To Understand Climate Mobility, Follow the Water

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To Understand Climate Mobility, Follow the Water

Water patterns shape and are shaped by human activity. As global warming causes temperatures to rise and vary around the world, changes in the amount, availability, and quality of water will be the primary pathway through which we experience the economic, political, and social impacts of climate change.

The likely increase in droughts, floods, storms, wildfires, landslides, ocean levels, and other effects of climate change will dramatically affect the distribution and cleanliness of water—everyone's need and right—and thus significantly alter the lives and movement of people across the globe.

Changes in water patterns—resulting in too much, too little, or too dirty water—will profoundly affect agriculture (and thus food security), access to clean water, and land use in general. These effects, and their impact on social and political institutions, will lead to major changes in where people live and how they make a living, and may increase conflicts within and across country borders.

In this report, we analyze the causes of water-related climate mobility, quantify its likely effects, and offer a path forward for reducing the impact as much as possible.

What Is Climate Mobility?

> **Climate mobility is an umbrella term for the voluntary or involuntary movement of people in response to alterations in their environment and living conditions primarily due to or associated with climate change.**

Climate mobility refers to both the voluntary movement and the involuntary movement (displacement) of millions of people in response to the impacts of climate change—whether or not proximately caused by the effects of water—and of the wide range of contingent sociopolitical and economic factors that will follow from such movement. Conversely, *climate immobility* refers to the inability or unwillingness of people to move because of various sociopolitical, economic, spiritual, and environmental factors. We use the term *mobility* rather than *migration* to describe these movements, in order to avoid the many (and often adverse) political implications of the latter term.

Most climate mobility is caused by changes in water patterns, makes it an especially challenging problem—global in extent and yet frequently local in causes and effects. Although many different stakeholders with competing interests need to be involved in the effort to mitigate it, most have as yet been unwilling to address the problem head-on. (See "Water Is a Wicked Problem.")

Climate mobility includes two kinds of geographical movement, aside from to immobility. People may move internally, within a country's borders, due to factors such a long-lasting local drought. Or they may move externally, across borders, although external movement accounts for only a small proportion of climate mobility, since climate hazards are often local in immediate impact.

Water Is a Wicked Problem

Like climate mobility, the global water crisis is a wicked problem—one that is especially difficult to solve directly because of its complexity and multiple interdependencies, and because in the past our collective, well-meaning mitigation efforts have all too often had unintended negative consequences. Still, recognizing the ten major shortcomings of water management and identifying "grains of hope" in our responses to them can help us achieve real advances in water reform and chart a smoother course forward. (See the exhibit.)

Shortcoming #1. Water management is a challenge that many of us recognize as important but few of us act on.

We hold more and more meetings and make lots of commitments, but these efforts have little meaningful impact.

Key Stat: 67

- The private sector followed through on just 67 of the more than 700 water-related commitments recorded during the 2023 UN Water Conference.

Grain of Hope

- Companies appear to be considering water impacts more strongly, and more of them are taking tangible action in the form of corporate target setting and disclosure for water impacts (for example, the Science Based Targets Network and Taskforce on Nature-related Financial Disclosures).

Shortcoming #2. We fiddle at the margins, and as a result our actions do not match the scale of the problem—or our lofty ambitions.

We invest in the same small-scale solutions without tackling the systemic problems that would lead to lasting change.

Key Stat: <1.2%

- Less than 1.2% of people in Africa with inadequate water access gained access to water via handpumps distributed by aid agencies between 2018 and 2021. That leaves more than 300 million people in the region without access to safe drinking water.

Grain of Hope

- Some regions have adopted systemic approaches to large-scale problems. In 2021, the World Food Program developed a systems approach to make the food supply in East Africa more robust against climate-related crises, enhancing the way food producers predict and deal with these disasters.

