



GAR

Global Assessment Report
on Disaster Risk Reduction

GAR Special Report 2023

Mapping Resilience for the
Sustainable Development Goals



United Nations

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For additional information, please contact:

United Nations Office for Disaster Risk Reduction (UNDRR)

7bis Avenue de la Paix, CH1211 Geneva 2, Switzerland. Tel: +41 22 917 89 08



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Soon after the adoption of the Sendai Framework for Disaster Risk Reduction and the Sustainable Development Goals (SDGs) in 2015, there was a consensus that it would be impossible for developing countries to achieve sustainable development if they were constantly recovering from disasters.

However, in the years since, we have experienced accelerated climate change, unsustainable development choices, growing inequality, poverty and humanitarian needs, that are all increasing the impacts of disasters. As a result, we are witnessing an ever-increasing number of compounding disasters and extreme events, which are holding back sustainable development progress.

This year marks the midterm reviews of both the SDGs and the Sendai Framework, which make clear that risk-informed sustainable development is no longer an option, but an imperative, if we want to ensure a sustainable future for all.

The UN Secretary-General warned this year that the SDGs were “disappearing in the rear-view mirror”, and urgently need “clear benchmarks on tackling poverty and exclusion, and on advancing gender equality.”

Changes are needed to flip systems that are creating risk and instead build resilience as the bedrock

for sustainable development. And to guide these changes, countries and development partners need to look beyond single SDG indicators to consider the overall impact on people, the planet and prosperity.

This 2023 special edition of the Global Assessment Report presents a new way of viewing and assessing progress towards sustainable development through the lens of risk and resilience in a changing climate. Resilience, after all, is a key connector between climate change, disaster risk reduction and sustainable development. Thus, by measuring and addressing current resilience deficits in a holistic manner, countries could, in turn, build resilience and accelerate progress towards the underlying SDGs.

Moreover, the metrics presented in the report can serve as tools for foresight, for planning into the future, in line with the Secretary-General’s ‘Our Common Agenda’ and his call for a periodic Strategic Foresight and Global Risk Report.

Measuring what is valued reflects societal priorities and provides the basis for the policies to follow. This is why it has never been more important that we understand how to measure and achieve resilience.

We hope this report will advance this approach and spark the changes needed to achieve development that is resilient for all.

水島直美.

Mami Mizutori

Special Representative of the UN Secretary-General for Disaster Risk Reduction
Head of the United Nations Office for Disaster Risk Reduction

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Coordinating lead authors:

Jenty Kirsch-Wood, United Nations Office for Disaster Risk Reduction (UNDRR); **Angelika Planitz**, United Nations Development Programme (UNDP), **Matthew Brubacher**, (UNDRR Consultant)

Contributing authors

Sophie Lee, **Hanoch Barlevi**, **Neven Knezevic**, **Farai Maxwell Marumbwa**, **Jen Stephens**, **Ingrid Sanchez Tapia**, **Laura Linda Healy**, **Margaretha Barkhof**, **Lars Bernd**, **Tamara Plush**, **Omar Robles**, **Stephanny Ulivieri**, **Ajoke Onojeghuo**, **Nicholas Reuge**, UNICEF; **Erica Allis**, **Yelena Minasyan**, **John Harding**, **Maria Macasil**, **Bob Stefanski**, **Valentin Aich**, WMO; **Pedro Conceicao**, **Samuel Akera**, **Babatunde Abidoye**, **Edvard Orlic**, **Abdo Seif**, **Abdulkareem Alsabri**, UNDP; **Riccardo Biancalani**, **Patrick Jacqueson**, **Arbab Khan**, **Carlo Cafiero**, **Wirya Khim**, **Sylvie Wabbes Candotti**, **Sara Viviani**, **Anne Kepple**, **Olivier Lavagned Ortigue**, **Ingrid Teich**, FAO; **Steven Kapsos**, **Catherine Saget**, **Nicholas Maitre**, **Marie-Claire Sodergren**, ILO; **Rui Kotani**, Geo Secretariat; **David Borges**, NASA, **Sara Minelli**, **Barron Or**, **Sasha Alexander**, **Daniel Tsegai**, **Franklin Odhiambo**, **Brian O'Connor**, UNCCD; **Mark Illife**, **Gregory Scott**, UN-GGIM; **Pierre Boileau**, **Pascal Peduzzi**, UNEP; **Regina Asariotis**, UNCTAD; **Sara Valero**, **Ginette Santana**, **Antra Bhatt**, **Sneha Kaul**, **Toshihisa Nakamura**, UN WOMEN; **Leonardo Souza**, UNDESA, **Qudsia Huda**, **Kai Von Harbou**, **Heather Adair-Rohani**, **Kerolyn Shairsingh**, **Erin Downey**, WHO, **Esteban Leon**, **Rosa Ochoa**, **Anna Karaan**, **Sovzin Al Youssef**, **Yana Atonenko**, **Rosa Surinach**, UNHABITAT, **Kristen Arnold**, WFP,

Ioannis Boukis, **Ifigenia Paramonou**, **Eirini Krampi**, Ministry for Climate Crisis and Civil Protection, Greece; **Roger Pulwarty**, NOAA, USA; **Cintia Bartz**, Municipality of Teresina, Brazil; **Nesibu Yasin Seid**, Disaster Risk Management Commission, Ethiopia; **Andrea Toreti**, JRC; **Thomas Brooks**, IUCN

Map development: **Catarina Costa**, **Vitor Silva**, **John Schneider**, GEM Foundation; **Fleur de Lotus Ilunga**, **Mina Lee**, **Guillaume Le Sourd**, United Nations Geospatial Information Section; **Keera Morrish**, **Brendan O'Neill**, **Rami Alouta**, Environmental Systems Research Institute (ESRI)

UNDRR internal review:

Paola Albrito, Loretta Hieber Girardet, Jeanette Elsworth, Stefanie Dannenmann-Di Palma, Sandra Amlang, Adam Fysh, Nazgul Borkosheva, and members of the UNDRR Risk Accelerator Group.

Design and production

Project coordinator: **Rhea Katsanakis**, UNDRR

Project support: **Emily Scroope**, UNDRR

UNDRR communications and outreach: **Jeanette Elsworth**, **Fanny Langella**, **Rosalind Cook**, **Frédéric Delpech**, and **Ken Hawkins**.

Copyeditor: **Richard Owsley**

Design, graphics and layout: **Donna Kirstein**

References, sources and image editing: **Giovana Santillán**

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EXECUTIVE SUMMARY

Global warming will surpass 1.5°C above pre-industrial levels during the next decade, due to greenhouse gas emissions. The constant rise in temperatures and related impacts combine with other pressures, thus increasing risk and undermining resilience. The increasing interconnectedness of people and human systems increases the risk of compound and cascading crises.

The maps in this report highlight how factors such as the rapid deterioration of biodiversity, the degradation of land and stress on water resources, lower the capacity of human systems to withstand hazards that are occurring more frequently and with greater intensity. Currently, only 50 per cent of countries have operational early-warning systems and even fewer have legislation in place to connect these systems to preparedness and response plans that can ensure prevention and anticipatory action, as well as response. Humanitarian needs are also rising, as disasters and conflict continue to create enormous human suffering.

While progress continues to be made towards increasing access to electricity, water, healthcare and education, progress towards reducing extreme poverty has been challenged by COVID-19 climate change and other factors (World Bank, 2022a). This has led to growing inequities and pressures on the planet, which are reversing other hard-won development gains. This is particularly the case for lower-income countries, who contribute the least to the causes of climate change and where the most vulnerable populations reside. These adverse impacts occur because the

pursuit of human development has not adequately considered the inadvertent effects on ecosystems and livelihoods. Building in resilience-thinking can accelerate the required paradigm shift for the benefit of people, the planet and prosperity, and future generations. However, interventions and investments in resilience must become more targeted, more systems-oriented and more capable of scaling-up. Systems must not only be able to recover from disasters but need to be adaptive and transformative to build a more sustainable, prosperous and equitable future.

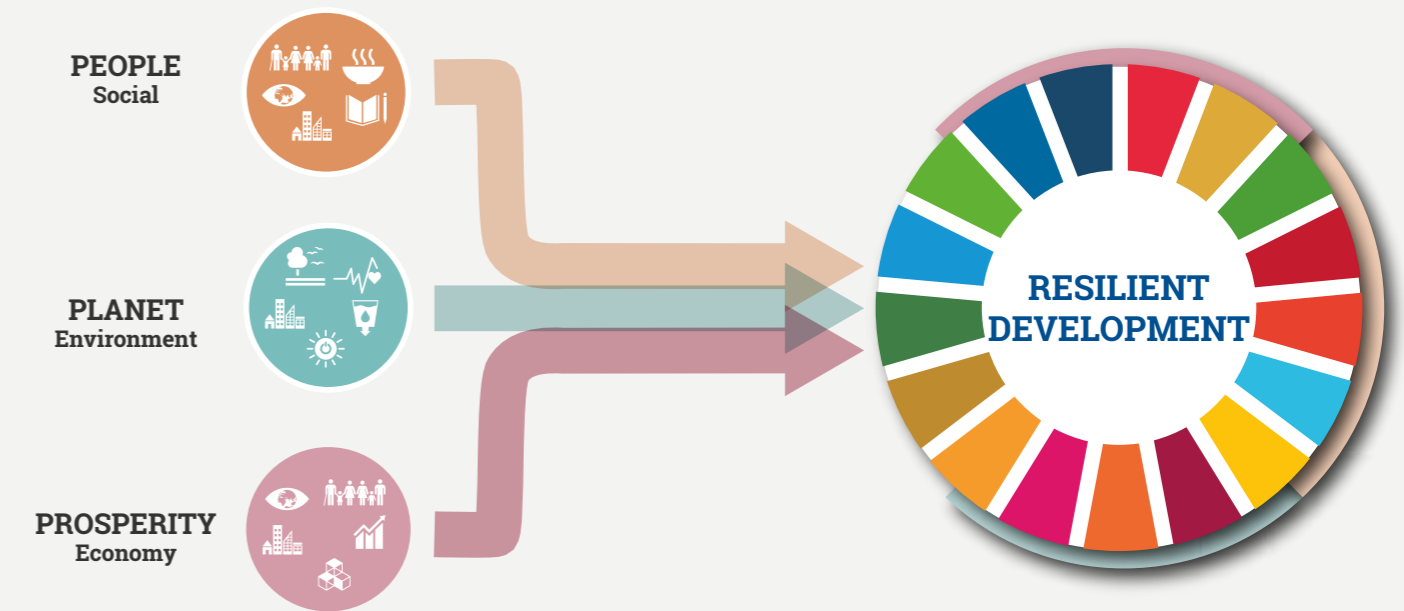
Developed to cover the period 2015-2030, the Sustainable Development Goal (SDG) framework has agreed targets and indicators and a data-gathering system that has been accepted and is being applied by United Nations Member States across the globe¹. Figure 1 shows the existing web of Sustainable Development Goals (SDGs) targets and indicators, that covers key interconnected progress across people, planet and prosperity. However, all too often, the progress data is collected independently in silos. When this same data is looked at holistically from the perspective of resilience-building, key resilience deficits that are holding back sustainable development become evident.

The maps in this report highlight a number of these resilience deficits that are holding back achievement of key sustainable development goals. At the same time, the report's action case examples show that this is not inevitable, and how action is possible on every continent to stop the worsening spiral of risk and disasters and to accelerate SDG target achievement.

Addressing resilience gaps will require the unprecedented scaling-up from with both resilience investment and adaptation action both from within the public and private sectors, particularly for the most vulnerable countries. As these investments take time to mobilize and prepare, delay will increase the inevitable costs. Action is needed now. Disaster risk reduction sits at the nexus between development, humanitarian and climate change action, and can

help foster more-sustainable resilient action in each. Readjusting development pathways requires a re-examination of how prosperity is measured, and a greater emphasis on resilience as key element of sustainable development today and in the future.

Figure 1. Resilient development – people, planet and prosperity



Source: UNDRR, 2023

¹ The Sustainable Development Goals Report 2022 shows that “we still lack timely, high-quality and disaggregate data to fully understand where we are and where we are headed. Investment in data and information infrastructure should be a priority of national governments and the international community” (United Nations, 2022a).

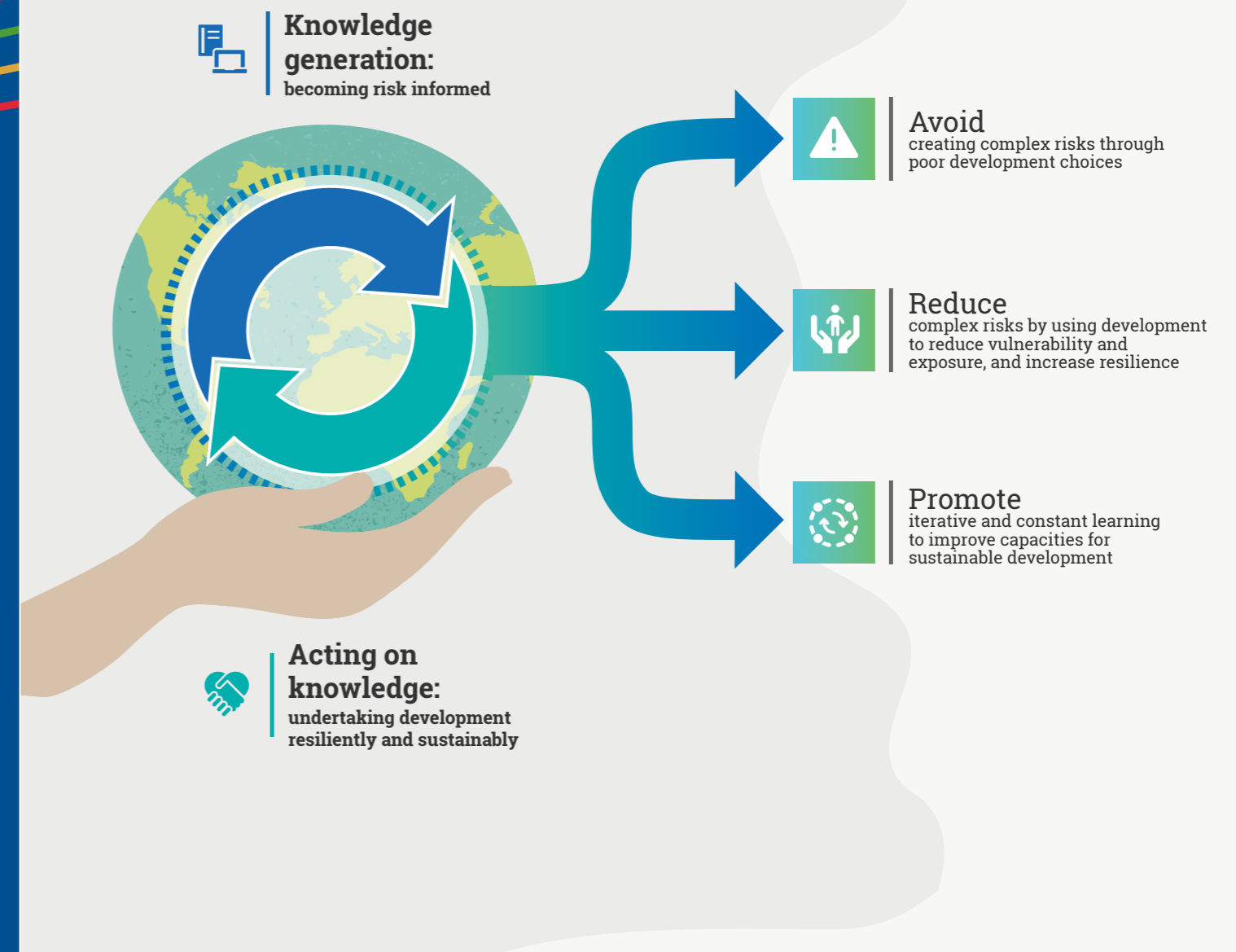
1. WHY RESILIENCE MATTERS:

This report explores what risk-informed sustainable development looks like in an increasingly complex and risky world. It highlights how risks are interconnected and how pitfalls can be transformed into opportunities to build resilience. It aims to support government policymakers charged with the difficult and innovative work of risk-informing development to face the increasingly complex set of threats resulting from the deepening climate crisis and other hazards. It also aims to highlight how resilience-building must be central to the framing of a more risk-informed post-2030 agenda.

The Sustainable Development Goals (SDGs) provide a framework of agreed collective goals for attaining sustainable development entitled *Transforming Our World: The 2030 Agenda for Sustainable Development* (United Nations, 2015a). United Nations Member States are mandated to collect and report data on their progress towards achieving their SDG targets. Using this information to assess resilience deficits at the macro scale is a 'quick win' to identify where risk reduction is needed. Given the imperative to transition to a carbon-neutral development model, understanding where resilience-building can create positive feedback loops and co-benefits is particularly important now.

The impacts of climate change are causing existing hazard events to become more intense and occur with greater frequency. These impacts combine with other risks and threats such as conflict, epidemics or inflation, creating compound crises, a phenomenon increasingly referred to as a polycrisis. Left unaddressed, these compound crises draw increasing amounts of resources into reactive responses rather than into prevention for building long-term resilience. These reactive responses can lead policymakers to choose maladaptive policies, which inadvertently worsen the impacts. Such trends amplify vulnerabilities and distract from addressing the root causes behind these risks.

Figure 2. Core elements and aims of resilient sustainable development



Source: Nadin, R. and Opitz-Stapleton, S. (2019) Figure 2: Risk-informed development and its core aims. In: *Risk-informed development: from crisis to resilience*. ODI and UNDP.

To reverse this downward spiral, countries and communities need to build systems that can prevent or better manage risk. This can include taking action such as investing in resilient infrastructure that can withstand disaster impacts, improving early-warning systems to reduce losses, and improving economic and social opportunities that can reduce underlying vulnerability to hazards. This ability to withstand risk, and recover from

disasters, in a manner that is transformative and bounces forward, is at the root of resilience (Alessi et al., 2020).

Urgent action to reduce risk is fundamental to simultaneously achieving the SDGs of the 2030 Agenda (United Nations, 2015c), the targets of the Paris Agreement (United Nations, 2015a) and the Sendai Framework for Disaster Risk Reduction 2015–2030

Table 1. Definitions of resilience

Definitions of resilience

PEOPLE

"The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner." (UNDRR, 2017)

"The ability of individuals, households, communities, cities, institutions, systems and societies to prevent, resist, absorb, adapt, respond and recover positively, efficiently and effectively when faced with a wide range of risks, while maintaining an acceptable level of functioning and without compromising long-term prospects for sustainable development, peace and security, human rights and well-being for all." (UN CEBC, 2020)

PLANET

"The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation." (IPCC, 2018)

PROSPERITY

"Economic resilience has two components: instantaneous resilience, which is the ability to limit the magnitude of immediate production losses for a given amount of asset losses, and dynamic resilience, which is the ability to reconstruct and recover." (World Bank, 2014)

(United Nations, 2015b). The pathways to achievement are inextricably linked, and positive action towards one needs to accelerate achievement of the others. It does not have to be a trade-off.

Fostering resilience requires governments, the private sector and civil society to better understand how choices or inaction to promote societal well-being (people), ecological or biosphere well-being (planet) and economic well-being (prosperity) interact to build or undermine resilience. The increasing interdependence of ecosystems and humanity reinforces the need to maintain the resilience of all systems. This is why the people, planet and prosperity paradigm is integral to forging sustainable development pathways, and why actions to promote peace and partnerships are so essential.

Understanding how to identify and measure vulnerabilities, or deficits, in resilience, as well as how to develop interventions that address current and future needs, is at the core of sustainable development. Figure 2 shows how becoming risk-informed is integrally linked to action that mitigates risk by avoiding poor development choices, reducing vulnerabilities and promoting the continual review and learning of resilience-building.

Building resilience makes physical assets stronger, and also creates more sustainable systems and ways of working. As a concept, resilience can describe a system trait (e.g. a disaster-resilient water-supply system), a process (e.g. resilient agricultural practices) or an outcome (e.g. a resilient city) (Moore et al., 2017). Strengthening resilience is critical to withstanding and responding to shocks and to achieving a country's development objectives (United Nations, 2020). Table 1 shows the definitions of resilience related to people, planet and prosperity.

Creating the conditions for sustainable development requires accelerated transformations in key systems, including food, water and energy, making them more effective at addressing growing demand while sustainably managing natural resources.

2. UNDERSTANDING RISK TO PEOPLE, THE PLANET AND PROSPERITY

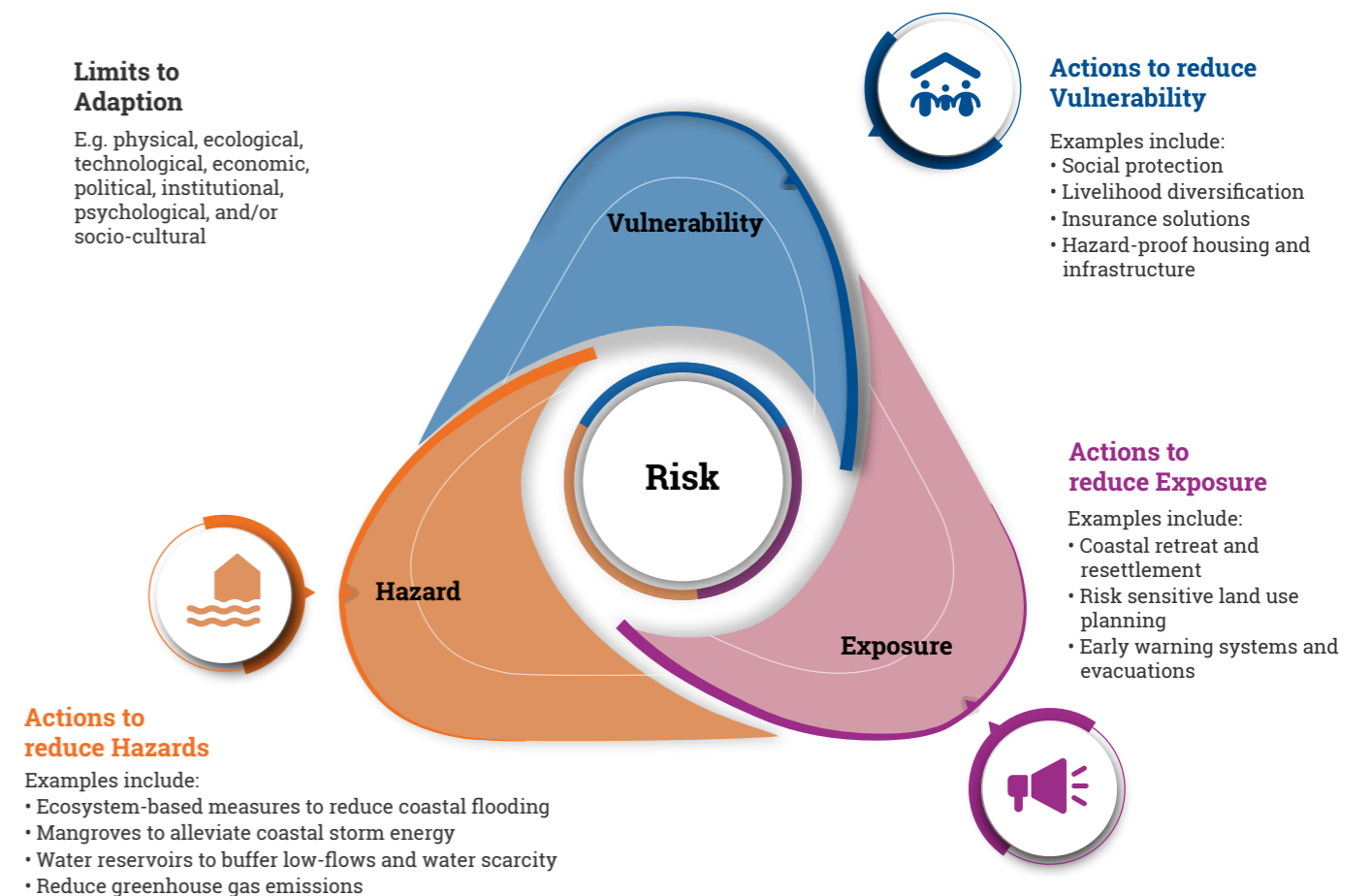
Risk is a function of how a hazard combines with vulnerability and exposure (Figure 3) (UNDRR, n.d.a). In other words, understanding the risk posed by hazards requires a better understanding of vulnerability and exposure. Vulnerability refers to the conditions determined by physical, social, economic and environmental factors or processes that increase the susceptibility of an individual, a community, assets or systems, to the impacts of hazards. Exposure refers to the location of people, infrastructure, housing, production capacities and other tangible human assets in hazard-prone areas. Disasters occur when any of these elements of risk is not reduced or adequately managed.

