only around a quarter of its usual precipitation between November 2015 and February 2016.[32]

Home of a beneficiary of the Improved Energy Supply for Poor Households Project in Majuro. The project aims to provide clean and affordable elecrtricity for low-income household.
© Asian Development Bank

Disaster displacement risk in the Marshall Islands

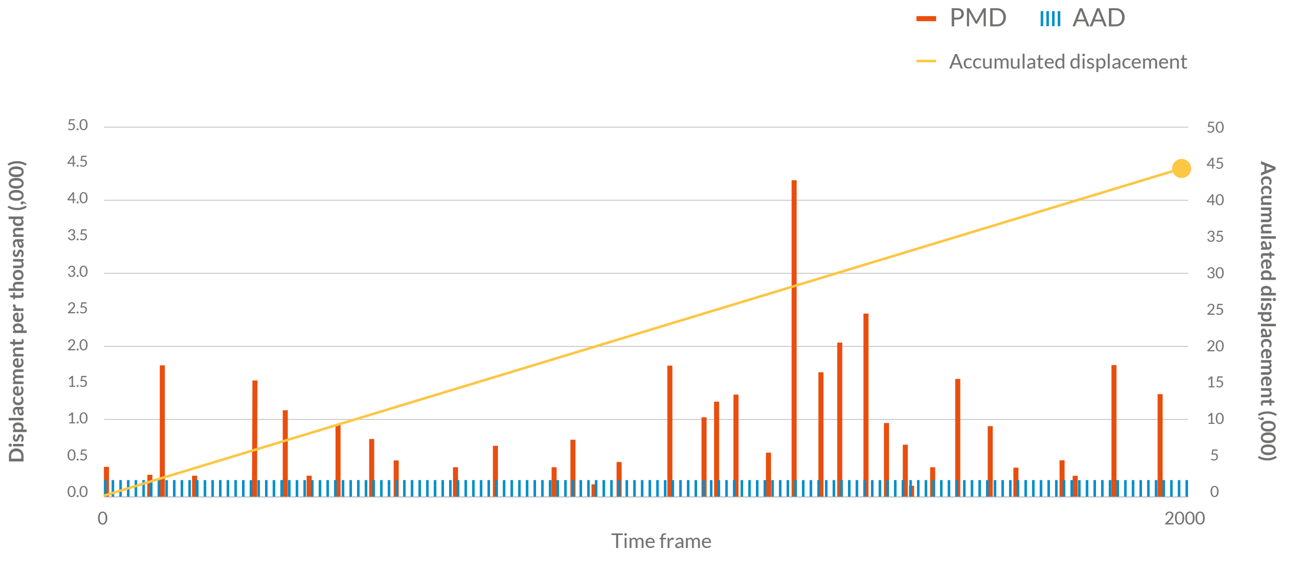
The baseline established by our global disaster displacement risk model presents results at the national level and provides insight into possible future displacement situations. The analysis of future displacement risk associated with sudden-onset hazards considers a large number of possible scenarios, their likelihood and potential housing damage, which serves as a proxy for displacement.

Given the scattered nature of the Marshall Islands, however, we are only able to estimate the risk of displacement for two hazards, cyclonic winds and tsunamis.

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. 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

Figure 4: How we calculate Probable Maximum Displacement (PMD) and Average Annual Displacement (AAD) by hazard



Source: Adapted from UNDRR, 2015

Box 2: 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.[33]

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.[34]

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 2). 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 it. 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 five people could be displaced by disasters in the Marshall Islands in any given future year. This is the country's AAD (see table 3). The scattered nature of the islands and the resolution of the model, however, mean the figure should be considered an underestimate, particularly given the significant disasters the country has experienced in the past and its vulnerability to climate change, which is increasing the risk of more frequent and extreme weather hazards.

AAD is useful for providing a sense of the scale of the annual risk of displacement, but it tends to hide potential outliers. Over a very long time span, for example, a high-intensity but low-frequency event such as a category two to three typhoon could strike the Marshall Islands and cause significant displacement. Such extreme events may not have occurred since record keeping began, but they could still happen and it is important the country be prepared for them. Typhoons Hester in 1952, Roy in 1988 and Zelda in 1991 are examples of unprecedented disasters to strike the archipelago.