The Ten Major Shortcomings of Global Water Management

1 Water management is a challenge that many of us recognize as important but few of us act on

2 We fiddle at the margins, and as a result our actions do not match the scale of the problem—or our lofty ambitions

3 We approach water management problems predominantly with an engineering mindset

4 We have forgotten where water comes from—it's not the tap!

5 We still try to manage water with outdated solutions and infrastructure

10 Access to water is a human right, but we allow water injustice to go largely unpunished

9 We don't treat water as a key element within the global commons, so we don't price it correctly

8 We neglect the fact that water security is fundamental to energy security and food security

7 We pursue inconsistent and fragmented action because our coordination along the water value chain is so limited

6 We have forgotten how to think locally

Source: BCG analysis.

Shortcoming #3. We approach water management problems predominantly with an engineering mindset.

Engineering solutions are failing us, and we seldom work with nature to solve the problem.

Key Stat: 150,000

- As of 2021, there were 150,000 economically obsolete dams in the EU, and only 240 of them were removed in 2021.

Grain of Hope

- Governments are deploying nature-based solutions in some areas. For example, the government of Rwanda used them in launching urban rehabilitation plans to restore wetlands in Kigali to minimize the effects of flooding.

Shortcoming #4. We have forgotten where water comes from—it's not the tap!

The engineered water cycle and the natural water cycle are intrinsically linked, but we treat them as if they were independent of each other.

Key Stat: 33 million

- Altogether, 33 million hectares of the world's irrigated farmland—10% of the total—use nonrenewable groundwater.

Grain of Hope

- A Greater Cape Town Water Fund initiative aims to restore ecological infrastructure to improve water security in the Western Cape Water Supply System by rehabilitating freshwater systems.

Shortcoming #5. We still try to manage water with outdated solutions and infrastructure.

Promulgation of water security standards continues to lag in efforts to alleviate water challenges. We need to significantly enhance current solutions to improve their efficiency and effectiveness.

Key Stat: 1.8 billion

- Globally, 1.8 billion people use pit latrines, which are notorious for contaminating groundwater and posing risks to livelihoods.

Grain of Hope

- The Gates Foundation launched the "Reinvent the Toilet Challenge" and invested $200 million to support R&D into reinventing the toilet and achieving other groundbreaking sanitation solutions.

Shortcoming #6. We have forgotten how to think locally.

We must treat water differently from CO_2 and employ bottom-up solutions rather than pursuing top-down imperatives.

Grain of Hope

- NGOs such as Water Aid have started implementing decentralized, high-tech water solutions such as solar water pumping in water-stressed areas—including Ethiopia and Mozambique—which are suited to local environments and independent of government infrastructure or funding.

Shortcoming #7. We pursue inconsistent and fragmented action because our coordination along the water value chain is so limited.

Disjointed efforts to implement change and varying mandates for funding and reporting on progress inhibit comprehensive and coordinated action.

Grain of Hope

- The World Wildlife Fund has assembled actors across sectoral boundaries to address the problem of water insecurity through the Table Mountain Water Source Partnership in Cape Town, South Africa.

Shortcoming #8. We neglect the fact that water security is fundamental to energy security and food security.

Ensuring food security and energy security is impossible without water security, yet we treat water security as a given and manage all three in silos.

Key Stat: 72%

- The global agricultural industry uses 72% of the world's freshwater supply.

Grain of Hope

- Water and Energy for Food is an international initiative to provide financial and technical support and investment facilitation for environmentally sustainable innovations that aim to improve energy and water efficiency in the agricultural sector.

Shortcoming #9. We do not treat water as a key element within the global commons, so we don’t price it correctly.

Pricing mechanisms can align societal and corporate incentives and help reduce the exploitation of water resources.

Key Stat: 200 times

- The price of water used by agriculture would increase by 200 times if the price reflected water’s true cost.

Grain of Hope

- The World Trade Organization has outlined an International Water Pricing Protocol that would enable companies and governments to account for the full cost of water use in international trade.

Shortcoming #10. Access to water is a human right, but we allow water injustice to go largely unpunished.

Transgressors who violate human and environmental rights to water seldom face accountability for their actions.