The choices and action taken today will affect the future relationships among hazards, vulnerability and exposure. For example, the most pressing way to reduce climate hazards currently is to reduce greenhouse gas emissions, which are currently making climate-related hazard events more intense and more frequent.

Understanding how those hazards lead to disasters in a country, and how they are likely to change in the future, is necessary to pre-emptively adapt to those impacts.

The ten resilience deficits, illustrated by 15 maps below, show how hazards are increasing vulnerability

Figure 3. Options for risk reduction through adaptation



Source: Adapted from Figure CB2.1 from (IPCC, 2019a)

and creating deficits in SDG progress. Combining risk modelling and drawing on the IPCC Representative Concentration Pathways (RCPs), assuming that the world will pass 1.5°C of warming above pre-industrial levels by the 2030s, the maps highlight the impacts of hazards, such as heatwaves, drought and air pollution, to show how they progressively inhibit progress in attaining the development objectives. In so doing, the maps utilize the SDGs to show the resilience gap found in people, planet and prosperity. Drawing from IPCC, the maps have been developed through a process of co-creation, drawing on expertise from across the United

Nations system. Experts from technical United Nations agencies such as UN DESA, UN-Habitat, UNDP, WHO, UNCTAD, UNCCD, FAO, UNICEF, ILO and the UN Map Division, worked with UNDRR and a team of expert global modellers to interrogate existing SDG data, available hazard maps and foresight data for climate change and other key drivers, such as demographic and urbanization trends. The maps are not presented as static projections, but instead show key inter-relationships across people, planet and prosperity SDG indices, and point to future potential development pathways based on business and usual action. A more detailed explanation of the sources

and methodology is available in the last chapter of this report and on the UNDRR website². An online version of maps and openly available data is available through the cited agencies and through the UNDRR Risk Information Exchange (UNDRR, n.d.b).

This report refers to “The Representative Concentration Pathways (RCPs), which describe four different 21st century pathways of greenhouse gas (GHG) emissions and atmospheric concentrations, air pollutant emissions and land use (IPCC, 2014).” RCPs range from RCP 2.6 (low-emission scenario) to RCP 8.5, which is the highest emission scenario. At the time the Representative Concentration Pathways (RCPs) were published, they included three scenarios that could represent emission developments in the absence of climate policy: RCP4.5, RCP6 and RCP8.5, described as, respectively, low, medium and high-end scenarios in the absence of strong climate policy (van Vuuren et al., 2011). RCP8.5 was described as representative of the top 5 per cent scenarios in the literature.” (IPCC, 2014)

In this report, estimates of urban damage due to floods are based on RCP 4.5, and work hours lost due to heat stress estimates are for RCP 2.6 and 6.0. Global-warming levels, which represent the increase in global surface air temperature from the pre-industrial era are applied to maps that depict drought projections, mean near surface air temperature and extreme sea levels.

As many of the SDG indicators are interrelated, the maps attempt to show some of these connections and to highlight the need to develop, longer term, more-integrated systems and analysis. They show that although progress is being made in attaining several SDG objectives, the way this progress is attained is itself often causing the pressures on planetary systems. These pressures, including increasing impacts of climate change and resource scarcity, are undermining progress in other SDGs. For example, while more people have access to electricity, the generation of that electricity is predominantly from the burning of fossil fuels, which contributes to climate change.

Taken together, the maps demonstrate why sustainability requires maintaining a balance between key systems, including the social (people), ecological (planet) and equitable economics (prosperity), to achieve resilient sustainable development. Recognizing the interdependence of these systems will reduce one progressing at the expense of the other, and it will create opportunities for synergies to improve the well-being of all three.

The case examples that accompany each map show that action to reduce resilience and thereby accelerate sustainable development is possible, but needs to be scaled-up urgently. Key elements for how to do this are the subject of Chapter 3 and draw on existing good practice lessons from the sustainable development, climate change and DRR communities. Finally, Chapter 4 encourages a re-examination of the way prosperity and development are defined and conceptualized, and draws a series of conclusions as to how competing interests can be rebalanced to attain more-sustainable development pathways.

² www.undrr.org



SUSTAINABLE DEVELOPMENT GOALS

PEOPLE

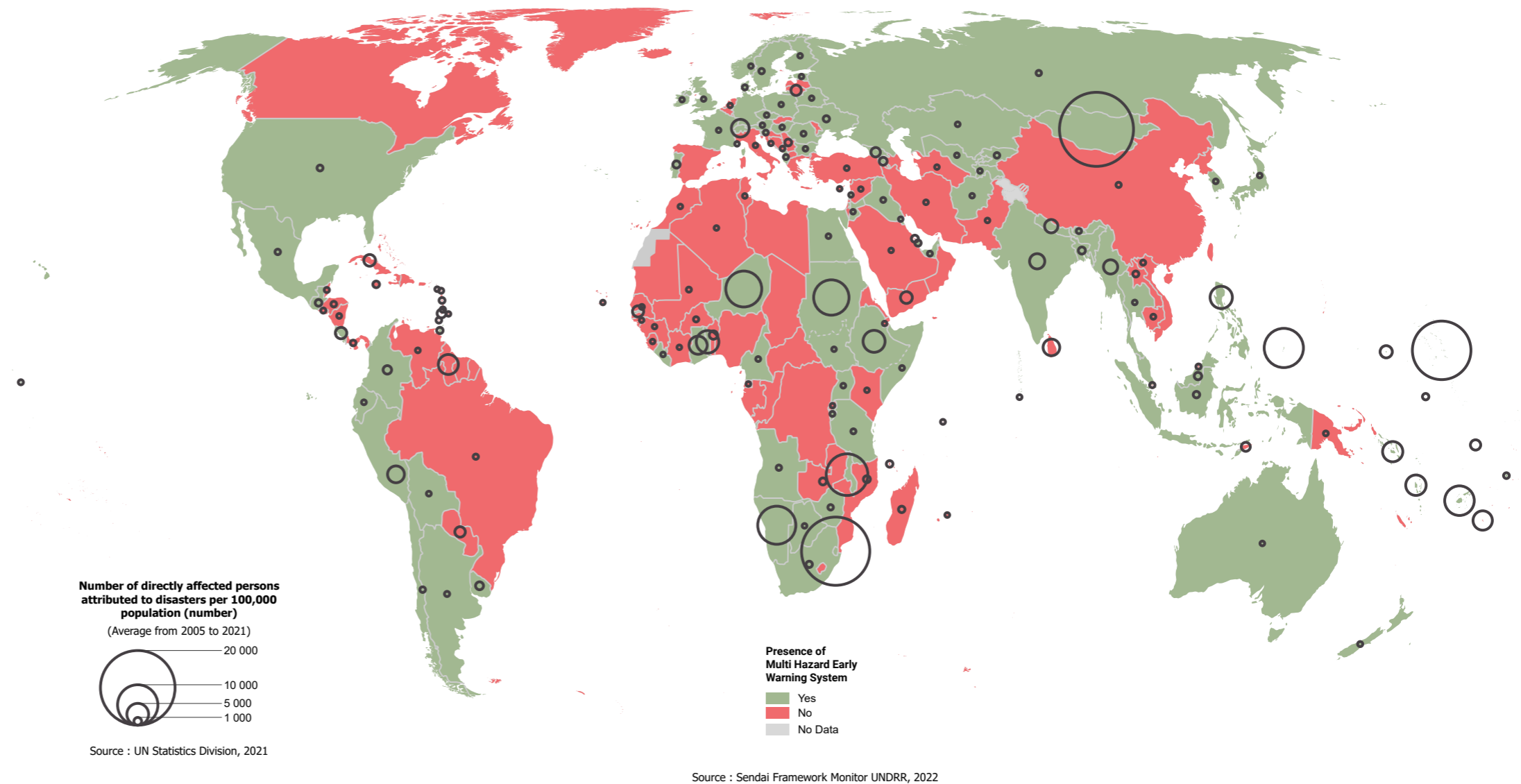
The sustainable development goals have the well-being of people at their core. Key SDG targets that highlight human well-being include: 1.5, 2.1, 2.4, 4.6, 11.5 and 13.1. At their core these SDGs aim to “end poverty and hunger, in all their forms and dimensions, and to ensure that all human beings can fulfil their potential in dignity and equality and in a healthy environment” (United Nations, 2015c).



Resilience deficit 1. Access to disaster early-warning systems

Map 1. Average number of people directly affected by disasters between 2005 and 2021, and countries with a currently operational multi-hazard early-warning system in 2022 (SDG indicators 1.5.1, 11.5.1 and 13.1.1)

The number of recorded disasters has increased fivefold over the past 50 years, driven in part by human-induced climate change (WMO, 2023). This trend is accelerating. Map 1 shows the prevalence of people affected by disasters and the countries that currently have operational early-warning systems (EWS). 62 million people directly affected by disaster in the last two decades live in countries without operational EWS. This means that without increased investment in resilience-building through extending early-warning-system coverage, developing countries are projected to have higher numbers of people affected by hazards as population growth continues. Map 2 shows this data in the context of future population growth, highlighting how exposure is increasing in countries where there is already a large number of people affected by disasters.



The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations. Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties. Final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined. A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).

Map 2: Average number of people directly affected by disasters between 2005 and 2021, and projected relative change in total population between 2022 and 2050 (SDG indicators 1.5.1, 11.5.1 and 13.1.1)

Provided risk reduction measures are taken, increased exposure does not necessarily need to result in increasing casualties and economic costs. Fortunately, as indicated in Map 1, most of the countries with the greatest exposure to hazards already have early-warning systems. These systems are already proving themselves effective in reducing the impact of hazards. And even where early-warning systems are in place, many have gaps (World Meteorological Organization, 2018) that need to be urgently

addressed. Against this backdrop, and despite the increasing number of people being affected by hazards, the number of mortalities due to hazards over the past 50 years has decreased threefold (WMO, 2021).

The proven capacity of these systems underlies the launch by the United Nations Secretary-General of the Early Warnings for All (EW4All) Initiative in 2022. This initiative aims to ensure the

whole world is covered by an EWS by the end of 2027. To save lives and livelihoods, EWSs need to be multi-hazard and connected to early action. They can be particularly effective if they are combined with investment in climate-resilient infrastructure such as flood-control systems, strengthening building codes and protecting environmental buffers, and are developed with the involvement of communities at risk (Rogers and Tsirkunov, 2011).

Key figures



126 countries with disaster risk reduction strategies (UNDRR, 2022b). (SDG indicator 1.5.3) (UN DESA, 2021)



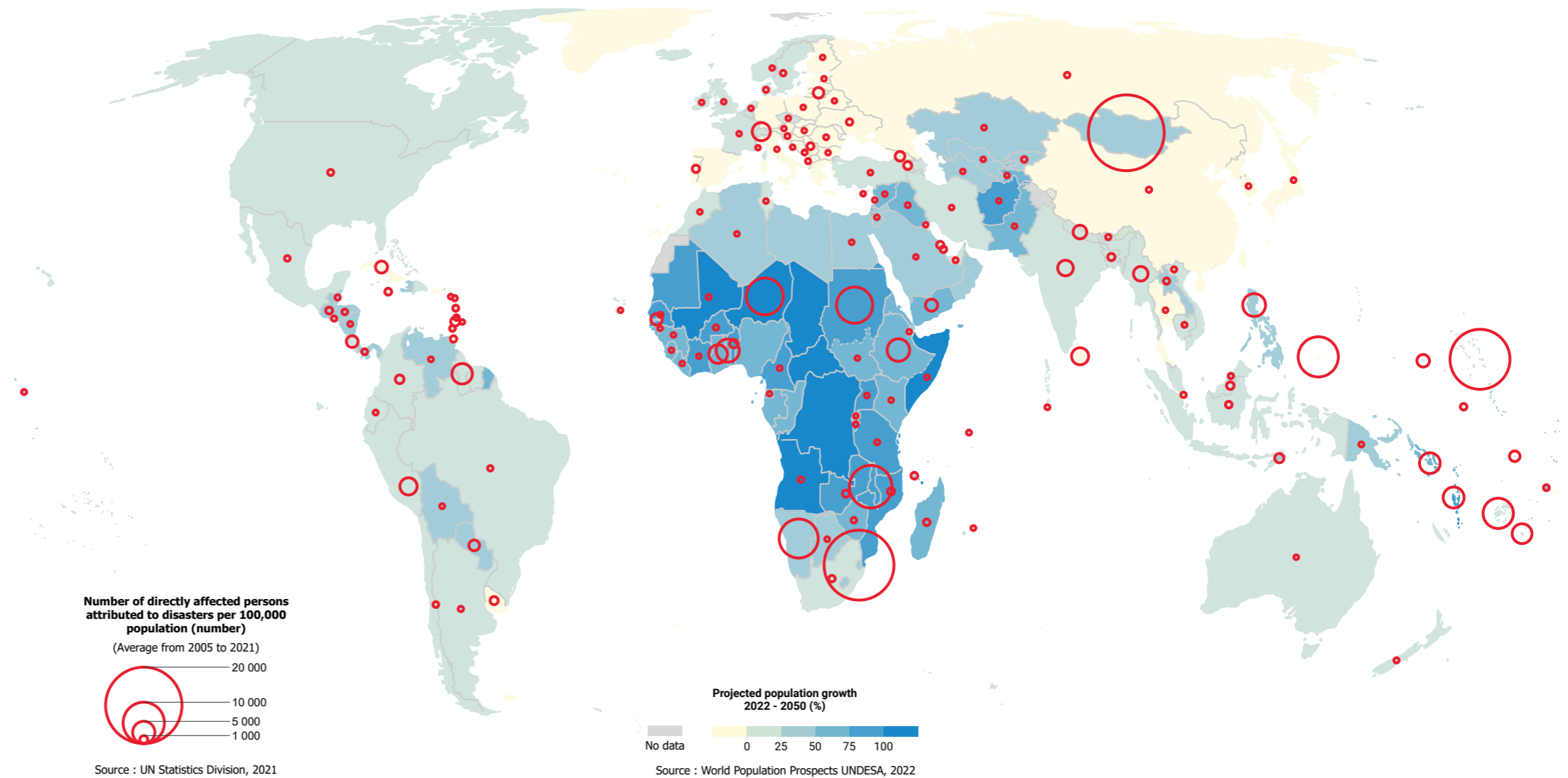
97 (estimated) Countries with early-warning systems (UNDRR, 2023).



4.2 trillion Net benefit of investing in resilient infrastructure in developing countries over the lifetime of the new infrastructure. There is a \$4 benefit for every \$1 of investment (Hallegatte et al., 2019).



66% Number of local governments that adopted disaster risk reduction strategies in 2021 (The Statistics Division of the United Nations Department of Economic and Social Affairs, 2022).



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ACTION CASE: BARBADOS

Fully exploiting the potential of early-warning systems

As climate change creates greater weather variability, EWSs are becoming increasingly vital tools for reducing hazard vulnerability. Their ability to forecast hazards and communicate risk assessments to those affected is made possible by integrating multiple science, technology and human systems. This interconnectivity is important to assess the scale of social, economic and ecological impacts and create the institutional collaboration needed to pre-emptively reduce vulnerability to the threats.

One country that expanded the design of its EWS to great effect is Barbados.³ As a Caribbean island, Barbados is regularly exposed to numerous hazards, including floods and hurricanes. In 2021, the island was affected by ash coming from a volcanic eruption in Saint Vincent and the Grenadines, which led to closure of the main airport, while dealing with the COVID-19 pandemic and was shortly after hit by Hurricane Elsa, the first hurricane to affect Barbados in over 65 years.

However, as higher temperatures combine with floods, the threat of vector-borne diseases is mounting.⁴ After a particularly costly outbreak of dengue fever in 2017, Barbados took steps to add biological risk forecasting to its EWS (Zeng et al., 2021). To do so, the Barbados Ministry of Health and Wellness partnered with national and regional climate organizations to develop climate-informed disease-forecast models. The system created through this transdisciplinary collaboration had the capacity to predict disease

outbreaks weeks, if not months, in advance (Lowe et al., 2020). Disease forecast reports, risk maps and climate-health bulletins inform a variety of networks, which are then able to take pre-emptive action to reduce outbreaks of vector-borne diseases.⁵

In Barbados early warning systems for hydrometeorological, environmental, biological and chemical hazards are more advanced than early warning capacities for geological, technological and societal hazards. This emphasizes an overall need to strengthen the MHEWS mechanism for the country.

To underscore its commitment to disaster resilience efforts on the national and local scales, the GoB has embarked upon: The Barbados Multi-Hazard Early Warning System (MHEWS) Roadmap and Action Plan (2021- 2024)⁶. This national instrument is aligned with the island's Comprehensive Disaster Management Country Work Programme 2019-2023⁷ that aims to significantly reduce impacts on the society, the economy as well as vulnerable and disadvantaged groups. The Barbados MHEWS policy seeks to build a national integrated MHEWS network that is science informed and evidence based, and which supports the decision-making of all stakeholders.

In February 2023, in recognition of the country's innovation, Barbados hosted the launch of the United Nations EW4All initiative. As part of the of Climate Risk and Early Warning Systems Caribbean initiative, Barbados continues to demonstrate the

cost-effectiveness of EWS as a critical disaster risk reduction and climate change adaptation measure that reduces economic losses and saves lives.⁸ The ability of Barbados to integrate disease-forecasting into its EWS shows the expansive capacity and versatility of these systems.



Barbados continues to demonstrate the cost-effectiveness of EWS as a critical disaster risk reduction and climate change adaptation measure that reduces economic losses and saves lives

³ The EWS is part of the Barbados Comprehensive Disaster Management Audit and the DEM Strategic Plan 2019-2023. It is based on four pillars: disaster risk knowledge, monitoring and analysis, warning dissemination and communication, and disaster response capability.

⁴ The main vector-borne diseases are dengue, chikungunya and zika.

⁵ One particular challenge is to treat standing water to reduce mosquito proliferation in a manner that also ensures water security, as water is scarce in Barbados.

⁶ CDEMA, DEM, (2021). "The Multi-Hazard Early Warning Systems Roadmap and Action Plan: Barbados (2021-2024)".

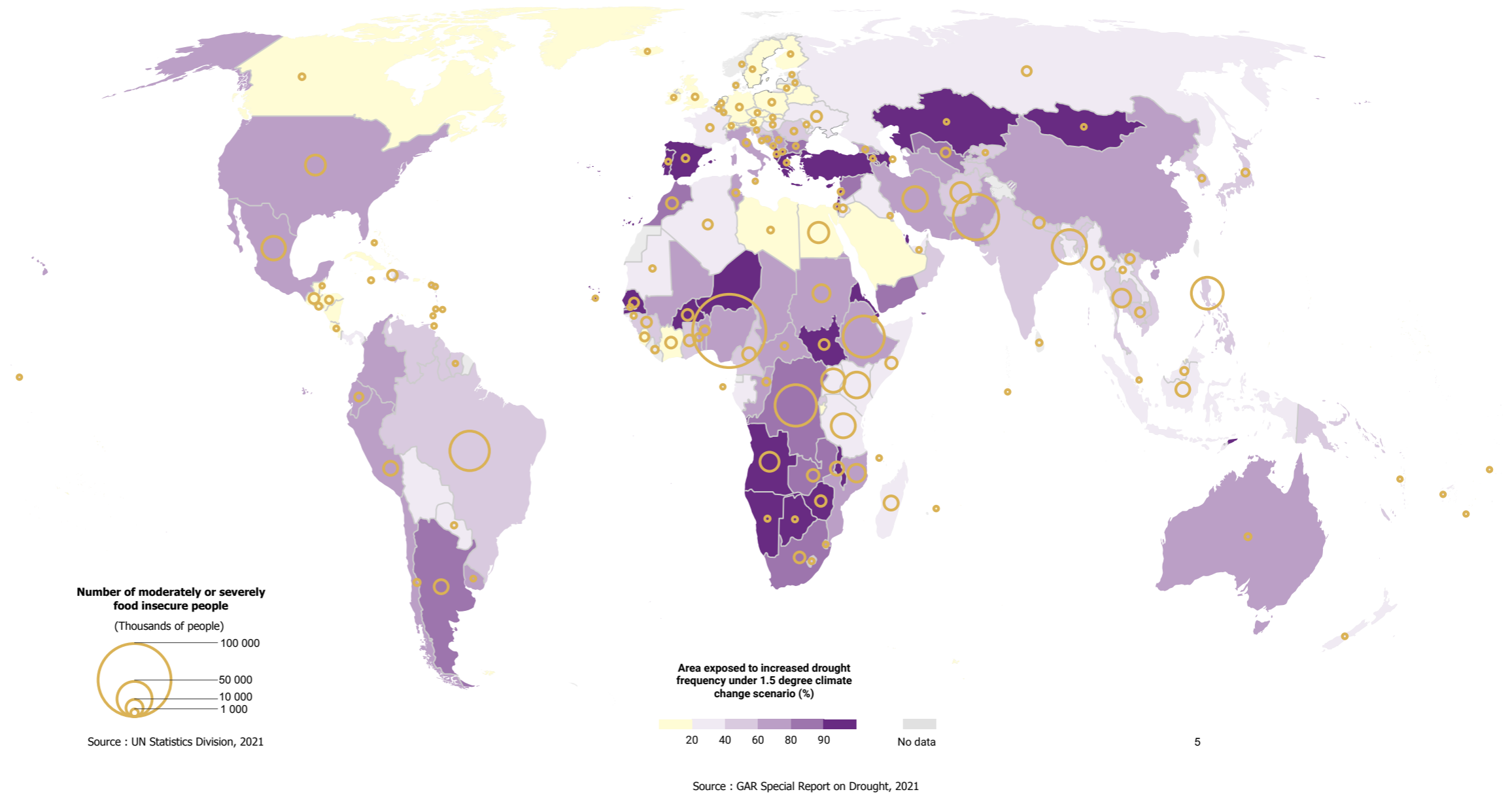
⁷ Department of Emergency Management. (2019). *The Barbados Comprehensive Disaster Management (CDM) Country Work Programme (CWP) 2019-2023*. Bridgetown: Government of Barbados.

⁸ The other example of a biological risks being integrated into EWS is in Europe. The Early Warning Systems for Vector-Borne Diseases is part of the European Centre for Disease Prevention and Control, increasing the lead time needed for a public-health response to disease emergencies (Climate-ADAPT, 2022).