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.

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 Marshall Islands

Return Period in years

Hazard	ADD	PMD 20	50	100	250	500	1,000	1,500
Storm Surge								
Cyclonic Wind	5	30	100	130	180	210	230	250
Earthquake								
Tsunami						10	60	110

Cyclonic winds and storm surges

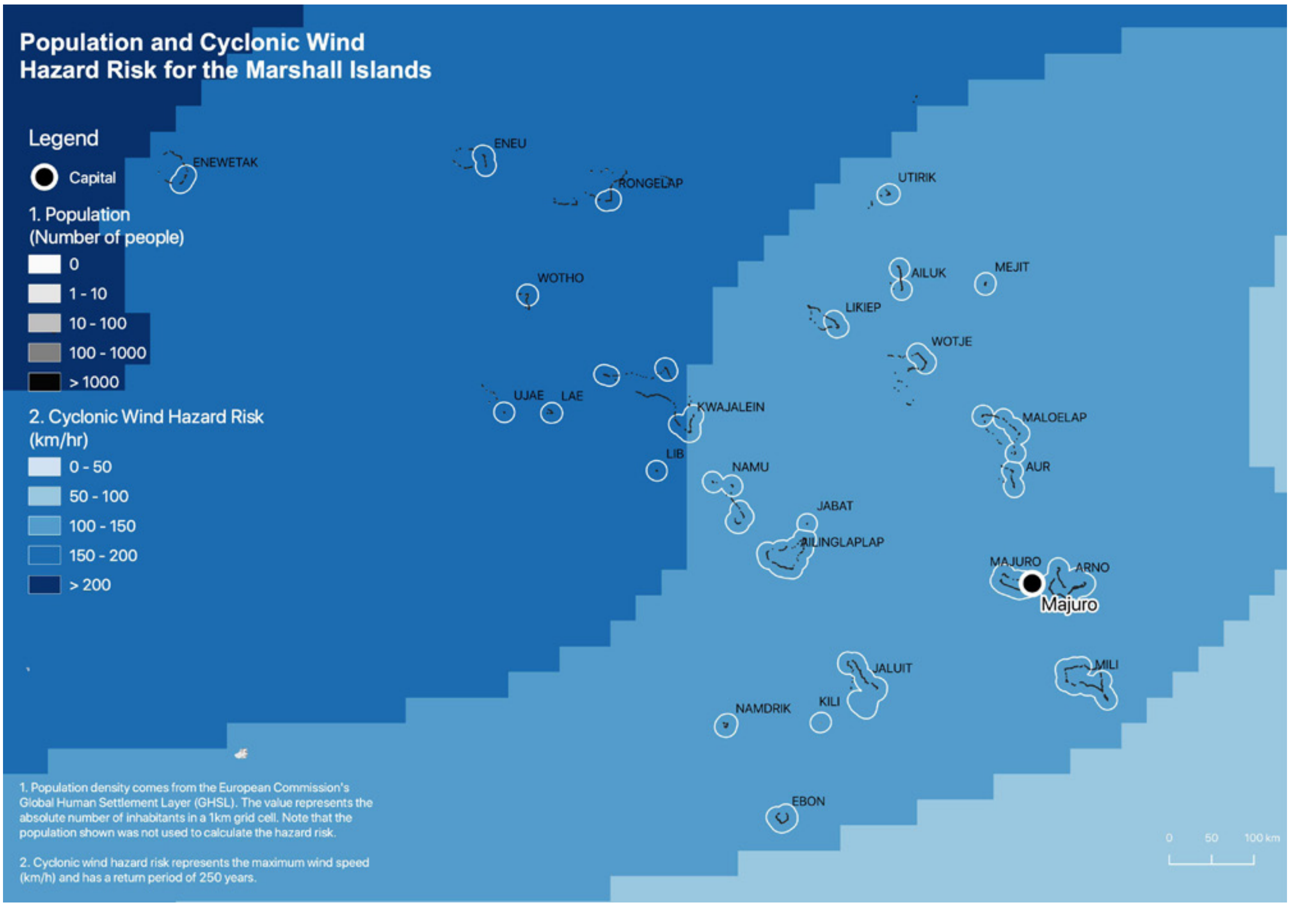
The risk of cyclonic winds risk is high in the Marshall Islands. The country sits south of the equator in the South Pacific convergence zone, where typhoons generally develop to the east. Strong winds affect the country about once every four to seven years on average, corresponding with ENSO events that warm the ocean waters and catalyse the genesis of typhoons.[35]