Grain of Hope

- Stop Ecocide International, founded in 2017, works to criminalize ecocide in a similar manner to genocide, crimes against humanity, war crimes, and crimes of aggression.


Of all the physical impacts of climate change, those involving water availability and quality will influence climate mobility the most.

Depending on whether people move by choice or by necessity, and on how long their effort to relocate lasts, climate mobility can be divided into two main types:

- **Movement** is the *voluntary* movement of people and can be either cyclical—most often seasonal—or long term. Voluntary movement usually occurs when people whose livelihoods are affected by climate events seek better economic opportunities in new locales.
- **Displacement** is the *involuntary* movement of people, either for short periods (typically less than a year) or longer periods. Involuntary displacement may be triggered by sudden-onset, short-term events such as storms and floods or by longer-lasting changes in climate and weather patterns.

Climate mobility doesn't always occur solely in response to the direct effects of climate change. Rather, it may occur in reaction to a wide range of complex, interdependent factors that planners, policymakers, and other stakeholders must consider in total when analyzing the causes of climate mobility and devising solutions for its adverse effects. Three major categories of factors are especially relevant:

- **Economic Factors.** A well-functioning economy maintains effective trade, sufficient employment to support livelihoods, fair and stable prices, and resilience to external shocks. These characteristics decrease the need for climate mobility.
- **Sociopolitical Factors.** Citizens in a robust, inclusive economy have confidence in their country's institutions and governance. A strong economy and good governance, in turn, rely on ecological stability. Cohesion between sociopolitical and ecological factors fosters greater resilience to climate change.
- **Ecological Factors.** A stable and resilient ecology prioritizes and protects natural resources and biodiversity. This relationship underpins such factors as food security and productive agriculture, which in turn promote a stable economy and a well-functioning sociopolitical sphere.

If people and governments allow global warming to continue unchecked, these three factors will fall more and more out of balance, increasing the likelihood of climate mobility. Failure to slow the accumulation of greenhouse gases in the atmosphere will likely result in higher global temperatures, disturbed weather patterns, and slower global economic growth, and significantly increase global displacements. (See "Two Crises.")

Why Water Matters

Of all the potential physical impacts of climate change, changes in the availability and quality of water will have the greatest effect on climate mobility. In this regard, six water-related natural hazards loom largest: droughts, floods, storms, wildfires, extreme hot and cold temperatures, and landslides caused by storms and floods. In 2022, storms, floods, and droughts caused 99% of internal disaster-related displacements; from 2018 to 2022, flood-related displacements increased by 123%. (See Exhibit 1.)