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Resilience deficit 2. Increasing drought risk and food insecurity

Map 3. Percentage of country area exposed to increased drought frequency under a 1.5°C climate-change scenario and current prevalence of moderate or severe food insecurity in the total population (SDG Indicator 2.1.2 and 2.4.1)



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UNITED NATIONS Geospatial
Map No. 4673.3
Jun 2023

Map 4. Percentage of country area exposed to increased drought frequency under a 2.0°C climate-change scenario and average prevalence of moderate or severe food insecurity in the total population between 2019 and 2021 (SDG Indicator 2.1.2 and 2.4.1)

Key figures



70% Percentage employment in low-income countries reliant on agriculture as source of income (World Bank Group, 2017)



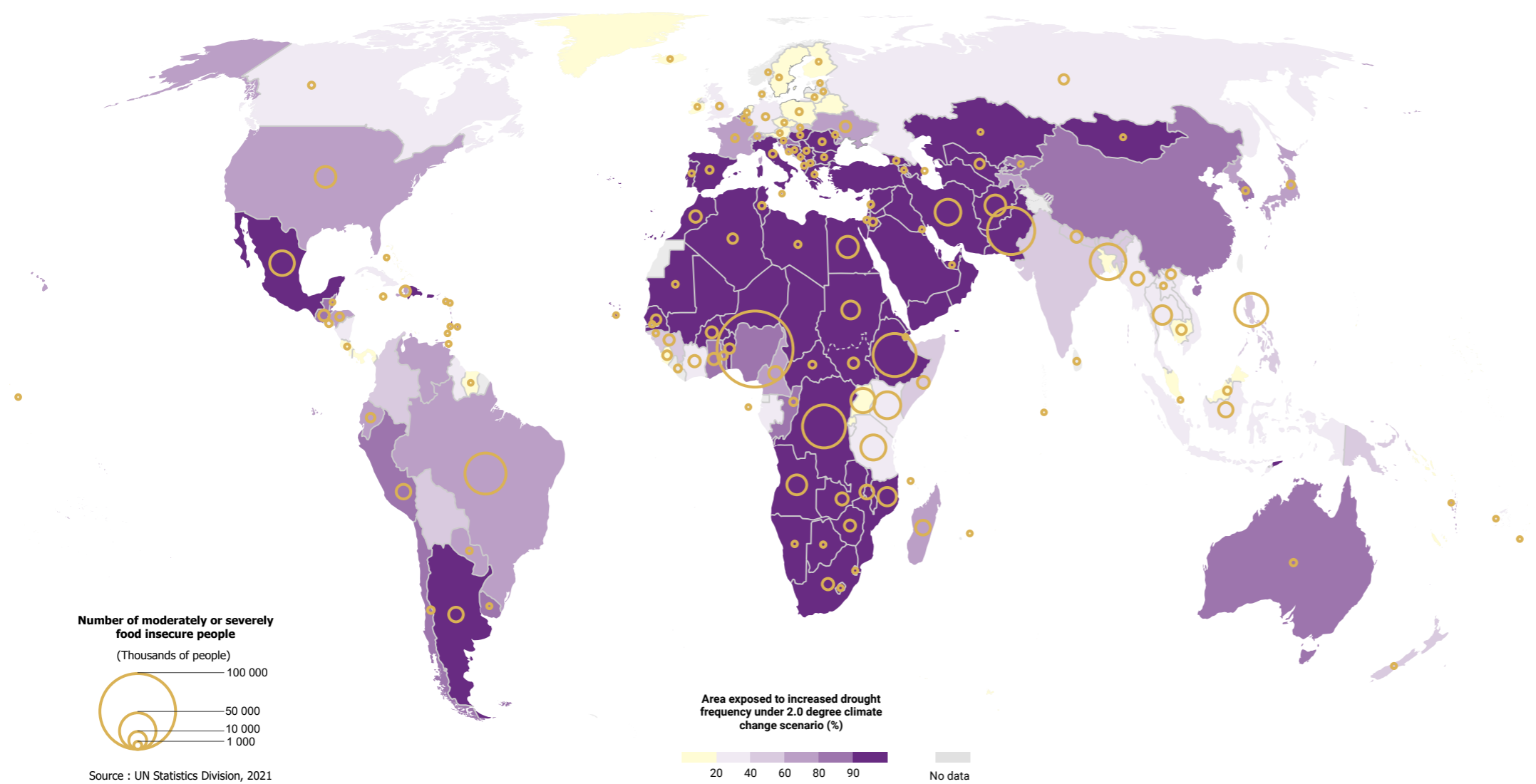
71 Additional food, feed and fertiliser trade restrictions imposed by countries in 2022 (World Trade Organization, 2023)



60% Increase in incidents of drought by the end of the century (IPCC, 2014)

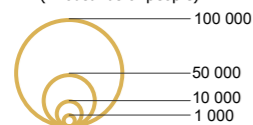


80% Percentage of global population at risk of crop failure and hunger in sub-Saharan Africa and south and south-east Asia. (The World Bank, 2022)



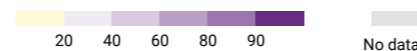
Number of moderately or severely food insecure people

(Thousands of people)



Source : UN Statistics Division, 2021

Area exposed to increased drought frequency under 2.0 degree climate change scenario (%)



Source : GAR Special Report on Drought, 2021

Globally, drought is one of the most lethal hazards (WMO, 2021), mainly because it increases food insecurity, which brings with it a cascade of highly damaging impacts. Due in part to climate change, incidents of drought have doubled in the last 40 years and their geographic range has expanded. This is reversing gains in food security and poverty reduction (FAO, n.d.a). Between 2014 and 2020, the prevalence of moderate to severe food insecurity rose by 22 per cent to 30 per cent with the highest rises in sub-Saharan Africa, central and south Asia and Latin America (FAO, n.d.c). Map 3 illustrates how drought, along with conflict and the COVID-19 pandemic, has contributed to a record increase in people facing acute food insecurity. In 2022, a new record was reached, with 345 million people facing acute food insecurity globally (WFP, n.d.).

Maps 3 and 4 show the percentage of a country's total area that will be exposed to increased drought frequency under the 1.5°C and 2.0°C climate scenarios respectively. Under the 2.0°C scenario, 103 countries will have increased drought frequency in at least 85 per cent of their territory.

Acting now to build resilience towards drought and food-security risk can stop this negative spiral and would accelerate achievement of multiple SDGs including 1, 2, 3 and 10.

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ACTION CASE: SAHEL REGION

Accelerating the greening of the Sahara through the Great Green Wall initiative

Managing slowly but steadily increasing pressures, such as desertification and soil erosion, requires durable and long-term responses. Setting these responses in motion early is important given the long lead times needed to steadily offset these encroaching risks. One example of such a durable response is the creation of a Great Green Wall (GGW) of vegetation along the southern edge of the Sahara, to counter climate impacts.

The idea gained traction in 2007 after its endorsement by the African Union. The aim is to restore 1 million km² of degraded land across 7,000 km of the Sahel, with the support of the 11 affected States and regional bodies. Although the original purpose was to counter desertification, the initiative broadened to focus on improving the livelihoods of the people who are largely dependent on rain-fed agriculture and livestock (FAO, 2014).

The Sahel is a hotspot for climate impacts, with temperatures expected to rise by 3–6°C by the end of this century (Niang et al., 2014). Rainfall patterns are also becoming unpredictable and more intense, thus making agriculture production challenging (Sultan and Gaetani, 2016). The planting of GGW vegetation provides numerous benefits as it sequesters carbon and improves water retention, thus lowering the risk of floods and improving soil productivity. The vegetation also provides shade and food for animals.

One of the less-recognized contributions of the GGW, is that it works with another process triggered by climate change – the greening of the Sahel. Precipitation rates and vegetation have been increasing since the droughts of the 1970s (Brahic, 2005). This greening of the Sahel, at least in its western regions, is due to changing monsoon patterns. Rather than moving humidity to the Atlantic, it is now starting to come back (Pausata et al., 2020). The water retention and transpiration of plants, including those being planted as part of the GGW, accentuate this greening process.⁹

Although most of the region may become wetter, increasing temperatures and evaporation will offset some of the benefits of higher precipitation.¹⁰ Therefore, more-resilient vegetation, agriculture and methods of managing livestock and human health will be needed to adapt to the changing climate. While the GGW mitigates droughts and floods and provides a range of economic and social benefits, managing slow-onset variables requires constant review and adaptation.



The Sahel is a hotspot for climate impacts, with temperatures expected to rise by 3–6°C by the end of this century



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⁹ A 'Great Green Wall' in the region could result in more rainy days (+9 per cent) and intensified heavy-rain events while reducing extreme dry spells. (Saley et al., 2019); (Zachos et al., 2008); (Goffner et al., 2019); (Yosef et al., 2018).

¹⁰ Less Saharan dust could reduce ocean and Amazonian productivity, for example, thus making afforestation potentially less effective as a carbon sink. (Ridgwell et al., 2022)

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Resilience deficit 3. Forced displacement and negative education outcomes

Map 5. Estimated number of internally displaced children (under 18) at the end of 2022 and youth-literacy rates (latest estimate since 2014) (SDG indicator 4.6.1)

Ensuring all children obtain a quality education is fundamental to creating a peaceful and prosperous world (United Nations, n.d.a). Forced displacement caused by conflict, epidemics and sudden-onset hazard events, is highly disruptive to children's education. According to the Internally Displaced Monitoring Centre, of the 71 million people displaced at the end of 2022, 30 million were under the age of 18. (Internal Displacement Monitoring Centre, 2023). According to the United Nations Refugee Agency, among those children classified as refugees, 61 per cent go to primary school, compared to 91 per cent globally (UNHCR, n.d.). This number does not include the many millions of people who are displaced within their countries who do not qualify as refugees.

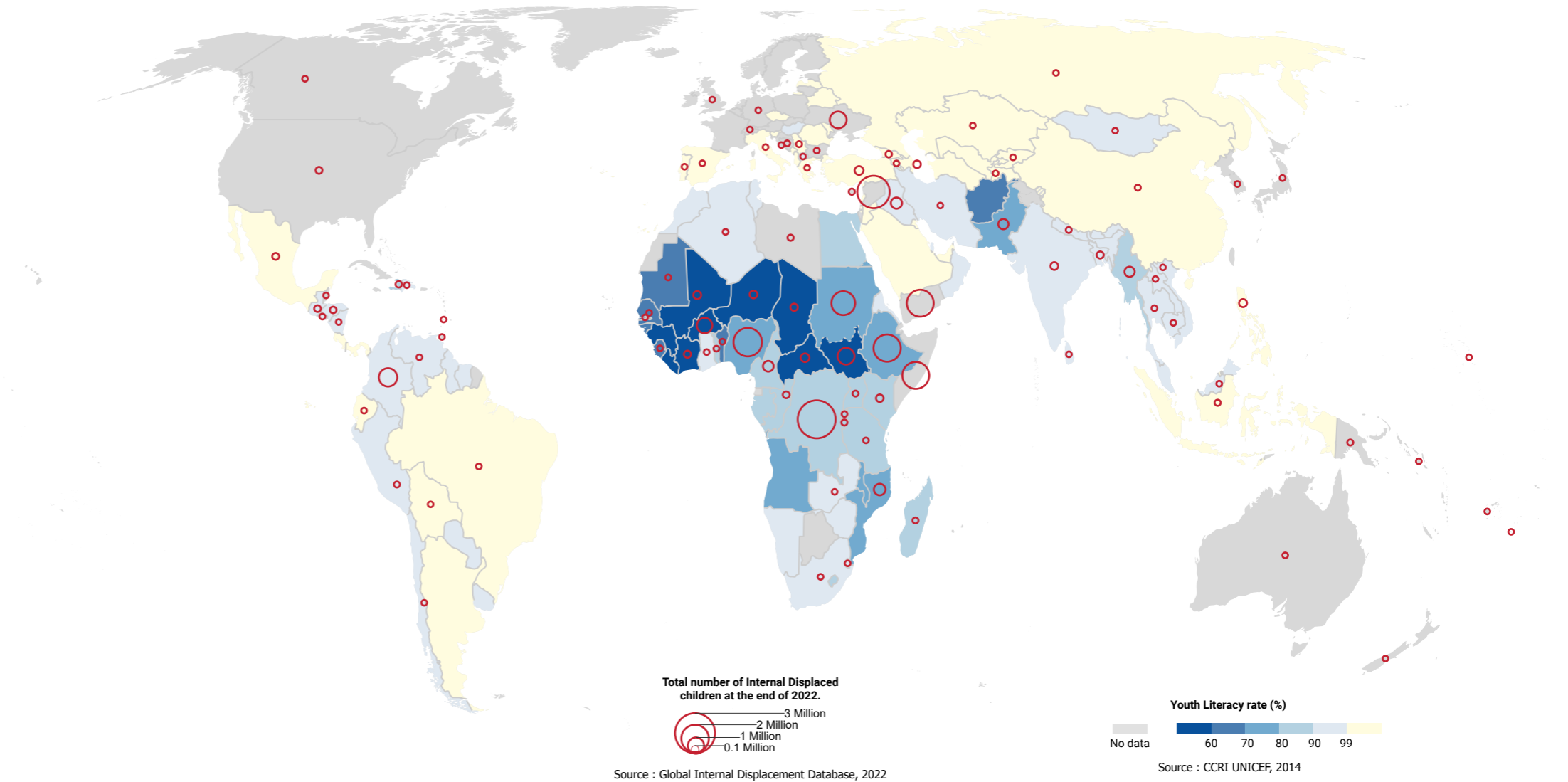
Displaced children often fall behind with their education, and their pathway to higher education and career opportunities narrows. For example, data on children displaced by conflict show that only 23 per cent enrol in secondary school, with that number dropping to 9 per cent in low-income countries (UNHCR, n.d.). By the time they reach university age, only 1 per cent move on to higher education (UNESCO, 2019). This limits the future of these children and results in the loss of tens of trillions of dollars in lost lifetime productivity and earnings (World Bank, 2018).

Map 5 shows the challenge of ensuring that children and youth are able to gain literacy skills in societies already experiencing high rates of internal displacement. Given that climate change is increasing internal-displacement risk in many ways, including making some coastal areas uninhabitable, changing crop suitability and even in some cases increasing conflict risks, increased investment to build resilience and prevent displacement where possible is essential.

However, in some cases, human mobility is also a key accelerator of sustainable development and can be a positive form of risk reduction when undertaken in a consultative, safe and voluntary manner, as showcased in the example of Fiji below.

Key figures

- 330 million** Children exposed to climate and environmental hazards in 2020 (UNICEF, 2021)
- 820 million** Number of children exposed to heatwaves in 2020 (UNICEF, 2021)
- 920 million** Number of children exposed to water scarcity in 2020 (UNICEF, 2021)
- 2 billion** Number of people affected by armed conflict in 2023 (United Nations, 2023b)



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ACTION CASE: FIJI

Pre-emptive voluntary relocation of communities to reduce exposure to disasters

Being able to forecast climate impacts and develop collective understanding of the realities of risk and limits to adaptation is critical to creating more-adaptive and anticipatory governance. This capacity enhances adaptive capacities and manages what can be painful but necessary trade-offs. This is the case for many communities in Fiji, who are at the forefront of the climate crisis as they are losing land, livelihoods, traditional fishing grounds and cultural assets due to sea-level rise, coastal erosion and recurring disasters. The development of a collective understanding and realization of these climate risks has led them to make a decision about whether to stay in their homes or relocate to safer locations where they would be more secure (Lyons, 2022). The process of deciding which communities to move first, where to move them, and how, also requires a deep understanding of inter and

intra-communal relations, land-tenure rights and a host of other considerations.

Fiji comprises over 300 islands, with a population of just under 1 million people. Much of the population is exposed to climate-induced impacts since many of its communities are located near the coast (World Bank Group, 2021). The country is no stranger to cyclones, which can hit several times a year. However, as the ocean warms, these storms are intensifying, and storm surges are moving deeper inland due to sea-level rise.

To address the growing concerns of its population and avoid further loss of life and property, the Fiji Government embarked on the first pre-emptive population-relocation programme due to climate impacts.

The government conducted an in-depth assessment of current and prospective climate impacts. It also established local community-consultative processes so community members could express their concerns and participate in the decision-making processes. One remarkable feature of the programme is that to ensure consensus, a decision to move requires 90 per cent agreement among all sectors of a community including women, youth and people with disabilities. If a community does not want to relocate, people are not forced to do so. Similarly, the responses of any receiving community are also considered. Through this process, 42 villages were identified for relocation. Of these, six have already moved. The process of relocating entire villages is challenging. Land claims need to be resolved, infrastructure with the requisite services needs to be built, and processes need to be made to support the often-traumatic process of leaving ancestral land.

To facilitate the movement of a community, relocation of schools and lowering disruption to children's education is always among the top priorities. To learn from each experience, with the support of the UNDRR, the Government developed a comprehensive risk and vulnerability methodology to inform standard operating procedures for planned relocations (UNDRR, 2019). These procedures are continually adapted as the

programme is implemented. In this way, lessons are learnt, thus improving the way in which future relocations are conducted. The learning process allows the Government and local authorities to continually review the risks and mitigation processes, thus minimizing risk and avoiding inadvertent damage.

Developing a shared understanding of climate risks, such as those affecting Fiji, is vital to developing consensus on how to manage those risks. Pre-emptive relocation is unfortunately one that is likely to be repeated elsewhere. The way the Fijian Government and communities took time to fully appreciate the situation, including avoiding disruptions to education, offers valuable lessons for other communities exposed to climate impacts.



the Fijian Government has embarked on the first pre-emptive population relocation programme due to climate impacts.



42 villages
were identified for relocation.

Of these, **six**
have already moved.



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SUSTAINABLE DEVELOPMENT GOALS

PLANET

The existing SDG indicator framework highlights that people can only prosper in a world where natural systems are nurtured and sustained. Key SDG targets that focus on planetary sustainability include 3.9, 6.4, 7.1, 7.2, 7.3, 11.6, 15.3 and 15.5. Overall, they aim to “protect the planet from degradation, including through sustainable consumption and production, sustainably managing its natural resources and taking urgent action on climate change, so that it can support the needs of the present and future generations” (United Nations, n.d.b).



Resilience deficit 4. Increasing water stress and population growth

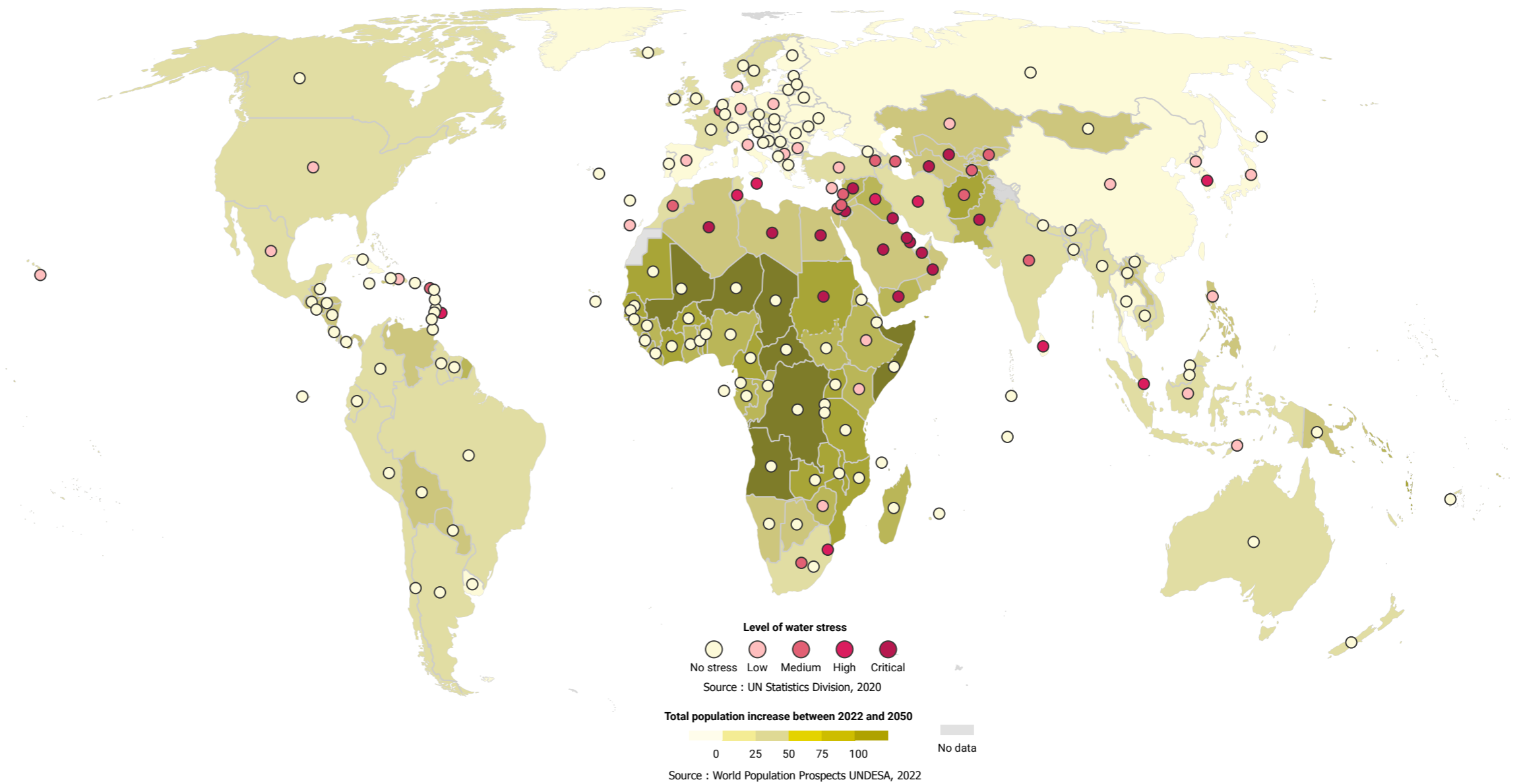
Map 6. Level of water stress in 2020 and projected relative change in total population between 2022 and 2050 (SDG indicator 6.4.2)

Map 6 shows how population and economic growth, combined with the impacts of climate change, are rapidly increasing demand on water resources. That means that by 2050, the total population in countries with critical water stress is expected to increase by 50 per cent, from 620 million currently to 933 million in 2050. Sustainably managing water resources requires that the amount of fresh water utilized is recharged by rainfall and the recycling of water. If this does not occur, the stress on water systems will steadily diminish groundwater storage.

More than two billion people are living in countries under water stress and 3.6 billion people face inadequate access to water at least one month a year. By the end of this decade, due to population and economic growth, demand for fresh water is expected to outstrip the supply by 40 per cent. As shown in Map 6, the level of water stress is likely to increase in the Middle East and West Africa due in part to population growth and increasing consumption.

Drought is both a symptom and a cause of water stress. While drought occurs when there are abnormally long periods of low rainfall, the impact on livelihoods, agriculture and livestock occurs when there is no longer enough water to meet demand. Drought amplifies water stress while the lack of water aggravates droughts (World Health Organization, n.d.b). Climate change is exacerbating this problem, as higher temperatures and lower humidity cause droughts to increase in frequency and severity. Africa is particularly vulnerable and has already suffered a 29 per cent increase in the number of droughts over the past two decades (World Health Organization, n.d.b).

Given the number of competing priorities, the solutions are complex and require multiple systems to work together. One of the best ways to encourage this collaboration is through integrated water-resources management (IWRM). This aims to forge integrated water planning that optimizes management of the supply and use of water. Countries with the capacity to implement IWRM processes tend to be more sustainable, with lower levels of water stress.