Typhoons 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 fuel and slow them down with greater friction than exists on the sea surface.[36]

On average five people a year are expected to be displaced considering all the events that could occur over the return period. The country could experience wind speeds greater than 160km/h and guts of more than 180km/h, particularly over the Ralik chain of islands. In terms of PMD, there is a 64 per cent probability that cyclonic winds will displace about 100 people at some point in the next 50 years.

As a typhoon 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 , which occur when storm surges coincide with uncommonly high tides caused when the gravitational pull of the moon and the sun are aligned.[37]

Map 2: Cyclonic wind risk map



We do not currently have data to calculate displacement risk associated with storm surges, but their impacts still exist. The worst inundation of this type took place when tropical storm Alice coincided with a high tide in November 1979, creating a storm surge of more than six metres that affected around 4,000 people on Majuro island.

Geophysical hazards

Tsunamis can travel long distances following seismic events. The archipelago is somewhat protected by coral reefs that dissipate wave energy, but the islands are still vulnerable to significant damage from tsunamis. Maximum wave height is estimated to be between one and two metres for most of the coastal areas at risk. The effects of such an event could be greatly amplified were they to coincide with a king tide.

In terms of PMD, there is a five per cent probability that a tsunami will displace about 110 people at some point in the next 50 years.

The country is in a relatively quiet seismic area. It is surrounded by the Pacific Ring of Fire, but its seismic hazard risk is very low. No significant earthquakes have been observed in recent history, and the magnitude of any future events would not be expected to cause significant damage to buildings or infrastructure.
Disasters have triggered about 320 million displacements around the world since we began collecting data on the phenomenon in 2008. This is more than three

Toward risk-informed decision making

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".[38]

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.[39]

Despite these advances, the number of disaster displacements is likely to increase in the future. Weather-related hazards account for around 90 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.

"*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.*" UNDRR - Global Assessment Report – 2013.[40]

IDMC's Global Disaster Displacement Risk Model

Box 3: 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.

Newly picked bananas in the food preparation of women in Majuro, Marshall Islands. © Asian Development Bank

Methodological considerations and caveats

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).[41] 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 the Marshall 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.[42]

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 from 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.

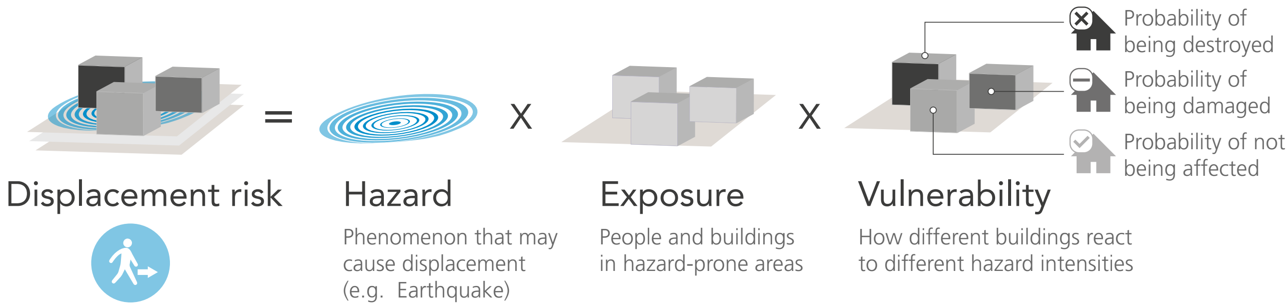
Our Displacement risk model is determined by three factors:

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 5).

The model does not account for pre-emptive evacuations, which means its estimates are inherently conservative. In countries with strong disaster preparedness capacity

Figure 5: Displacement risk: How is it estimated?



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.[43]

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 make 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.[44]

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.

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

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International Organization for Migration (IOM)
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PLATFORM ON DISASTER DISPLACEMENT
FOLLOW-UP TO THE NANSEN INITIATIVE

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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