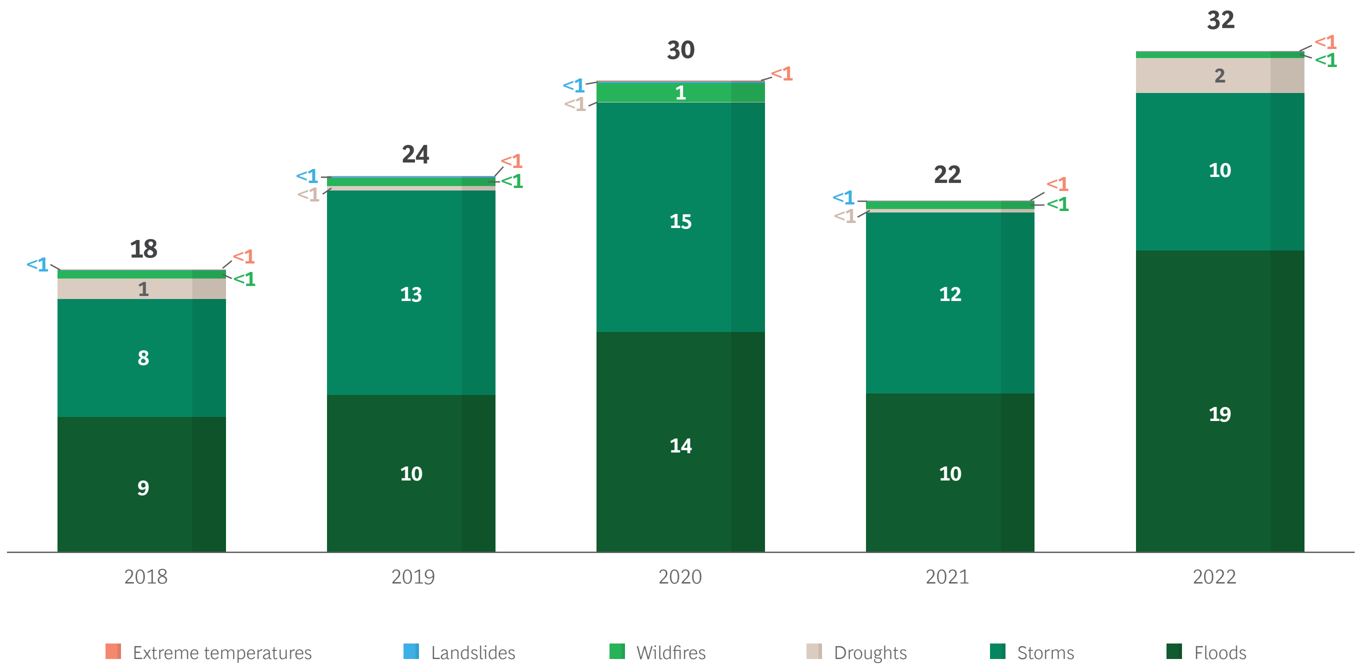
Disruptions in the natural water cycle can trigger crop failure, degrade and erode of soil and surrounding land, damage infrastructure and property, and significantly change ecosystems. These effects, in turn, increase a population's vulnerability to other climate impacts across sociopolitical, economic, and demographic spheres. Results may include loss of income sources and livelihoods, financial losses due to ecosystem damage, food insecurity, competition for water, and political conflict, all of which contribute to increased climate mobility. These effects are visible in a country-by-country analysis of climate-related internal displacements from 2014 to 2022. (See Exhibit 2.) The most populous countries experienced the largest total internal displacement, but the greatest displacement relative to population occurred in sub-Saharan Africa and Asia. (See the Appendix for a description of the methodology we used to analyze water risk and resulting climate mobility.)

Despite the increased negative impacts of water-driven climate mobility, countries have thus far made little progress on improving water resource management to mitigate these impacts. As a result, the international community's prospects for meeting the targets it set for 2030 in connection with the UN's Sustainable Development Goal #6, which calls for adequate clean water for all, are worsening. (See "Slow Progress Toward WASH Goals.")

The manner in which climate change disrupts water patterns and prompts people to relocate depends on whether the problem is too little water, too much water, or the available water is too dirty.

Exhibit 1 - Storms, Floods, and Droughts Cause Almost All Internal Disaster-Related Displacements

Annual internal displacement, by disaster type, 2018–2022
(millions displaced)

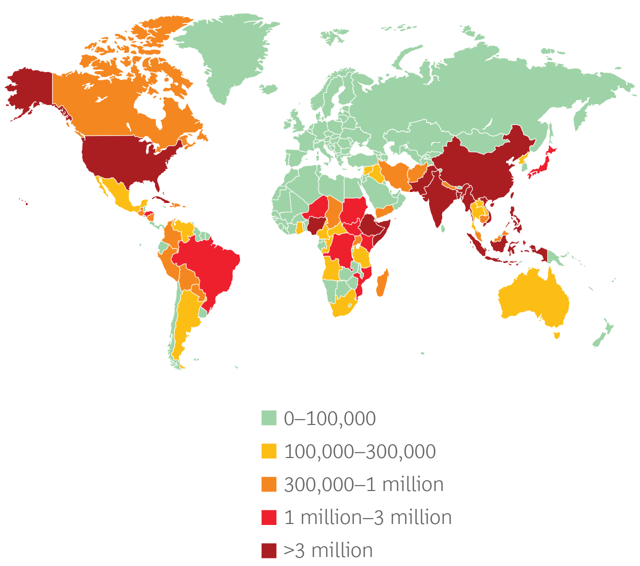


Sources: IDMC Global Reports on Internal Displacement (2019–2023); BCG analysis.