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ACTION CASE: YEMEN

Transformation within crises

No other resource is more consequential than water. The availability and affordability of water underpins the economy, livelihoods and health of any society. Sustainable management of water, in a context of increasing temperature and greater intermittency in precipitation, and greater demand, requires an in-depth understanding of the limits to managing this finite resource.

Yemen has always had to deal with water scarcity. Its communities have developed multiple coping mechanisms to adapt to arid conditions, using agricultural techniques such as terracing to capture water flows. However, the advent of electricity has significantly increased pressure on water resources as agriculturalists were able to significantly increase groundwater extraction. Lured by cash crops such as khat, demand for water has soared, with agriculture constituting 93 per cent of water consumption (UNDP, 2022a).

Together with a rapidly increasing population, water tables in the country are falling several metres every year. As a result, by as early as 2025, the period of 'easy water' is likely to be over, as non-renewable water reserves empty.

The coming end of easy water in Yemen is as foreseeable as it is certain. However, the lack of political will, coupled with fragmentation due to conflict, has impeded collective efforts to build a more sustainable system. To avoid feedbacks between water scarcity lowering agricultural outcome which feeds intercommunal tension, a host of interventions are needed (UNDP, 2022a).

With the right preparations and sufficiently early investments, the worst-case results can be averted, and a more resilient and integrated system of using

renewable water created. Efforts that are already creating ecological and economic dividends include working with farmers to restore traditional farming practices including terracing, rainwater harvesting and the promotion of drought plant species. This includes working with khat farmers to change the incentives so that this water-intensive crop can be replaced with one that is both nutritious and has value as an export. It also includes building more-inclusive governance modalities such as local water-user associations, which encourage collective decision-making on the allocation and management of water resources.

Yemen has many challenges, and understanding the drivers of these challenges and their consequences is vital to developing the appropriate response (IPCC, 2023b). Partnerships with organizations, like the United Nations Development Programme and civil society organizations, are helping communities to understand their risks and to find sustainable solutions. Understanding the implication of trends and working with the incentives that they create can reveal opportunities for making long-overdue structural changes.

With the right preparations and sufficiently early investments, the worst-case results can be averted, and a more resilient and integrated system of using renewable water created.



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Resilience deficit 5. Increased land degradation and biodiversity loss

Map 7. Percentage of degraded land in 2019, and the IUCN Red List of Threatened Species Index for 2020 (SDG indicators 15.3.1 and 15.5.1)

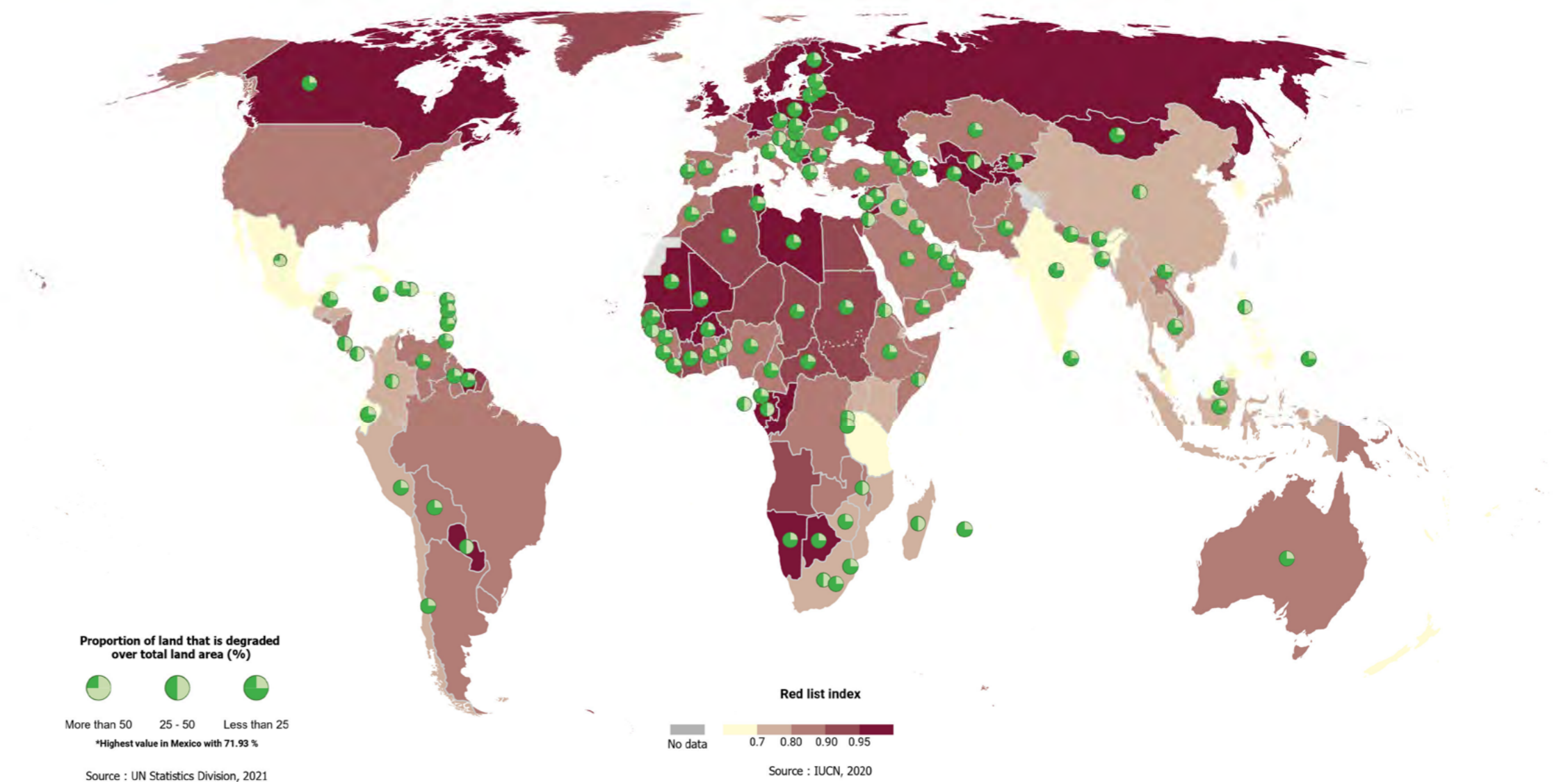
Protecting biodiversity is essential for maintaining the integrity of the ecosystems on which humanity depends. Land degradation, most of which is due to converting land for agriculture, is the primary driver for biodiversity loss (IPCC, 2019b). Agriculture alone is the primary threat to 24,000 of the 28,000 (86 per cent) species at risk of extinction (Benton et al., 2021). One in four species are threatened with extinction.¹¹ The world is losing approximately 100 million ha or 1 million km² of land to degradation every year (UN DESA, 2023b). So, while food productivity has increased, the practices utilized undermine long-term food security and ecosystem functioning.

As shown in Map 7, land degradation, much of which is due to deforestation and unsustainable agriculture practices, contributes to biodiversity loss. The Red List Index measures the total change in the extinction rate of all species. Land degradation also contributes to indirect losses due to the release of carbon from the soil, which decreases its productivity and ability to absorb water.

Reversing this trend requires policies that encourage sustainable land-use management, including allowing nature to restore the land. This is the commitment made at the United Nations Convention on Biological Diversity in 2021 when countries committed to protecting 30 per cent of land and 30 per cent of ocean by 2030. Realizing this is fundamental to maintaining the stability of the ecosystems on which human prosperity is based.

Key figures

- 1%** Increase in global proportion of forest area within protected areas, between 2010 and 2020 (FAO, n.d.d)
- 90%** Loss of forest due to agriculture between 2000 and 2018 (FAO, n.d.b)
- 7%** Increase in forest area under management between 2010 and 2020 (FAO, n.d.d)
- 9.2%** Red List Index overall extinction of species between 2000 and 2022 (SDG indicator 15.5.1) (UN DESA, 2022)
- 5-20%** Amount of carbon emissions that can be offset through the better management of soils (IPCC, 2019b)
- 37%** Number of countries on track to meet their national biodiversity targets (UN DESA, 2022)



¹¹ The primary drivers of biodiversity loss are changes in land and sea use, direct exploitation of organisms, climate change, pollution and invasion of alien species (IPBES, 2019).

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ACTION CASE: INDONESIA

Creating a steady state in the governance of natural resources in Cidanau Watershed

Reaching a steady state where consumption remains at or below the carrying capacity of natural ecosystems, on which Indonesia's rich biodiversity relies, is critical to sustainability. On Java Island in Indonesia, finding this steady state between the water produced by its watershed and the increasing demand of its cities and industry was challenging. A solution became possible only after different actors, each with their own set of interests and decision-making, came together to achieve a common and mutually beneficial objective that was good for both the economy and the environment.

The Cidanau Watershed is a nature reserve created to preserve the rich habitat of Indonesia's native species. It is also the primary source of fresh water for two districts in Java: Serang and Pandeglang. It provides water for the citizens of the main city, Cilegon, as well as to over 100 industries, including the largest steel maker in south-east Asia, the Krakatau Steel Company. The water generated for the city comes from the only mountainous area on the island. The capacity of this ecosystem to provide fresh water came under threat due to deforestation for agricultural purposes. The resulting erosion reduced and polluted the water, clogging waterways. As the mountains are protected as a nature reserve, the

government initially tried to resettle farmers and reforest the area, but these efforts had little success due to lack of agreement with the farmers.

To address the situation, the local government and a civil society organization, Forum Komunikasi DAS Cidanau (FKDC), brought the private sector and farmers together to find a solution. Instead of one actor deciding a course of action, all stakeholders decided on creating a Payment for Environmental Services (PES) scheme. In a PES, those that benefit from ecoservices pay those conserving the nature that provides them (Amaruzaman et al., 2022).

In this case, the Cidanau-based industries provide payments to farmers who maintain forests through agroforestry practices. The local government is an investor in this scheme and FKDC certifies that both sides fulfil their part of the deal. Started in 1994, the Cidanau Watershed PES is one of the longest-running schemes in the world and has the full support of the national and local governments. This example demonstrates how polycentric governance works when there is political will from all actors, a common legal framework and higher-level governance support (Ostrom, 2010).



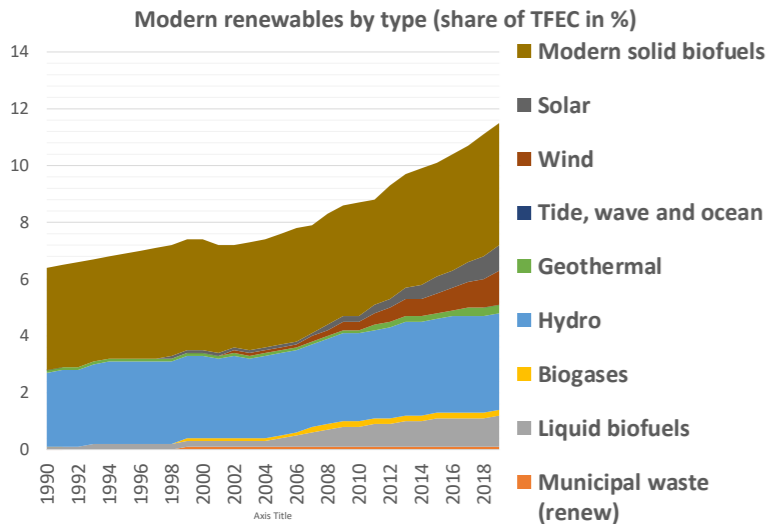
Cidanau Watershed PES is one of the longest-running schemes in the world and has the full support of the national and local governments

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Resilience deficit 6. Increased heat stress and energy consumption

Map 8. Energy efficiency in 2020, share of modern renewables in total energy consumption in 2020 and mean near-surface air temperature under a 2°C warming scenario SSP2-4.5 (SDG indicators 7.2.1 and 7.3.1)

Graphic 1 Share of modern renewables in the total energy consumption 1900-2019 (%)



Source: UN DESA, 2023 prepared for this report

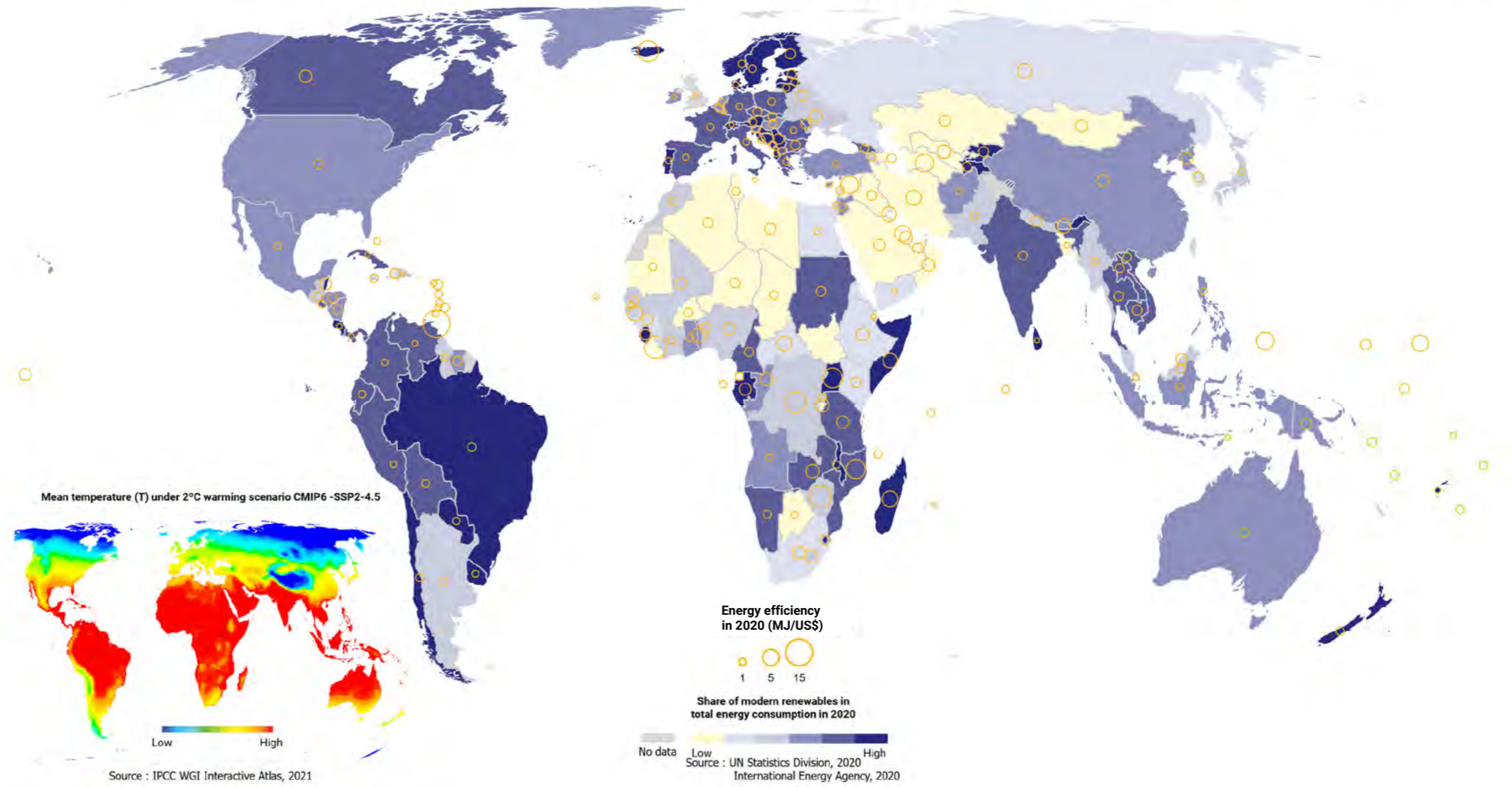
Heat negatively affects electricity production while simultaneously increasing demand due to the need for cooling. As shown in Map 8, many of the countries with the lowest rates of energy efficiency and renewable energy are also the most affected by heat stress due to climate change.

Global efforts to reach carbon-reduction objectives through electrification are driving a race to decarbonize the electricity sector. This race can be won only by improving energy efficiency and switching to less carbon-intensive forms of production, namely renewable energy. However, installation of new renewable capacity needs to outpace demand.

The pace of the energy transition is currently well below what is required to achieve carbon neutrality by 2050. As shown in Graphic 1 on modern renewable energy, the percentage of renewable energy has doubled between 1990 and 2020 from 6 per cent to 12 per cent. However, as more people are using more electricity, the overall consumption of fossil fuels also continues to rise (Economist Intelligence Unit, 2022). To get ahead of increasing energy demand, investments need to be significantly increased, to create more clean energy and to use that energy more efficiently.

Key figures

- \$5.9 trillion** Global expenditure on fossil-fuel energy subsidies in 2020, (SDG indicator 12.c.1) (International Monetary Fund, 2022)
- 2%** Increase in modern renewable-energy use in final energy consumption (2010-2019) (SDG indicator 7.2.1) (UN DESA, 2022)
- 91%** Population with access to electricity in 2020; up from 83% in 2010 (SDG indicator 7.1.1) (UN DESA, 2022)
- 3.2%** Amount of yearly energy-efficiency improvement needed to reach target by 2030 (SDG indicator 7.3.1) (UN DESA, 2022)



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ACTION CASE: INDIA

Combating heat using a participatory approach

When addressing threats as widespread and deadly as heatwaves, any risk-mitigation plan requires extensive participation of the affected population. India has therefore implemented heat action plans (HAPs) in cities across the country through the broad participation of the public and local governments.

Often referred to as the 'silent killer of climate change', increasing heatwaves are among the most impactful of hazards, particularly in tropical and subtropical climates such as India. Exposure to this risk is high in India because of its geography, strong population growth and urbanization. This exposes more people to the risk, and urban areas, particularly slums, tend to act as heat islands due to paved surfaces re-radiating heat.

Cities trap heat and often also have higher concentrations of air pollution. Cities produce roughly 78 per cent of carbon emissions, the majority of which come from the energy sector, and substantial airborne pollutants that adversely affect the populations living within them. When combined with heat stress, the adverse impacts of pollution on human health increase. Heat tends to oxidize pollutants, thus increasing stress on a body that is already weakened by the need to regulate temperature. The net result of the combination of high pollution and heat is that the risk to mortality increases by as much as threefold.

To reduce exposure, save lives and reduce over-reliance on air conditioning, the Indian Government, municipalities and local organizations are increasingly implementing HAPs. As there is no one-size-fits-all approach, each plan is developed locally through broad participation and consultation. This consultative process is always the first step as it builds engagement and confidence in the system, and allows a greater array of resources to be utilized. Broadening support ensures there is political support from local

governments, weather data from meteorological agencies, and input from civil society and universities.

While each HAP is tailored to the local context, they all have essentially four characteristics:

- A graded EWS, from mild to severe
- A public-awareness campaign on dangers and mitigating measures
- Trained medical staff and facilities that are prepared

Systems and infrastructure to improve water distribution and roof-cooling programmes, to shade spaces and to expand public gardens.

Since the first HAP was implemented in Ahmedabad in 2013 to broad success, the programme has expanded to 23 of India's most heat-prone states, with each following the Government's National Disaster Management Authority Heat Guidelines (NRDC, 2022). The Government and review studies credit HAPs as having saved thousands of lives, due to their participatory and flexible approach.



increasing heatwaves are among the most impactful of hazards, particularly in tropical and subtropical climates such as India.



To reduce exposure, save lives and reduce over-reliance on air conditioning, the Indian Government, municipalities and local organizations are increasingly implementing HAPs.



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Resilience deficit 7. Increased air pollution and mortality

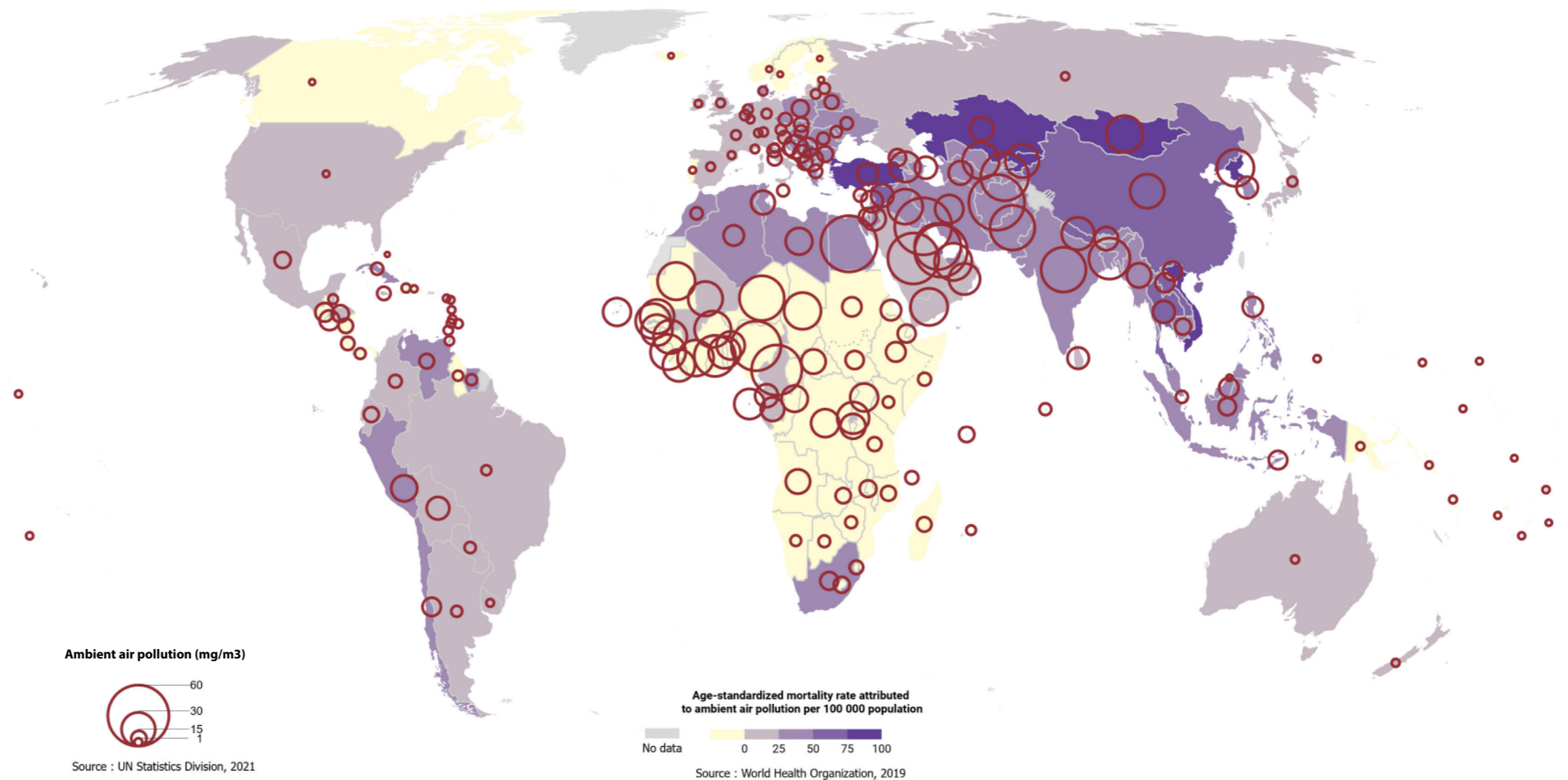
Map 9. Ambient air pollution measured by the annual mean levels of fine-particulate matter and ambient air-pollution-attributable death rate (SDG indicator 11.6.2)

Air pollution kills approximately 6.78 million people a year (World Health Organization, 2022) (United Nations, 2019). Of these, 3.5 million deaths are attributed to outdoor pollution while 3.8 million deaths occur due to indoor air pollution. Indoor air pollution is caused by cooking with wood, coal and kerosene, and disproportionately affects women and girls (World Health Organization, 2022). Map 9 shows the correlation between the lack of access to clean fuels and air pollution that leads to higher mortality rates. This map also shows the disparity between developed economies where clean fuels predominate and developing countries where traditional means of cooking remain common. Eight of the 20 countries with highest mortality rate due to air pollution are also among the

20 countries with the highest population increase, which means that mortality is likely to further increase without urgent action to address this resilience deficit. Action is possible, and often has other positive benefits. Switching to the use of cleaner fuels like solar, wind or biogas reduces pollution. Policy choices to apply subsidies, facilitate microfinance and deploy tax incentives can facilitate a fair and rapid transition to a cleaner, more-resilient energy mix (World Health Organization, n.d.a).

Key figures

-  **2.4 billion** People without means of clean cooking (SDG indicator 7.1.2) (UN DESA, 2022)
-  **11% Reduction in global fine-particulate matter pollution** between 2000 and 2019 (SDG 11.6.2) (World Health Organization, 2023a)
-  **5%** Percentage of total global energy use consumed to cool in buildings globally in 2017 (International Energy Agency, 2018)
-  **99%** Urban population that lives in areas exceeding World Health Organization guidelines on air quality (UN DESA, 2022) by 2030 (SDG indicator 7.3.1) (UN DESA, 2022)
-  **69%** Percentage of people using clean fuels for indoor cooking (up from 50% in 2000) (WHO, 2023)



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Over the past decade, new local leadership and more-participatory forms of governance have unlocked a new approach to urban development. This has sought to integrate the city, utilize natural systems rather than combat them, and focus on improving the way inhabitants live together.



ACTION CASE: BRAZIL

Leading the way to climate-smart urban planning in Teresina

Latin America is the most urbanized region in the world. While just over half of the world's population lives in cities, in Latin America that number is over 80 per cent and growing (Ezquiaga Arquitectura, Sociedad y Territorio S.L., 2015), (Statista, 2023). Within Brazil, the northern state capital of Teresina is one of the most rapidly urbanizing cities, and is located in one of the poorest regions in the country (Parra, 2022). Ensuring that the livelihoods of the growing urban populations are safeguarded, including that people can enjoy the benefits of clean air, requires constant learning and innovation.

As with many rapidly growing cities, maintaining a liveable and functional environment while continually expanding is challenging. In Teresina, rapid urbanization has occurred through unplanned horizontal expansion. Poorer populations, many of whom are new arrivals, have settled on the fringes, forming favelas (Espindola et al., 2017). Infrastructure to maintain and integrate the expansion is inadequate, resulting in increasing inequalities and higher poverty rates (UN-Habitat, 2021b).¹² Although the city's old title was Cidade Verde, Portuguese for green city, previous urbanization policies have resulted in green areas being replaced with grey infrastructure (Carneiro et al., 2021). This has magnified the temperature, increased air pollution, reduced the absorption of precipitation and increased river flooding, and thus exposed the population to higher rates of mosquito-borne diseases (Turmena and Maia, 2022).

Over the past decade, new local leadership and more-participatory forms of governance have unlocked a new approach to urban development. This has sought to integrate the city, utilize natural systems rather than combat them, and focus on improving the way inhabitants live together. This vision looked beyond the utilitarian functions of the city to one that encouraged innovation and polycentric decision-making. To ensure progress, new measurements and data have been collected and visualized in layered mapping, showing the interconnected nature of the different sectors (CARTO, n.d.). Although there are too many initiatives to describe, two stand out as being demonstrative of learning and innovation, and capable of providing numerous co-benefits.

The first policy was to restore Teresina as a green city – one that was in balance with its surroundings. The city put a moratorium on horizontal expansion, to enhance its capacity to absorb water from river flooding and rainfall and to do so in a manner that improves water quality. This was intended to rationalize infrastructure investment, intensify vertical development and preserve a green belt around the city that would allow for water run-off and cooling. An affordable housing programme was created to relocate vulnerable buildings, reduce exposure to flooding, make way for infrastructure improvements and address housing deficits.¹³ The city also developed a storm-drainage system. Finding that it did not have sufficient public financing, the city developed public-private partnerships and used this with support from the World Bank to construct canals and decontaminate lagoons. It also reforested areas along the rivers and streams and incentivized further greening by implementing an urban tree-planting programme.

To integrate the city while reducing costs and carbon emissions, steps were taken to modernize its public transportation system. Given that the intention was further integration, the city chose a participatory approach. This included forming 15 teams comprising public transport users to participate in 'open innovation', where they could provide recommendations to improve route planning and other recommendations for use by transportation planners (Euroclima, 2022). The city also diversified its transportation with three light-rail systems and the opening of 64 km of cycle lanes (Uchoa, n.d.). The transportation improved access to services, including health and education as well as employment (UN-Habitat, 2021b).

The ability of Teresina to learn how to adapt to climate impacts while cleaning its air and lowering emissions has attracted support from within the country and internationally. Organizations ranging from the World Bank to the European Union and the United Nations have engaged with the city to support efforts to build resilience and raise standards of living for all.¹⁴

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¹² Poverty incidence is estimated at around 47 per cent in Teresina (UN-Habitat, 2021b).

¹³ Teresina adopted a major policy - Urban Perimeter Act – in 2015 for freezing the urban perimeter.

¹⁴ UN Habitat has developed a Climate Resilience Profiling Tool to provide a strategic action plans for cities. This tool is used in conjunction with the City Resilience Global Programme (CRGP) to address issues such as climate change and sustainable urban planning and development (UN-Habitat, 2021a).

1 NO POVERTY

8 DECENT WORK AND ECONOMIC GROWTH

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

11 SUSTAINABLE CITIES AND COMMUNITIES

13 CLIMATE ACTION

SUSTAINABLE DEVELOPMENT GOALS

PROSPERITY

Ensuring that “all human beings can enjoy prosperous and fulfilling lives and that economic, social and technological progress occurs in harmony with nature” is a central facet of the Sustainable Development Goals (United Nations, n.d.b). Key SDG targets that highlight the importance of ensuring current and future prosperity across the globe include 1.1, 8.2, 8.5, 9.a, 11.1, and 13.1.



Resilience deficit 8. Increasing flood risk and urbanization





Map 10. Percentage of urban population living in slums (latest value since 2006), increase in urban damage between 2010 and 2030 relative to the 2010 values under the SSP2 RCP4.5 scenario, for flood with a return period of 100 years and projected relative change in urban population between 2022 and 2050 (SDG indicator 11.1.1)

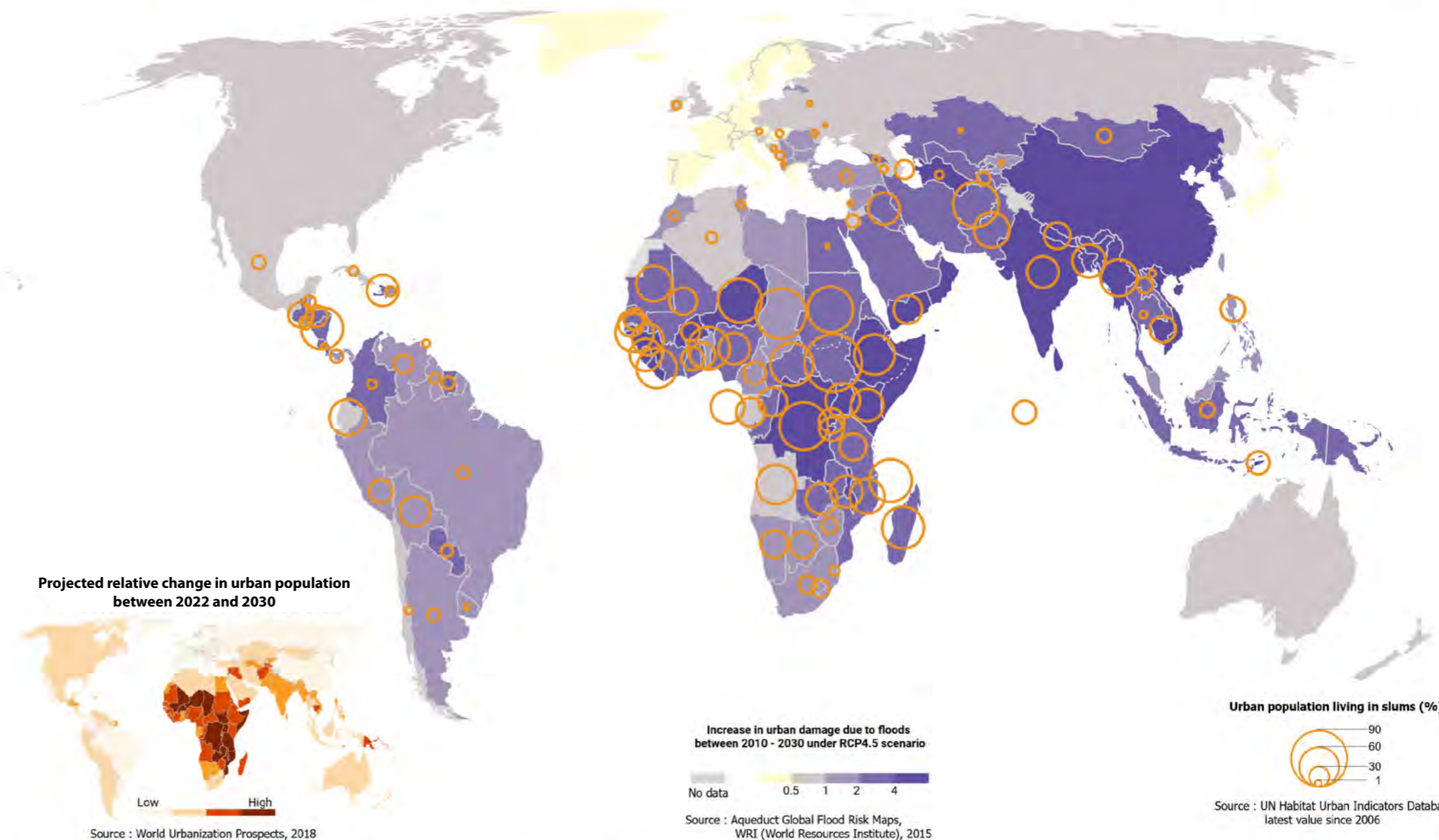
Flooding is one of the costliest metrological hazards, causing hundreds of billions of dollars of damage annually (Ward et al., 2013). Although the impacts of climate change on riverine and urban flooding vary (Alifu et al., 2022), with some areas expected to receive more rain and others less (IPCC, 2021a), the overall increase in the intensity of rains increases flood risk, particularly in south Asia, south-east Asia and the western Amazon (Eccles et al., 2019). The population in slums and unplanned urban settlements is projected to double by 2050, an increase of 100 per cent from 760 million in 2022 to 1570 million in 2050 (Arnell and Gosling, 2016).

Urban areas, where most of the world's population lives, will be particularly vulnerable, given the inability of urban surfaces to absorb rain (Hettiarachchi et al., n.d.). In some regions, such as Europe, direct damage due to flooding is expected to increase sixfold without climate change adaptation and risk reduction, with losses per square metre being the highest in urban areas (European Commission, 2020). Map 10 shows the projected damage to urban areas due to riverine flooding based on urban-population growth rate. The map also shows the correlation between poor infrastructure vulnerable to riverine flooding and the preponderance of urban slums.

Map 10 shows that without rapid action to address this resilience deficit, many of these already vulnerable people will be also exposed to significantly higher flood risk

Key figures

-  **45.2%** Urban population with convenient access to open public areas. (SDG indicator 11.7.1) (UN DESA, 2022)
-  **20-24%** Increase in global population exposure to flooding between 2000 and 2018 (Tellman et al., 2021)
-  **31%** Economic losses due to hazards caused by flooding between 1970 and 2019 (WMO, 2021)
-  **170%** Projected increase in damage caused by riverine flooding with 2°C warming without adaptation (IPCC, 2022) (WMO, 2021)



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ACTION CASE: THE EUROPEAN UNION:

Integrating climate risk data into the broader risk management system

Despite being in a high-income region, European Union member states face numerous threats due to earthquakes, biodiversity loss, as well as climate threats including wildfires, heatwaves, floods, sea-level rise and storm surges. To create a fuller appreciation of climate-exacerbated risks, the European Commission is developing increasingly sophisticated policy instruments to assist its member states in collectively fostering complex systems of understanding of risk and resilience. These tools are intended to build foresight into policy-making and enhance the anticipatory governance of EU member states in both urban and rural areas.

This system is evidence-based, premised on building analytical tools based on integrating data from national statistics sources. To ensure this system of data gathering and integration is harmonized among its member states, in 2021, the European Commission conducted a climate-impact assessment to identify and address gaps in data-gathering methodologies and standards.

As information is only as good as how it is utilized, the European Commission and the European Environment Agency created a common analytical platform called the

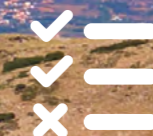
Climate Adaptation Platform (Climate-ADAPT). Climate-ADAPT provides a set of analytical tools capable of measuring current and future vulnerabilities of regions and sectors and proposing adaptation strategies and actions. Among the instruments are the Risk Data Hub, which pulls together national datasets, and the Resiliency Dashboard, which provides data on multi-dimensional risks based on the main threats or megatrends. Collectively, these efforts work to socialize and harmonize metrics so that European Union member states have the information needed to develop more-effective policies to absorb and respond to shocks.

Drawing from these resources, the European Commission was able to develop and adopt a strategy to adapt to the unavoidable impacts of climate change and other threats by developing resilience in all sectors by 2050. Specifically, the strategy recalls the importance of ensuring that climate actions are informed by robust data and common risk-assessment tools. To ensure synergies with mitigation, this strategy is closely connected with, and contributes to, European Union efforts to become climate-neutral by 2050.

The case of Greece

One European Union member state that is utilizing these tools and the resources flowing from the European Commission adaptation strategy is Greece. In 2021, Greece adopted its own Recovery and Resiliency Plan, which, with European Union financial support, is implementing 106 investment measures and 68 reforms, at a cost of €30 billion. One of the main aims of this plan is to accelerate the transition to a low-carbon resilient economy. Using the systems analysis of these tools, the plan has identified a multitude of projects across interrelated sectors. These range from reforestation to flood mitigation, irrigation networks, waste management and environmental protection, as well as reforms to its legal and regulatory frameworks to improve transportation, education, health, digitization and redesigning the labour market to fuel, and benefit from, the transition.

Although Greece often suffers from dry and hot summers, these conditions are often interspersed by rapid flooding causing death, injury and destruction of infrastructure. To protect its people and rich heritage, the government utilized a mix of loans, grants and national financing to upgrade its infrastructure, improving drainage and expanding natural water sinks. These investments will save money and lives, and ensure that its heritage sites are protected.



In 2021, Greece adopted its own Recovery and Resiliency Plan, which, with European Union financial support, is implementing 106 investment measures and 68 reforms, at a cost of €30 billion.

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Resilience deficit 9. Increasing heat and poverty

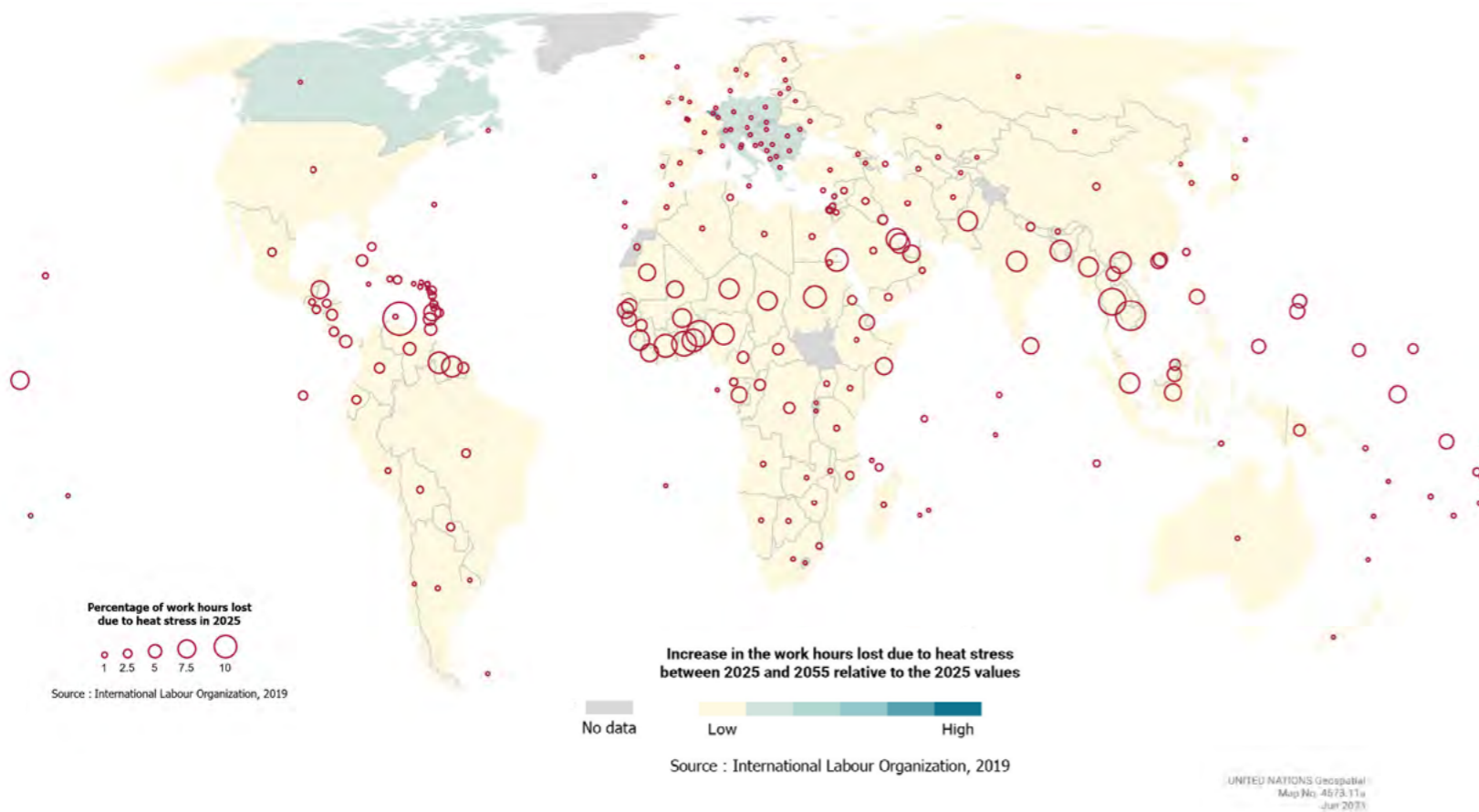
Map 11. Percentage of work hours lost due to heat stress in 2025 and increase in the work hours lost due to heat stress between 2025 and 2055, relative to the 2025 values, for RCP 2.6 and RCP 6.0 scenarios (SDG indicators 8.2.1 and 1.1.1)

Note: RCP = Representative concentration pathway.

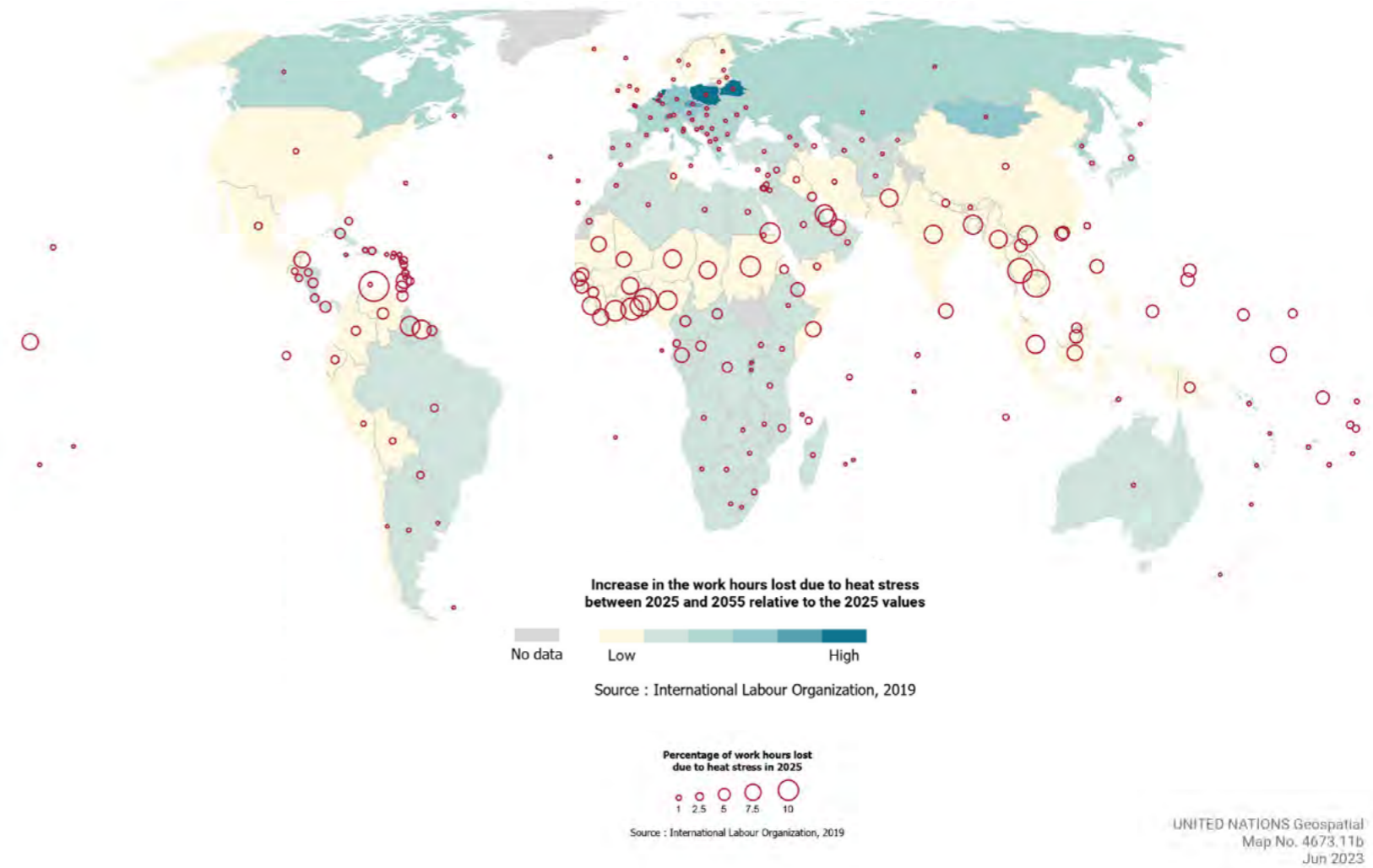
Working under the right conditions is important for productivity, health and well-being. When temperatures rise above 26°C, labour productivity begins to decline. At 34°C, productivity drops by 50 per cent. In 1995, the economic loss due to heat stress at work was \$280 billion (International Labour Organization, 2019). That figure is

rising as temperatures increase, with expectations that economic losses will reach \$2,400 billion in 2030. This is 2.2 per cent of total working hours worldwide – a loss equivalent to 80 million full-time jobs (International Labour Organization, 2019).

RCP 2.6 scenario



RCP 6.0 scenario



Key figures



45.2% Urban population with convenient access to open public areas. (SDG indicator 11.7.1) (UN DESA, 2022)



31% Economic losses due to hazards caused by flooding between 1970 and 2019 (WMO, 2021)



20-24% Increase in global population exposure to flooding between 2000 and 2018 (Tellman et al., 2021)



170% Projected increase in damage caused by riverine flooding with 2°C warming without adaptation (IPCC, 2022) (WMO, 2021)

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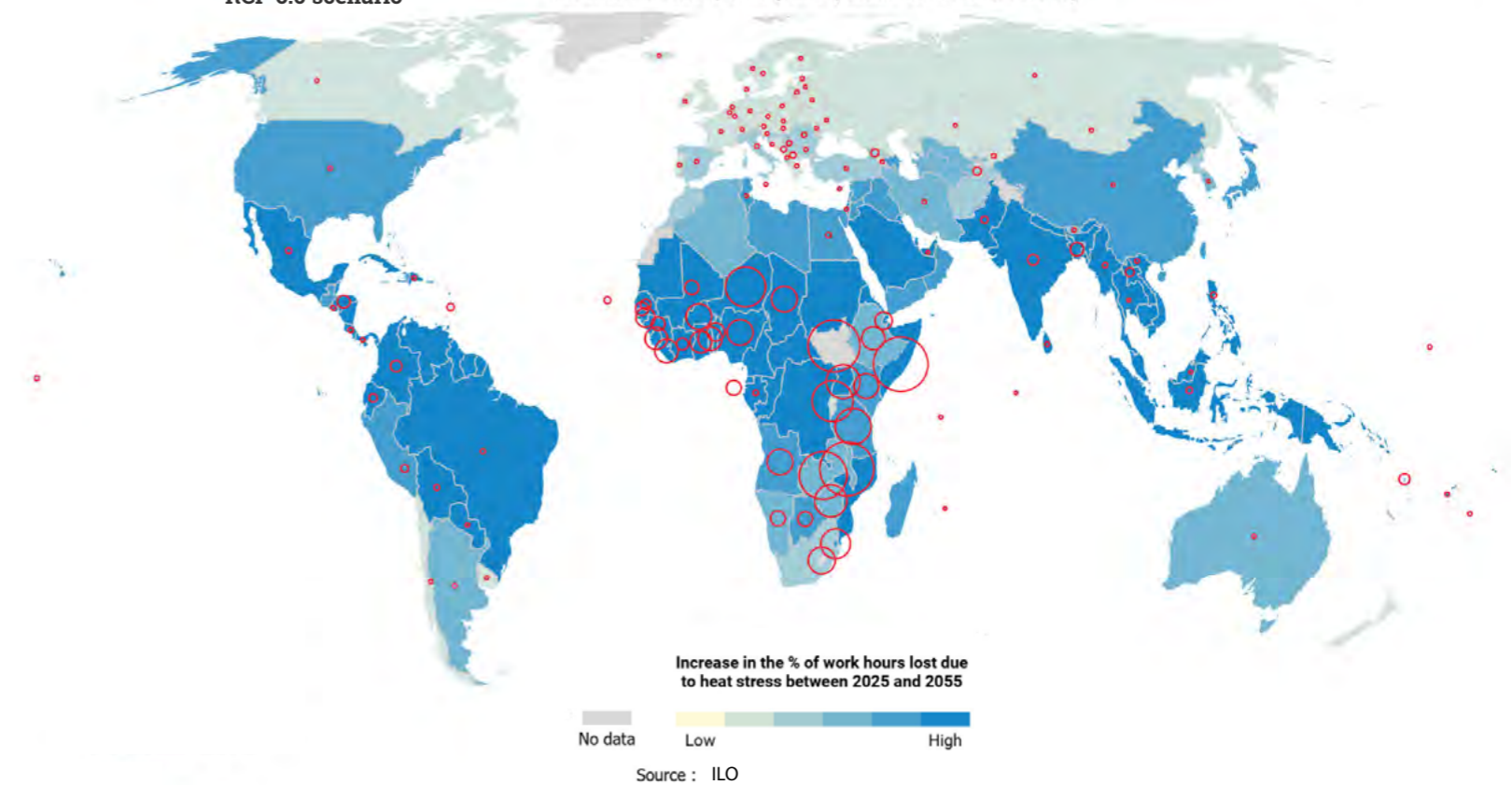


Map 12 Increase in the percentage of work hours lost due to heat stress between 2025 and 2055 for RCP 2.6 and RCP 6.0 scenarios, and proportion of population living below the international poverty line (latest values since 2015)

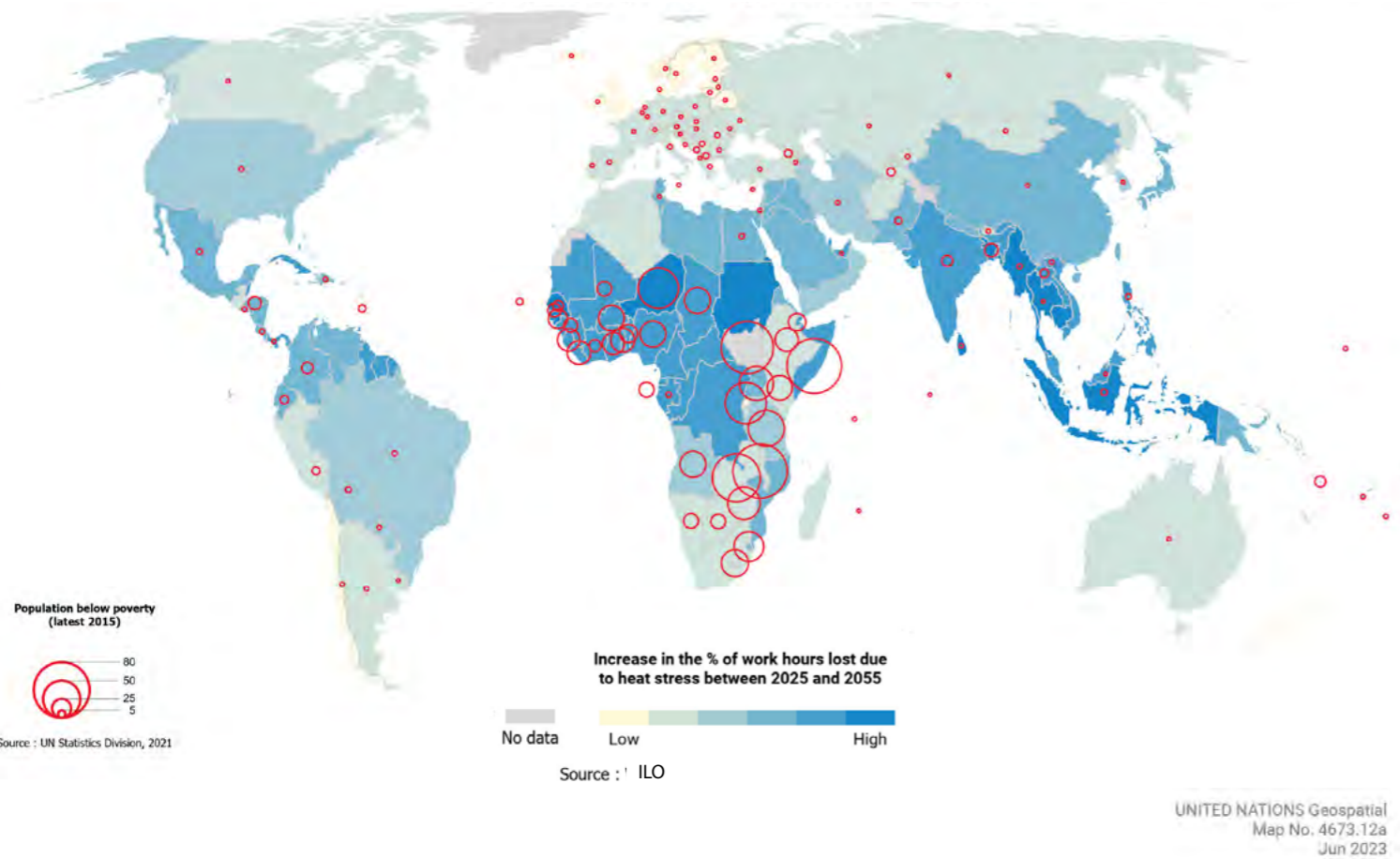
Note: RCP = Representative concentration pathway.

The impact of heat is inherently inequitable. Lower- and middle-income countries are affected the most, and those working in hard labour, primarily agriculture workers, are affected the worst, as shown in Map 11. This trend correlates strongly with poverty rates. Such inequities will increase over time without mitigative measures. As illustrated in Map 12, the loss of working hours due to heat contributes to higher poverty.

RCP 6.0 scenario



RCP 2.6 scenario



Key figures



60% Percentage of loss in the agricultural sector out of total working hours, projected to be lost due to heat by 2030 (International Labour Organization, 2019)



80 million This is 2.2 per cent of total working hours worldwide – a loss equivalent to 80 million full-time jobs (International Labour Organization, 2019)



5.3% and 4.8% Loss of working hours in south-east Asia and West Africa by 2030 due to heat stress (International Labour Organization, 2019)



49% vs 10% Percentage of labour loss in Africa compared to in the Americas under a scenario of 3.0°C warming (Dasgupta et al., 2021)

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ACTION CASE: MALDIVES

Strengthening resilience through economic diversification

A crisis often brings opportunity and a chance to change course. This is the case with Maldives, which, after making impressive development gains, found that its reliance on tourism for growth, in combination with environmental pressures, threatened to undermine its achievements. To consolidate gains and increase its resilience, including against rising temperatures, Maldives embarked on a diversification strategy across all major sectors, including its economy, and its electricity and water systems.

Situated in a remote region of the Indian Ocean, with its communities separated over hundreds of coral islands, life in Maldives is dependent on, and exposed to, the forces of nature. To develop its economy and allow its population to reach the level of affluency of other nations, Maldives embarked on a development strategy that focused largely on tourism, and an energy system that relied on fuel imports. This resulted in it achieving upper middle-income status according to the World Bank, and in raising the standard of living for its citizens (World Bank, 2023).

However, the COVID-19 pandemic and slow-onset environmental pressures have revealed vulnerabilities. Maldives experienced a 33 per cent economic contraction during the pandemic. Hazards related to diminishing freshwater reserves, cyclones and sea-level rise threatened to undermine the country's advances (Asian Development Bank, 2020a). The government response was to create recovery programmes that encouraged economic diversification, collaboration and innovation.

To diversify its economy away from tourism, Maldives has shifted investments to the 'Blue Economy' (sustainable use of ocean resources). It has taken steps

to modernize its fishing industry, improving the capacity to refine its products. It has banned the use of fishing nets¹⁵ and expanded marine-protection areas, which now cover 543 km² (Ministry of Environment, Climate Change and Technology, Republic of Maldives, 2022a). Also, starting in 2023, all single-use plastics have been banned (PSM News, 2023). These measures help make the economy more resilient while also protecting the coastal ecosystems, providing a buffer against storms and tidal surges.¹⁶

To address chronic water shortages, the government has diversified and decentralized water management. It has implemented new climate-resilient IWRM systems on four main islands, that combine rainwater harvesting with desalination and water-rationalization interventions. Improvements are being made to recycle wastewater, with dozens of water-treatment plants constructed on the islands (World Bank, 2019). It has also increased water storage and developed water-security plans for the event of water shortages. These policies improve access to clean water and allow the groundwater to recharge, thus improving ecosystems and reducing pollution, while also reducing costs related to water management (UNDP Climate, 2022).

Maldives is investing in renewable energy to enhance the resilience of its electrical system. In December 2022, the country opened its first 5 MW solar facility outside the capital as part of a programme to develop 50 MW of solar and battery capacity, supported by the World Bank. The innovative financing framework utilized for this project may be used as a model in other small island developing States, including Mauritius and Seychelles (Chen et al., 2023). Maldives is also expanding rooftop solar capacities, which increased from 1.5 MW to 21.5 MW between 2009 and 2019 (Ministry of Environment,

Climate Change and Technology, Republic of Maldives, 2022b). To improve grid stability, high-voltage connections are being built between the islands.¹⁷ These efforts improve resilience and are also cost-effective by reducing expenditure on expensive fuel imports. Energy transition is also central to achieving the country's ambition to become net zero by 2030.

The combination of these diverse set of interventions marks a turning point for Maldives, moving it away from reacting to emergencies to more sustainable, longer-term solutions.



[The Maldives is] moving away from reacting to emergencies to more sustainable, longer-term solutions.



¹⁵ Fishing accounts for 90% of the country's exports. (Ministry of Fisheries, Marine Resources and Agriculture, 2019)

¹⁶ The Maldives Ministry of Environment is implementing the Coastal Protection Projects.

¹⁷ Interconnection of the power grids: Hulhulmale'–Hulhule'–Male' (phase 1 in 2021) and Male'–Villingili–Gulhifalhu–Thilafushi (phase 2 in 2023); (Asian Development Bank, 2020b)

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Resilience deficit 10. Risk of climate change to coastal infrastructure

Map 13. Increased exposure of the top-100 global container ports to extreme sea levels (ESLs): projected change of the return period (Tr) of the baseline 1-in-100 years extreme sea level (ESL100) under different global-warming scenarios (i.e. 1.5°C, 2°C SWLs). (SDG 1.5, 9.1, 9.a, 13)

With over 80 per cent of the volume of global trade in goods carried by sea, seaports are key nodes in the network of global supply chains, providing critical access to global markets (Verschuur et al., 2022) as well as the ocean economy, and vital to trade and development (Asariotis, 2021). At the same time, these complex infrastructure assets, often integrated within large urban agglomerations, are at the frontline of climate change (Izaguirre et al., 2020). Related impacts can result in significant damage, as well as costly disruption and delay across supply chains, with potentially far-reaching consequences for international trade and the sustainable-development prospects of the most vulnerable nations, including SIDS, that depend on their seaports as lifelines for trade, energy, food, tourism and in the context of DRR (Asariotis, 2020). Global port-specific risk from natural hazards has been estimated at US\$ 7.5 billion per year, with 32 per cent of the risk attributed to tropical cyclone impacts, and an additional US\$ 63.1 billion of trade estimated to be at risk (Verschuur et al., 2023). However, a single extreme event can cause much higher losses, such as Hurricane Sandy (2012) which caused over US\$ 60 billion losses (Strauss et al., 2021), including extensive damage and a week-long shut-down of the US New York/New Jersey container port (Strunsky, 2013).

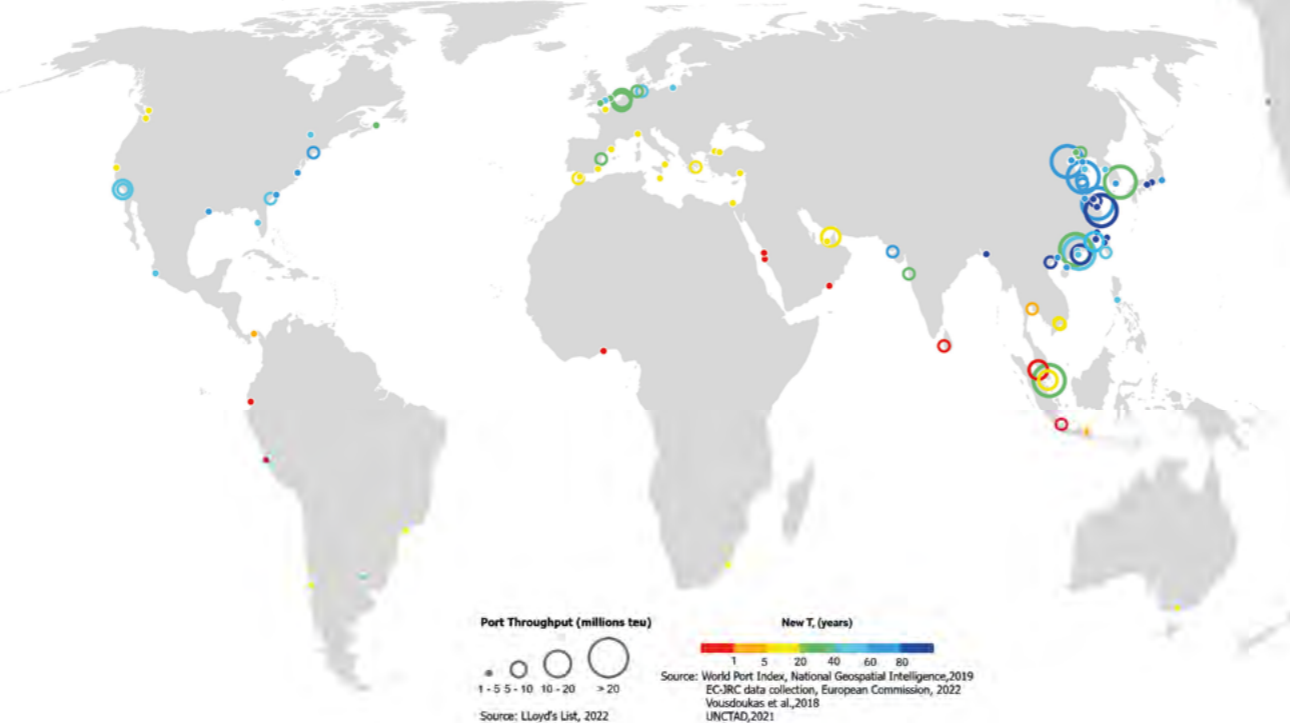
Under increased global warming, seaports will be exposed to rising mean and, particularly, extreme sea levels (ESLs) that could overwhelm their current defences and lead to extensive flooding and operational disruptions. Port defences are designed to withstand extreme events with a certain return period, commonly the 1-in-100 years ESL (ESL100) estimated at the time of design or construction. However, ESLs of a magnitude so far expected to occur once a century (ESL100), will occur much more often under climate change.

Map 13 shows the evolution of the return period for the baseline (mean of the 1980 – 2014 period) 1-in-100 years extreme sea level (ESL100) under different global-warming scenarios, at the top-100 global container ports.

With maritime trade expected to triple by 2050 (ITF, 2019) and climate-driven hazards expected to increase, significant acceleration of investment in climate change

adaptation and resilience-building for ports is needed to avert, minimize and address damages or losses and safeguard supply chains. Major scaling-up of affordable investment in infrastructure adaptation will be critical for developing countries (United Nations Conference on Trade and Development, 2022b), particularly vulnerable SIDS that are sea-locked and therefore depend particularly on their ports and airports. The case study below on Jamaica and Saint Lucia demonstrates that key coastal transport-infrastructure assets in these countries are at a high and growing risk of coastal flooding and operational disruptions, as early as in the 2030s, in the absence of adaptation measures.

2.0°C Specific Warming Level



Key figures



38% Global container port activity occurring in areas of high hurricane risk between 1980 and 2020 (Notteboom et al., 2019)



4.7% Increase in carbon emissions due to shipping between 2020 and 2021 (United Nations Conference on Trade and Development, 2022a)

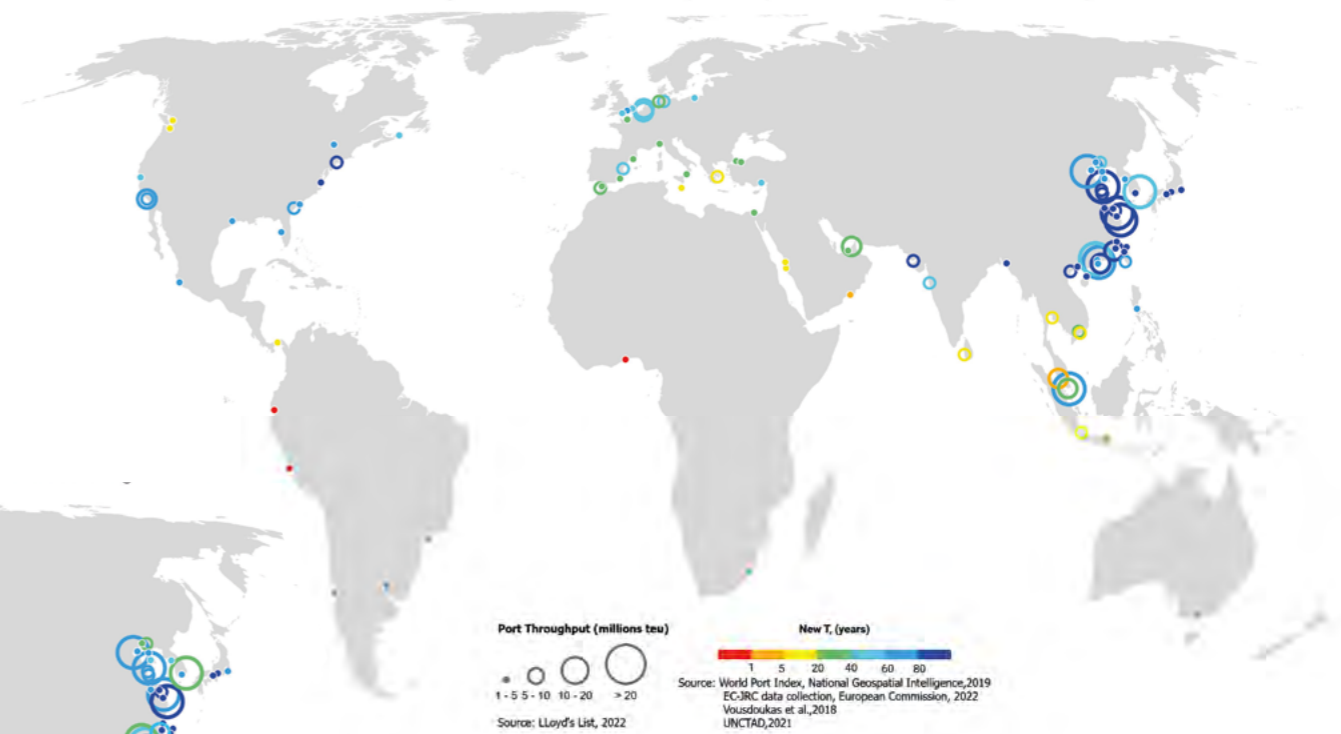


0.6 to 1.1 metres Projected average sea-level rise by 2100 (IPCC, 2021a)



\$6.9 trillion a year Global investment needed in infrastructure to meet SDGs (OECD et al., 2018)

1.5°C Specific Warming Level



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ACTION CASE: JAMAICA AND SAINT LUCIA

Safeguarding ports with long-term investment

Located in what is often termed 'hurricane alley', Jamaica and Saint Lucia are no strangers to flooding and hurricanes. These weather patterns are, unfortunately, expected to gradually intensify due to the slow-onset effects of climate change, as are the costs associated with these impacts (IPCC, 2021c). Studies indicate that economic losses due to storms and floods amount to approximately 7 per cent of GDP in Jamaica (UNCTAD, 2017a) and 2 per cent in Saint Lucia (UNCTAD, 2017b). These costs are due primarily to the interruption of operations at the ports and airports in the country, but also to damage caused to infrastructure (Monioudi et al., 2018).

As climate change heats the oceans, tropical storms strengthen and sea levels rise. This creates additional risks to ports and airports, as well as the surrounding network of rail, roads and industrial complexes. Jamaica

and Saint Lucia have two main airports and two main seaports. These installations are on or near the coast and are generally 1-2 metres above sea level. As island nations, both countries are aware of the threats posed by climate change to their air and sea transportation systems, and both have developed long-term plans and governance structures to solicit investments to upgrade their transportation networks. These upgrades are critical to offsetting the steadily increasing pressures caused by climate change, and key to generating economic growth.

Jamaica's Kingston Container Terminal is one of the largest ports in the Caribbean and is the country's largest employer. Ensuring that the port is constantly upgraded to improve resilience is part of the national Climate Change Policy Framework (UNCTAD, 2017a). To fund the multi-year and multi-million-dollar investments

required, Jamaica has blended loans from the InterAmerican Development Bank and other partners, with private investments, outsourcing the work to private holding companies (Feller, 2019). Similarly, Saint Lucia has included support to its ports in its national adaptation plan (Government of Saint Lucia, 2018), soliciting a similar array of financing to upgrade the capacities of its main seaport, Castries, to receive cargo and cruise ships (Pate, 2022).

Managing slow-onset variables, such as those faced by island nations from storms and flooding, requires long-term vision and sustainable financing. The investments made in Jamaica and Saint Lucia will create wealth and will also reduce risks to infrastructure and supply chains.



both have developed long-term plans and governance structures to solicit investments to upgrade their transportation networks.

These upgrades are critical to offsetting the steadily increasing pressures caused by climate change, and key to generating economic growth.



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Extreme shocks and cascading impacts


Map 14. Percentage of population in poverty (<\$1.9 per day) in 2019 and increase between 2019 and 2022 (SDG indicators 1.1.1 and 8.5.2)


Disasters occur only when a lack of resilience allows systems to be overwhelmed. As hazard events become more frequent and more intense due to climate change, efforts to build resilience and reduce existing risk, while avoiding the creation of new risk, need to be accelerated. Given the frequency and overlapping nature of events, even relatively small but frequent events can have an outsized impact if countries do not have the opportunity to recover and restore their systems.

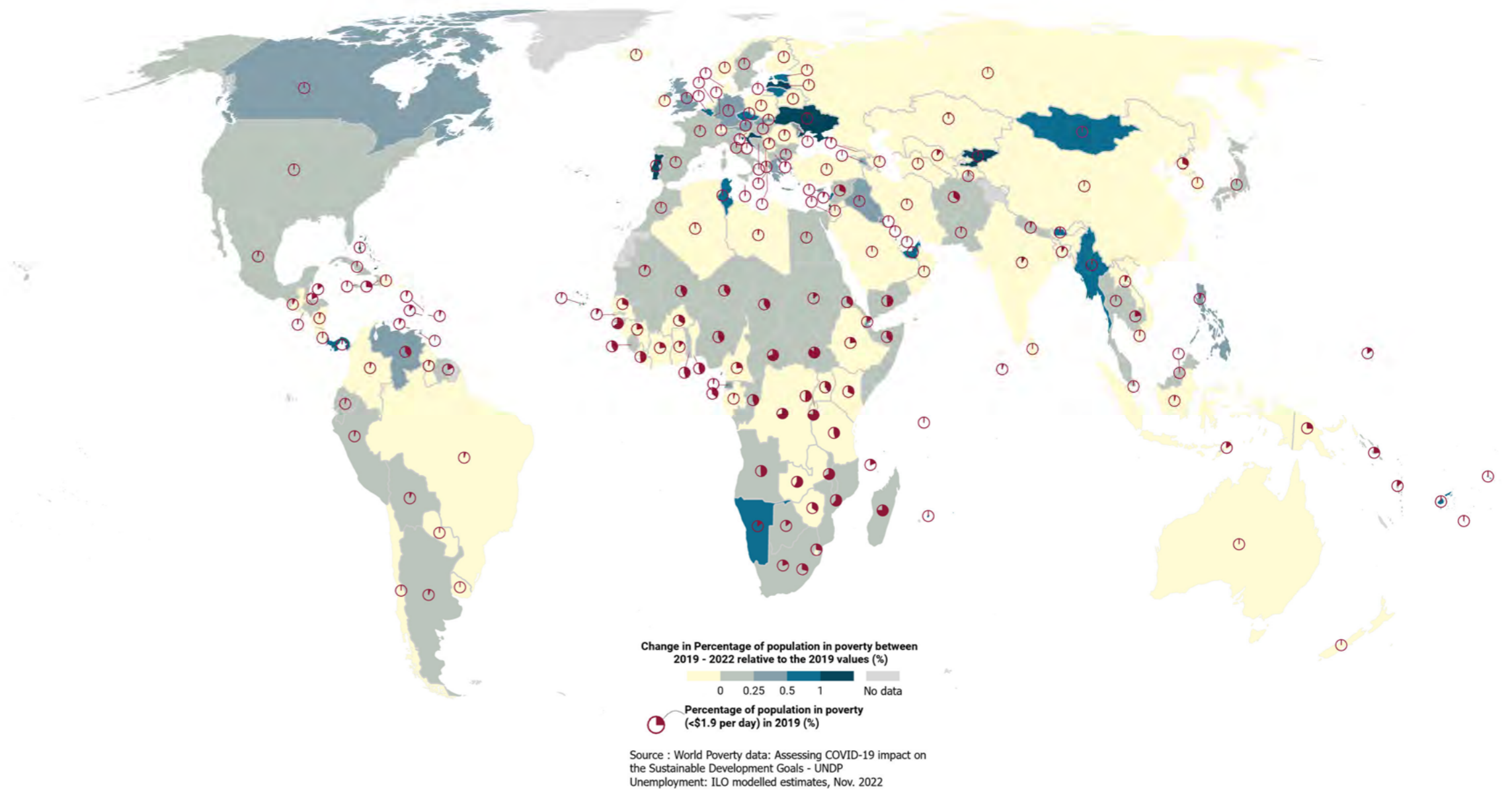
While most disaster-related losses are due to smaller and medium-sized events, infrequent high-impact shocks can wipe out decades of sustainable gains in a short period in areas with high levels of resilience deficits. As such, it is also important to plan and act to prevent the potential impacts of lower-frequency, high-impact events. When, unfortunately, events like the COVID-19 pandemic do occur, it is essential to understand what went wrong, and how impacts cascaded across systems to undermine sustainable development. This lesson can help inform future action to better prevent and prepare for future similar hazard events.

Between 2019 and 2022, poverty rates increased globally by 8 per cent, pushing an additional 54 million people into poverty. The countries that experienced the highest rise in poverty rates are illustrated in Map 14. COVID-19 resulted in economic losses, many of which disproportionately affect the most vulnerable people.

Key figures

 **6.2 million Deaths** directly attributable to COVID-19 (WHO, 2023).

 **70 million** Number of persons that fell into extreme poverty in 2020 due primarily to COVID-19 (the global extreme poverty rate of 8.4% in 2019 increased to 9.3% in 2020) (World Bank, 2022b)





The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations. Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties. Final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined. A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).

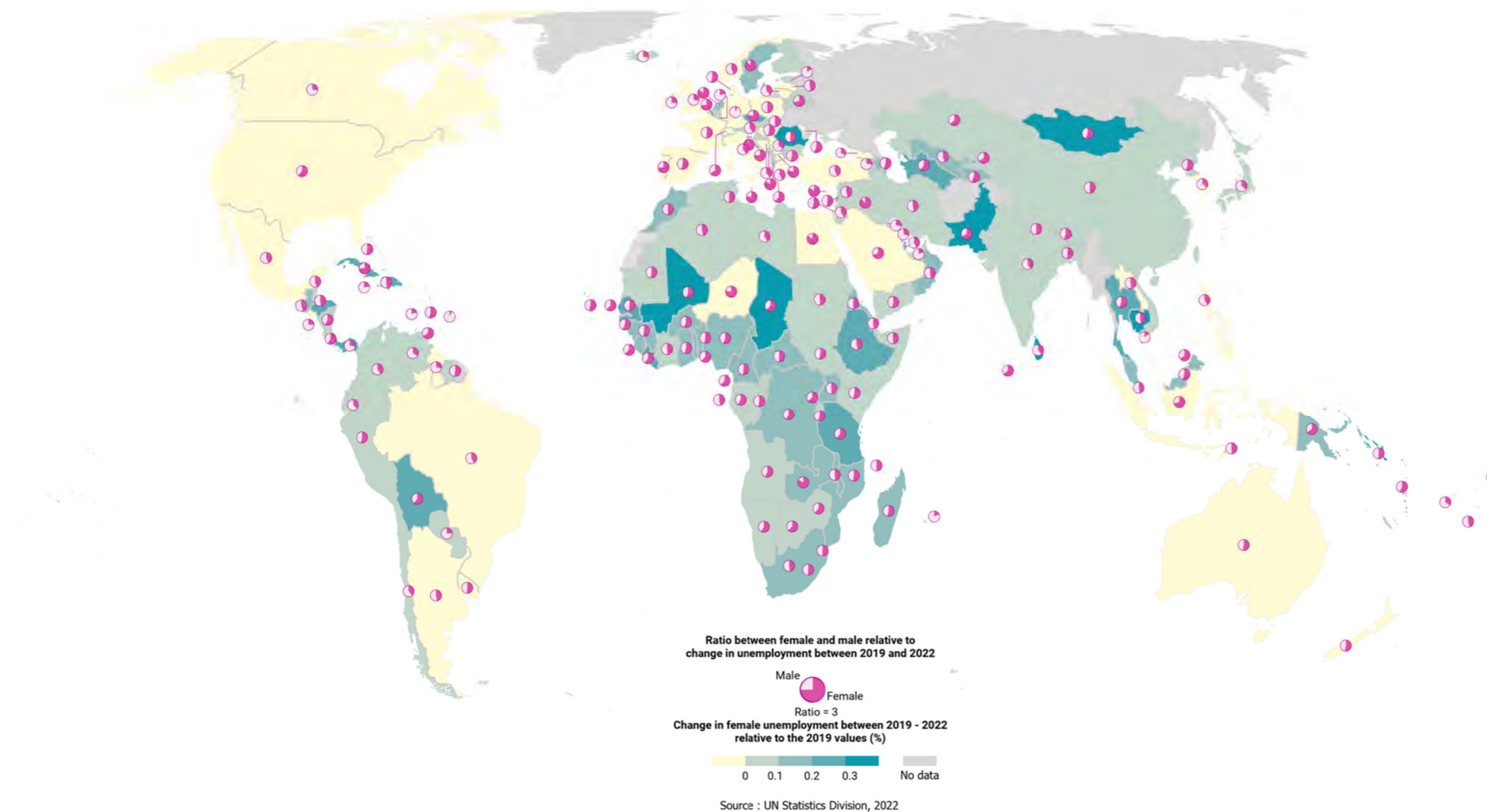
Map 15: Change in female unemployment between 2019 and 2022 relative to the 2019 values and ratio between female and male unemployment rates between 2019 and 2022 (SDG indicators 1.1.1 and 8.5.2)

As seen in Map 15, between 2019 and 2020, women's employment levels fell by 4.2 per cent compared to 3 per cent for men (ILO, 2021). In a study of 58 countries, women living with children were more likely to lose their jobs than men living with children (29 per cent compared to 20 per cent) (UN Women, 2021b) (UN Women, 2021a). The long-term impact is that progress to achieve SDG targets on gender equality has significantly regressed, with some reports stating that 40 years were lost (World Economic Forum, 2021a).

Key figures

 **135 Years** Years expected to close the gender-inequality gap from 2021 (World Economic Forum, 2021b)

 **43%** Percentage of women employed compared to 69% of men in 2021 (ILO, 2021)

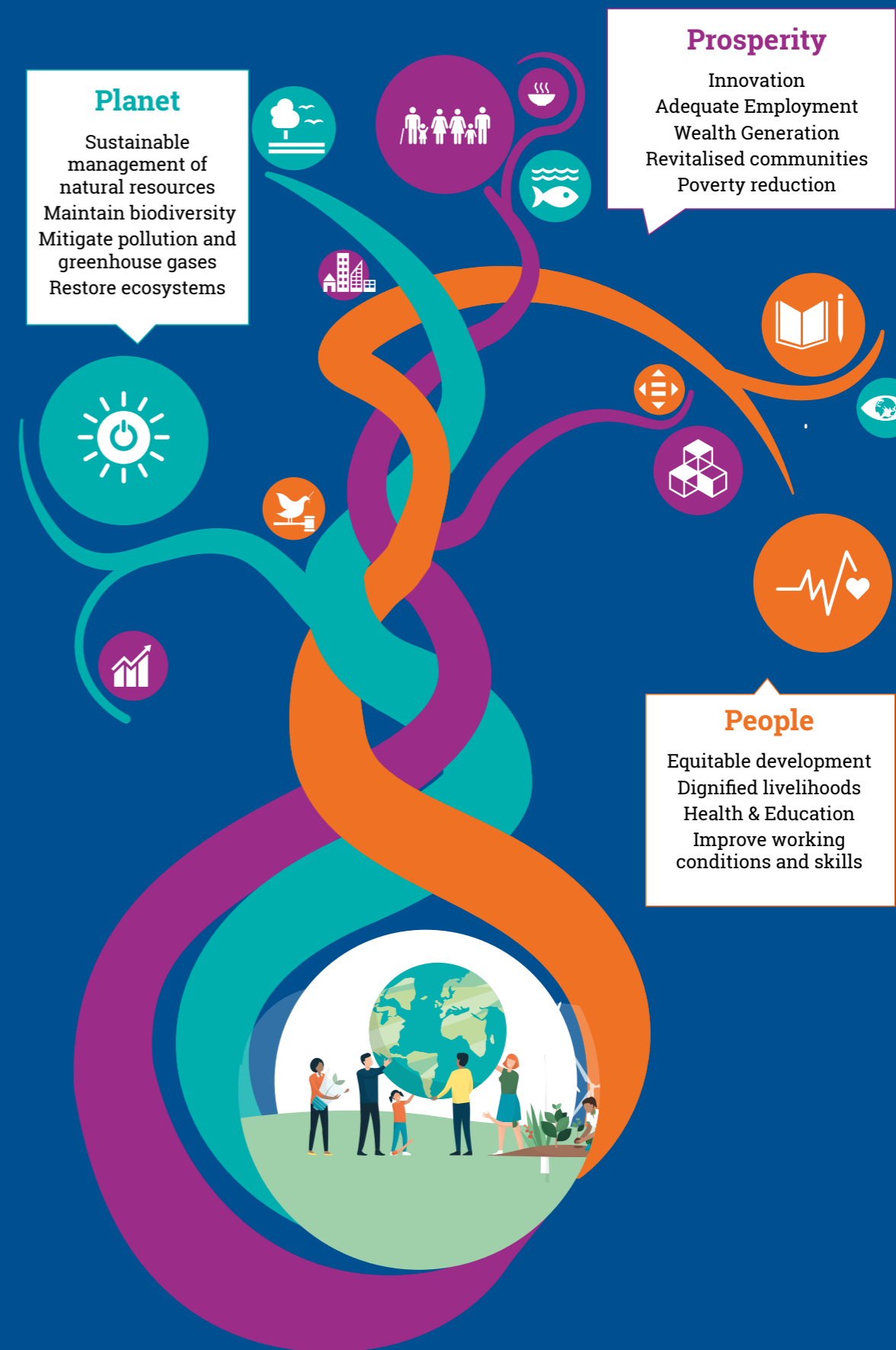


The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations. Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties. Final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined. A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).

3. HOW TO BUILD A MORE RESILIENT FUTURE

Taking action to address resilience deficits in a rapidly changing world is challenging, but not impossible. The action cases included in this report are examples of positive resilience-building in action. Figure 4 illustrates pathways to making sustainable development choices.

Figure 4. Pathways to making sustainable development choices



Source: Adapted from (IPBES, 2021)

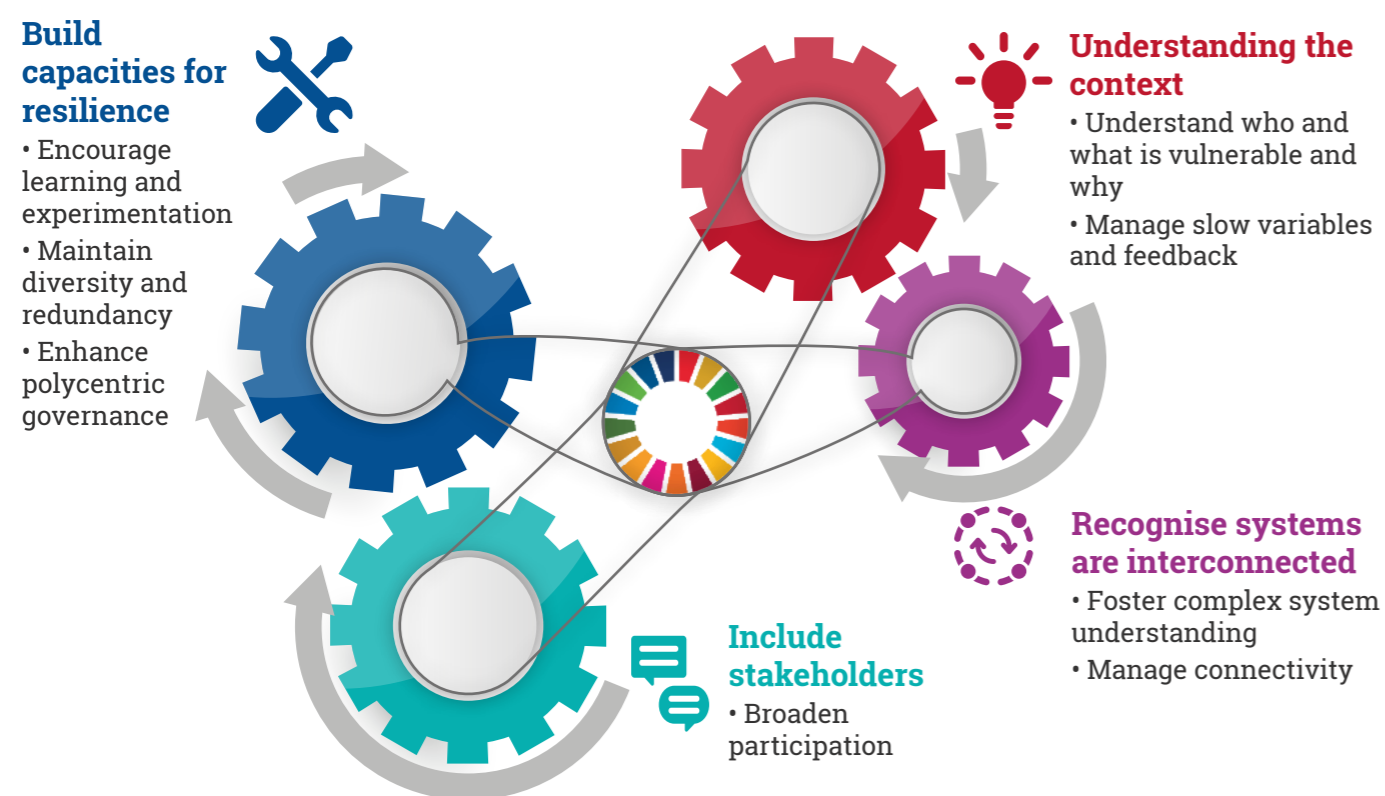
In 2020, UNDP Common Guidance on Helping Build Resilient Societies, highlighted the four key elements, in Figure 5 below, that help make sustainable development resilient.

In 2022, the Global Assessment Report of UNDRR echoed these same themes, while the IPCC Report of the same year also highlighted the importance of resilient sustainable development, and expanded on key themes. Resilience can be seen as a key connector between climate change, disaster risk reduction and sustainable-development action. The experience gained through action now is also essential to improving foresight capacity, and to fostering more-collaborative, participatory processes, and an agile and anticipatory style of governance that will be essential for a volatile climate future (UNDP

Global Centre for Public Service Excellence, 2018). The action cases in this report highlight that countries and communities are already applying these elements in their policies and actions to build a more resilient future.

Figure 5 summarises how key elements of sustainable development need to include understanding risk, recognising systems are interconnected, including stakeholders and building capacities for resilience.

Figure 5. Elements of sustainable development



Source: Adapted from (United Nations, 2020)

Table 2. Summary of key resilience elements and related action cases

Key UN guidance/ IPCC element	Why it matters	Relevant action case examples from the report
3.1 Understand the risk and context	Understanding risk is the bedrock priority of the Sendai Framework, from which other actions stem.	All
3.1.1 Understand who and what is vulnerable and why	When developing a strategy, who needs resilience, and from what, are the first questions to ask? In answering, it is important to understand how changes in one system affect other systems, so the integrity of the whole can be addressed (United Nations, 2020).	Fiji Yemen
3.2 Recognize systems are interconnected	Understanding how systems are interconnected is important in deciding what type of strategy is needed and where to prioritize investments. Given that the impacts of climate change increase over time, this requires a capacity to understand how slow-onset feedback affects already complex systems (United Nations, 2020).	All
3.2.1 Foster complex system understanding	Although systems are interlinked, each actor has its own set of needs and thinking patterns that dictate how they interact and affect other elements within the same system. Using a complex-systems approach is a way to move beyond reductionist thinking, to appreciate the integrity of the system as a whole. Doing so allows policymakers to anticipate the range of impacts and to avoid inadvertent maladaptive interventions.	European Union Yemen
3.2.2. Manage connectivity	Connectivity refers to the way different components within a system interact. This connectivity can either be a source of risk or a source of resilience. For example, a family network can help its members through difficult times but, as experienced during the COVID-19 pandemic, the same interaction can contribute to spreading the disease. Socially, connectivity can build cohesion and help build trust, and bring different insights and perspectives. However, too much homogeneity can lower innovation and critical reasoning.	Barbados Jamaica and St Lucia
3.2.3 Manage slow variables and feedbacks	Slow-onset variables and feedback accumulate in natural systems gradually, increasing exposure to threats. For instance, increasing temperatures may slowly reduce the productivity of certain types of crops, leading to more food insecurity. Deciding how to intervene to modify slow-onset processes requires an understanding of how they are changing and why.	Great Green Wall India

3.2.4 Maintain diversity and redundancy	<p>In nature, diversity and redundancy are critical to resilience. That a diversity of species performs the same or similar functions means that when one species is no longer able to function, the others fill in the gap. In human systems, the concept of redundancy is often avoided, to reduce costs. However, as seen in the examples, maintaining diversity can significantly improve resilience in multiple sectors, from water to energy.</p>	<p>Maldives European Union</p>
3.3 Include multiple stakeholders	<p>Including multiple stakeholders increases resilience as it allows more people to participate, thus mobilizing society to take collective action to protect itself from common risks. Broadening participation requires more time and resources, but the intervention that is decided upon will have greater buy-in and the chances of it being sustainable will have improved (United Nations, 2020).</p>	<p>All</p>
3.3.1 Broaden participation	<p>Broadening participation expands the scope of knowledge and builds legitimacy. It ensures information circulates through the system and maintains cohesion and unity of purpose. As creating constructive participation can often be time-consuming, it requires adequate preparation to harness the positive aspects of broadening participation.</p>	<p>Brazil India</p>
3.4 Build skills and capacity for resilience	<p>The capacity of people and systems to withstand and adapt to shocks can be improved if the following three methods are pursued in parallel: facilitating learning and experimentation, building diversity and redundancy so several actors can perform the same or similar functions, and ensuring all actors are working collaboratively to address a common set of challenges (United Nations, 2020).</p>	<p>All</p>
3.4.1 Encourage learning and experimentation	<p>Adaptive management and learning are vital to maintaining the versatility needed to navigate through volatile, uncertain and changing circumstances. Optimizing performance requires continual testing and adapting of approaches based on impact and experience.</p>	<p>Brazil</p>
3.4.2 Foster flexible and connected 'polycentric' governance	<p>Polycentric governance occurs when several actors operate together to address a common set of problems. This capacity to work collaboratively requires the actors to operate under a common set of norms and rules. This element complements the other elements as it allows for greater diversity and participation to be utilized effectively.</p>	<p>Indonesia</p>

4. CONCLUSIONS:

The SDG indicators were established to unify and broaden the way the world measures progress towards sustainable development. As demonstrated in this report, they can also be useful in understanding the interconnectedness of people, the planet and prosperity, and the importance of building resilience across these systems.

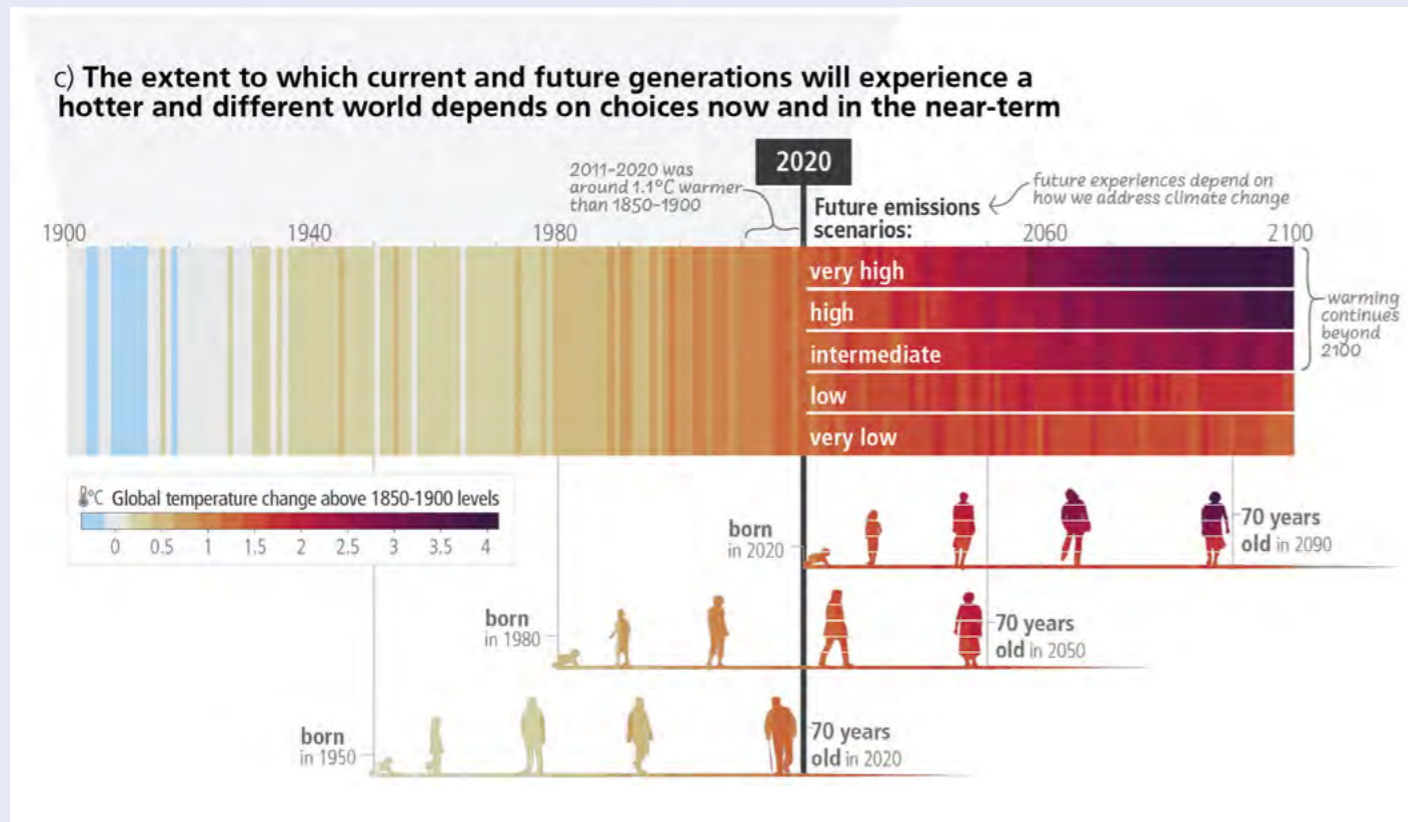
The SDG indicators are also a way to move beyond viewing progress as simply a matter of growth in GDP. Although GDP is a useful reference for the size and growth of an economy, it is not an accurate measure of what makes life worthwhile. While GDP measures the level of consumption, it does not show how growth affects the standard of living or if development is sustainable. And even though it shows average earnings, it does not consider how those earnings are distributed within a society.

The speed and scale of climate-change impacts on planetary, human and economic health will accelerate as the global temperature surpasses 1.5°C above pre-industrial levels. Figure 6 shows the generational impacts of climate change. These impacts will combine

with other pressures, including degrading planetary health, conflict and other hazards, to create compound risks that undermine the sustainability of achievements made in global development.

These compound or layered hazards have a higher aggregate impact than if they were to occur separately. Moreover, the speed at which they occur erodes resilience, as systems are not afforded the time to recover. If humanity is to continue to progress and achieve the desired development objectives, a more holistic approach is required that balances human progress with the need to maintain the integrity of natural ecosystems.

Figure 6: Generational impacts of climate change



Source: Figure SPM.1 (c) from (IPCC, 2023a)

Failing to recognize and address resilience deficits holds back sustainable-development progress and risks reversing the progress achieved so far. Making risk-informed choices is essential to set countries on a more sustainable future path – one that is adapted to the volatile climate future and which can prevent and better manage disasters and potential future polycrises. Therefore, key lessons from this report are the following:

- To avoid intensification of the current polycrisis, urgent action is required to curtail greenhouse gas emissions and to build resilience to the shocks and hazards that are curtailing sustainable development.
- Action to build resilience is possible and can accelerate achievement of current sustainable-development targets in a way that safeguards people, the planet and future prosperity.

- The SDG indicator framework is not just a set of development objectives. The indicators can also be utilized as a tool to identify and quantify resilience deficits and the counterposed accelerator action that can build resilient sustainable development despite the complex future.
- Using existing data for the kind of analysis included in this report's maps can help ensure that climate adaptation and building resilience is holistic and contributes towards the future well-being of people, the planet and the economy. Identifying resilience deficits also helps policymakers move beyond using only economic growth as the primary indicator of progress.
- Improving the accessibility and quality of hazard and SDG-progress data can make a cost-effective contribution to improved risk management and climate change adaptation decision-making.

Utilizing SDG indicators as a tool to identify resilience deficits that are hindering target achievement is helpful, because of their broad scope and because the metrics and processes to collect the data are already in place.

- Investing earlier in resilience and adaptation can avoid costs of hazard impacts, and save lives and money. Replacing destroyed crops, infrastructure and electricity transmission networks costs more than preventing disasters in the first place.
- Striking a balance between the needs of people, the planet and prosperity is not just a desirable goal, but a fundamental requirement. The pursuit of human development must be recalibrated to not only maintain the integrity of ecosystems, but also to restore them. Doing so requires a re-examination of what is required for sustainability. The metric of perpetual economic growth must be expanded to include the broader interests of society and rebalanced to include the costs and benefits affecting natural ecosystems.

Measuring what is valued reflects societal norms and provides the basis for the policies to follow. Looking beyond 2030, increased recognition in emerging international systems of the need to balance the resilience of people, the planet and prosperity will be essential for current and future generations.

Methodology and sources

The maps included in the report represent an inter-agency effort to assess current and projected resilience deficits towards the achievement of the SDGs. The maps are the result of collaboration between UNDRR, the GEM Foundation, the United Nations Agencies that are custodians for the Sustainable Development Goals (SDGs) Indicators depicted in the maps, and institutions who conduct research on the topics addressed in this report.

Each map showcases country values of one specific SDG indicator and one or multiple risk drivers, such as natural hazards like heat, flood or drought, or demographic or urbanization trends, that create resilience deficits. Where possible, the maps also show future projections of these resilience deficits under various climate scenarios, based on IPCC greenhouse-gas-emission-rate scenarios, representative concentration pathways (RCPs) or considering different global warming levels.

Map 1

SDG	Variable	Year	Source
1.5.1, 11.5.1 and 13.1.1	Number of directly affected persons attributed to disasters per 100,000 population (number)	2005-2021	SDG Portal
	Countries that reported having MHEWS (multi-hazard early-warning systems)	2022	Target G report, UNDRR

The number of directly affected persons represented in the map corresponds to the average number of directly affected persons attributed to disasters per 100,000 population between 2005 and 2021. The data used to calculate the average values is available on the SDG Portal (United Nations, 2023a)

The information relative to the countries that reported having MHEWS is available in section 2 of UNDRR's Target G report (UNDRR, 2022a)

Map 2

SDG	Variable	Year	Source
1.5.1, 11.5.1 and 13.1.1	Number of directly affected persons attributed to disasters per 100,000 population (number)	2005-2021	SDG Portal
	Relative change in total population between 2022 and 2050 (%)	2022	United Nations, Department of Economic and Social Affairs, Population Division (2022). Probabilistic Population Projections based on the World Population Prospects 2022

The number of directly affected persons represented in the map corresponds to the average number of directly affected persons attributed to disasters per 100,000 population between 2005 and 2021. The data used to calculate the average values is available on the SDG Portal (United Nations, 2023a).

The values of the relative change in total population use the median (50 per cent) prediction interval of the probabilistic projections of total population by country from the World Population Prospects 2022 (United Nations, 2022b). The values represented in the map were calculated as follows:

$$\frac{(Pop_{2050} - Pop_{2022})}{Pop_{2022}} \times 100$$

Map 3 and 4

SDG	Variable	Year	Source
2.1.2	SDG Portal	3-year average: 2019-2021	FAOSTAT
	Percentage of country area exposed to drought frequency increase (%)	2021	GAR SR on Drought 2021

The values for the prevalence of moderate or severe food insecurity are available on the FAOSTAT website (FAO, 2022a).

The percentage of country area exposed to drought frequency increase was calculated based on the GAR SR on Drought 2021 Figure 1.3 data. This figure shows the "Change in meteorological drought frequency (events/decade) from recent past (1981–2010) to 2100 for four projected warming levels of global surface air temperature." As stated in the report, "The projections indicate the global temperature increase from pre-industrial values (1881–1910). GWLs are reached during slightly varying time windows, depending on the climate simulation." In these maps, the lower GWL (1.5°C and 2°C) scenarios are presented, as these are explicitly included as targets in the Paris Agreement and their "time windows are centred approximately in the years 2025 and 2040 (median values from all combinations of global circulation models and regional circulation models)". The complete dataset covers the entire planet in a gridded format. This dataset was filtered by selecting only the positive values, which represent an increase in the meteorological drought frequency. For each country, the area covered by these grid points was measured and compared with the total country area, to calculate the metric presented in the map: the percentage of country area exposed to drought frequency increase.

Map 5

SDG	Variable	Year	Source
4.6.1	Youth literacy rate (%)	Latest value since 2014	UNESCO Institute for Statistics
	Estimated number of internal displaced children (under 18) at the end of 2022 (number)	2022	Internal Displacement Monitoring Centre (IDMC). Global Internal Displacement Database Data (2023)

The data on youth literacy rate was retrieved from the Children’s Climate and Environment Risk Index (CCRI) methodology, which was developed and shared by UNICEF. As mentioned in CCRI, the source of this data, used both in CCRI and in this report, is UNESCO Institute for Statistics.

The number of internal displaced children (under 18) values correspond to the sex and age disaggregated data (SADD) of the total number of internally displaced persons (IDPs), available at the Global Internal Displacement Database of the Internal Displacement Monitoring Centre (Internal Displacement Monitoring Centre, 2023). The definition of total number of IDPs is presented in the methodological notes of the data: “Represents the total number of internally displaced persons (IDPs), in a given location at a specific point in time. It could be understood as the total number of people living in a situation of displacement as of the end of the reporting year.” The same methodological notes explain how the SADD estimates are derived: “Sex and age disaggregated data (SADD) for displacement associated with conflict or disasters is often scarce. One way to estimate it is to use SADD available at the national level. IDMC employs United Nations population estimates and projections to break down the number of internally displaced people by sex and age.” For more information read the methodological notes at (Internal Displacement Monitoring Centre (IDMC), 2023).

Map 6

SDG	Variable	Year	Source
6.4.2	Level of water stress: freshwater withdrawal as a proportion of available freshwater resources (%)	2020	SDG Portal
	Relative change in total population between 2022 and 2050 (%)	2022	United Nations, Department of Economic and Social Affairs, Population Division (2022). Probabilistic Population Projections based on the World Population Prospects 2022

The level of water stress relative to 2020 is available on the SDG Portal (United Nations, 2023a).

The values of the relative change in total population use the median (50 per cent) prediction interval of the probabilistic projections of total population by country from the World Population Prospects 2022 (United Nations, 2022b). The values represented in the map were calculated as follows:

$$\frac{(Pop_{2050} - Pop_{2022})}{Pop_{2022}} \times 100$$

Map 7

SDG	Variable	Year	Source
15.3.1	Proportion of land that is degraded over total land area (%)	2019	SDG Portal
15.5.1	Red List Index	2020	SDG Portal and IUCN. 2022. The IUCN Red List of Threatened Species. Version 2022-2. https://www.iucnredlist.org .

The two indicators used in map 7 are available on the SDG Portal (United Nations, 2023a). The proportion of land that is degraded is relative to 2019, while the Red List Index values correspond to 2020.

Map 8

SDG	Variable	Year	Source
7.2.1	Share of modern renewables in the total energy consumption (%)	2020	IEA (2022), World Energy Balances; Energy Balances 2020, United Nations, New York, 2022; Energy Statistics Database 2020, United Nations, New York, 2022
7.3.1	Energy efficiency (megajoules per USD constant 2017 PPP GDP)	2020	IEA (2022), World Energy Balances Energy Balances 2020, United Nations, New York, 2022. Energy Statistics Database 2020, United Nations, New York, 2022

Mean near surface air temperature under a 2°C 2021 warming scenario SSP2-4.5 (°C)

IPCC WGI Interactive Atlas: Gutiérrez, J.M., R.G. Jones, G.T. Narisma, L.M. Alves, M. Amjad, I.V. Gorodetskaya, M. Grose, N.A.B. Klutse, S. Krakovska, J. Li, D. Martínez-Castro, L.O. Mearns, S.H. Mernild, T. Ngo-Duc, B. van den Hurk, and J.-H. Yoon, 2021: Atlas. In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press. Interactive Atlas available from Available from <http://interactive-atlas.ipcc.ch/>

The data on share of modern renewables and energy efficiency was provided by IEA (World Energy Balances) and United Nations (Energy Balances 2020 and Energy Statistics Database 2020).

The values of the mean near surface air temperature are available on the IPCC WGI Interactive Atlas (IPCC, 2021d). The SSP2-4.5 scenario is commonly considered as the 'middle-of-the-road' intermediate GHG scenario, where CO2 emissions remain around current levels until the middle of the century, and start to decline after that, and socioeconomic factors follow their historic patterns.

Map 9

SDG	Variable	Year	Source
11.6.2	Annual mean levels of fine particulate matter (population-weighted), by location (micrograms per cubic metre)	2019	SDG Portal
	Ambient air pollution attributable death rate (per 100 000 population, age-standardized)	2019	WHO

Data on ambient air pollution attributable death rate is available on the Global Health Observatory of WHO (World Health Organization, 2023b), while the annual mean levels of fine particulate matter can be accessed from the SDG Portal (United Nations, 2023a).

Map 10

SDG	Variable	Year	Source
11.1.1	Proportion of urban population living in slum households (%)	Latest value since 2006	UN Habitat Urban Indicators Database
	Increase in the urban damage between 2010 and 2030 relative to the 2010 values under the SSP2 RCP4.5 scenario, for flood with a return period of 100 years (%)	2015	Aqueduct Global Flood Risk Maps, WRI (World Resources Institute)
	Relative change in urban population from 2022 to 2050 (%)	2018	United Nations, Department of Economic and Social Affairs, Population Division (2018). World Urbanization Prospects: The 2018 Revision, Online Edition.

The proportion of urban population living in slum households is available on the UN Habitat Urban Indicators Database (UN Habitat, 2021) and corresponds to the latest value since 2006.

The data for urban damage comes from the Aqueduct Global Flood Risk Maps of the WRI Institute (Luo, 2015), which provides current and future river flood risk estimates in urban damage by country. The increase in urban damage was calculated as follows:

$$\frac{(Urban\ damage_{2030} - Urban\ damage_{2010})}{Urban\ damage_{2010}} \times 100$$

The values of urban damage for 2010 correspond to the baseline hydrological and socioeconomic scenarios, while the values for 2030 correspond to the SSP2 socioeconomic change and RCP 4.5 climate-change scenarios. As previously mentioned, the SSP2-4.5 scenario is commonly considered as the middle-of-the-road intermediate GHG scenario, where CO2 emissions remain around current levels until the middle of the century, and start to decline after that, and socioeconomic factors follow their historic patterns.

The values for relative change in urban population use the median (50 per cent) prediction of the urban population at mid-year by country from the World Urbanization Prospects 2018 revision (UN DESA, 2018). The values represented in the map were calculated as follows:

$$\frac{(UPop_{2050} - UPop_{2022})}{UPop_{2022}} \times 100$$

Map 11 and 12

SDG	Variable	Year	Source
1.1.1	Proportion of population living below the international poverty line (%)	Latest value since 2015	SDG Portal
	Increase in the % of work hours lost due to heat stress between 2025 and 2055 relative to the 2025 values (%)	2023	ILO 2019 Working on a Warmer Planet: The effect of heat stress on productivity and decent work
	Hours lost due to heat stress in 2025 (%)	2019	ILO 2019 Working on a Warmer Planet: The effect of heat stress on productivity and decent work
	Absolute increase in the % of work hours lost due to heat stress between 2025 and 2055 (%)	2019	ILO 2019 Working on a Warmer Planet: The effect of heat stress on productivity and decent work

The proportion of population living below the international poverty line is available on the SDG Portal (United Nations, 2023a), and corresponds to the latest value since 2015.

Data on the work hours lost due to heat stress was provided by ILO. The data includes estimates of working hours lost to heat stress by a healthy worker assumed to be working in the shade for a physical work intensity compatible with construction and agriculture (400W). The estimates are presented for two climate scenario pathways, RCP2.6 and RCP6.0, which, according to the ILO 2019 Working on a Warmer Planet report, “respectively predict temperature increases of 1.5°C and 2.7°C above pre-industrial levels by the end of the century. The RCP2.6 scenario entails vigorous climate action being taken today to decarbonize the economy and enhance carbon sinks, thereby limiting global warming to 1.5°C and effectively mitigating future climate change. The RCP6.0 scenario also involves mitigation, but of a weaker sort, so that global warming is limited only to 2.7°C.”

Based on this data, increase in the percentage of work hours lost due to heat stress between 2025 and 2055 presented in map 11 was calculated as follows:

$$\frac{(\% \text{ Work hours lost}_{2055} - \% \text{ Work hours lost}_{2025})}{\% \text{ Work hours lost}_{2025}} \times 100$$

The absolute increase in the percentage of work hours lost due to heat stress, in map 12, corresponds to:

$$\% \text{ Work hours lost}_{2055} - \% \text{ Work hours lost}_{2025}$$

A detailed explanation on how the percentages of working hours lost due to heat stress were estimated, including the climate data used in the analysis, can be found in Appendix I - Detailed Methodology of the Working on a Warmer Planet (International Labour Organization, 2019).

Map 13

SDG	Variable	Year	Source
	Seaport location	2019	World Port Index 2019
	ESLs ₁₀₀ projections for the global coastline	2018	EC-JRC data collection
	Port throughput for top 100 container ports (in million TEU)	2021	Lloyd's List

The datasets used in this map were provided by UNCTAD, and have the following sources: Data collation and treatment, Dr I Monioudi, University of the Aegean. Seaport location from World Port Index 2019 (National Geospatial-Intelligence Agency, 2019). ESLs₁₀₀ projections for the global coastline from EC-JRC data collection (European Commission, 2022); see also Vousdoukas et al., 2018 (Vousdoukas et al., 2018). Port throughput (in million TEU) for top 100 container ports in 2021 from (Lloyd's List, 2022)

Map 14 and 15

SDG	Variable	Year	Source
1.1.1	Percentage of population in poverty (<\$1.9 per day) in 2019 (%)	2022	Assessing COVID-19 impact on the Sustainable Development Goals - UNDP
1.1.1	Change in percentage of population in poverty between 2019 and 2022 relative to the 2019 values (%)	2022	Assessing COVID-19 impact on the Sustainable Development Goals - UNDP
8.5.2	Change in female unemployment between 2019 and 2022 relative to the 2019 values (%)	2022	ILO-modelled estimates
8.5.2	Ratio between female and male relative changes in unemployment rate between 2019 and 2022	2022	ILO-modelled estimates

The poverty values presented in this map were obtained from the UNDP study on Assessing COVID-19 impact on the Sustainable Development Goals, which “assesses the impact of three different COVID-19 scenarios on the SDGs, capturing the multi-dimensional effects of the pandemic over the next decades” (UNDP, 2022b). The change in percentage of population in poverty was calculated as follows, considering the COVID-19 scenario modelled in the report:

$$\frac{(\text{PovertyPop}_{2022} - \text{PovertyPop}_{2019})}{\text{PovertyPop}_{2019}} \times 100$$

The unemployment data is available on ILOSTAT (International Labour Organization, 2023), disaggregated by gender. The relative change in female unemployment (RCU_{female}) was obtained as follows:

$$RCU_{female} = \frac{(\text{Female unemployment}_{2022} - \text{Female unemployment}_{2019})}{\text{Female unemployment}_{2019}} \times 100$$

After calculating the RCU_{male} using the same formula as above, the ratio between female and male relative changes in unemployment, which is presented in the map, corresponds to:

$$\frac{RCU_{female}}{RCU_{male}}$$

Abbreviations and acronyms

Acronyms

AR	Assessment Report, published by the IPCC for each assessment cycle
CCRI	Children's Climate Risk Index
COVID-19	coronavirus disease
CRGP	City Resilience Global Programme
DRR	disaster risk reduction
ESL	Extreme Sea Level
ESRI	Environmental Systems Research Institute
EWS	Early warning system(s)
EW4All	'Early Warnings for All' initiative
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
FAQ	frequently asked questions
FKDC	Forum Komunikasi DAS Cidanau
GAR	Global Assessment Report
GDP	Gross Domestic Product
GEM	Global Earthquake Model
GEO	Group on Earth Observations
GGW	Great Green Wall
GHG	greenhouse gas
GWL	Global Warming Level
HAP	Heat Action Plan
IDMC	Internal Displacement Monitoring Centre
IEA	International Energy Agency
ILO	International Labour Organization
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	The Intergovernmental Panel on Climate Change
ITF	International Transport Forum
IUCN	International Union for Conservation of Nature and Natural Resources
IWRM	Integrated water-resources management

JRC	Joint Research Centre, European Commission
NASA	National Aeronautics and Space Administration
NRDC	Natural Resources Defense Council
MHEWS	Multi-hazard early warning systems
MW	megawatts
OCDE	Organisation for Economic Co-operation and Development
ODI	Overseas Development Institute
PES	Payment for Environmental Services
PSM	Public Service Media
RCP	Representative Concentration Pathways
SADD	sex and age disaggregated data
SDG	Sustainable Development Goals
SIDS	small island developing States(s)
SSP	Shared Socioeconomic Pathways
TEU	twenty-foot equivalent unit
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNCTAD	United Nations Conference on Trade and Development
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UN-GGIM	United Nations Global Geospatial Information Management
UN HABITAT	United Nations Human Settlements Programme
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
UN WOMEN	United Nations Entity for Gender Equality and the Empowerment of Women
USA	United States of America
WFP	World Food Programme
WGI	Working Group I
WHO	World Health Organization
WMO	World Meteorological Organization
WRI	World Resources Institute

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