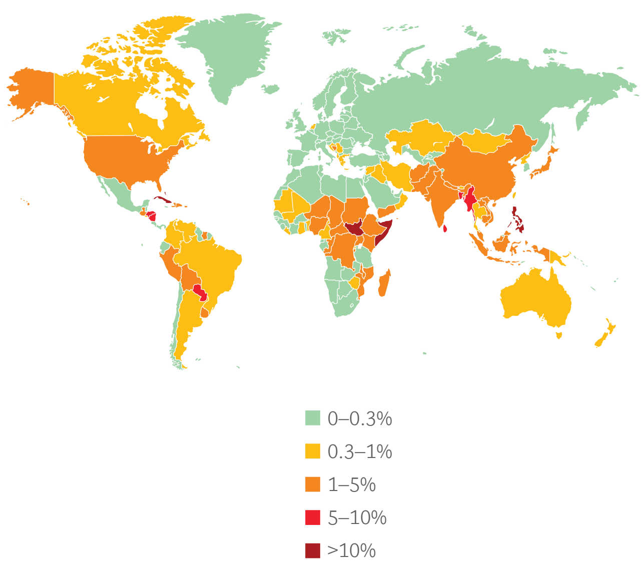
Note: Disaster types include only weather-related events; they exclude geophysical events such as earthquakes and volcanic eruptions.

Exhibit 2 - Over the Past Decade, Southeast Asia, Central Africa, and the Americas Saw the Largest Numbers of Climate-Related Internal Displacements

Total internal displacements, 2014–2022 (millions)



Internal displacements relative to population, 2014–2022 (%)



Sources: Internal Displacement Monitoring Centre; population by country from statistictimes (2024); BCG analysis.

Note: Climate hazards include storms, floods, droughts, wildfires, and extreme temperatures, in line with the IDMC's disaster definitions; relative number of people displaced is calculated as a percentage of each country's total population.

Two Crises

The effects of climate change in two very different places—Somalia and the many small island nations scattered across the world's oceans—illustrate the distinctions between the types of climate mobility.

Human-caused climate change in Somalia has had a severe impact. Prolonged periods of drought have led to a 55% increase in the price of basic foods and a 61% increase in the Integrated Food Security Phase Classification's "crisis" level of food insecurity. Worsening social, political, and economic difficulties—including weak governance and tensions between ethnic, regional, and religious groups—have led to prolonged conflict in the country, exacerbated by terrorist groups that use water as a weapon, destroy water infrastructure, block access to rivers and other water sources, and poison wells. As a result, more than 1.6 million people have been involuntarily displaced.

Small island nations are experiencing very different impacts from climate change. Many of them depend heavily on tourism, which is a form of voluntary short-term mobility. But at the same time, they are extremely vulnerable to the effects of climate change, which can negatively impact tourism. For example, in the Maldives and the Seychelles, tourism accounts for 30% or more of national GDP, but the combination of the low land elevation and rising sea level poses a serious threat to the islands' livability of the islands. Among the potential harms are increased frequency of flooding, decreased attractiveness as a tourist destination, and lower incomes.

Slow Progress Toward WASH Goals

Goal #6 of the UN's Sustainable Development Goals reads, "Ensure availability and sustainable management of water and sanitation for all." However, progress toward providing 100% of the world's population with access to a safely managed drinking system, a safely managed sanitation service, and a handwashing facility with soap and water at home—sometimes referred to as *water, sanitation, and hygiene* (WASH)—has been slow.

According to the UN, fully achieving this goal would require an annual investment of $114 billion from now through 2030, with the largest share going to safe management of water for sanitation and safe access to clean water for personal use. Yet in 2021, for example, development assistance for water issues totaled just $8 billion—a gap of $106 billion between actual investment and the investment needed that year.

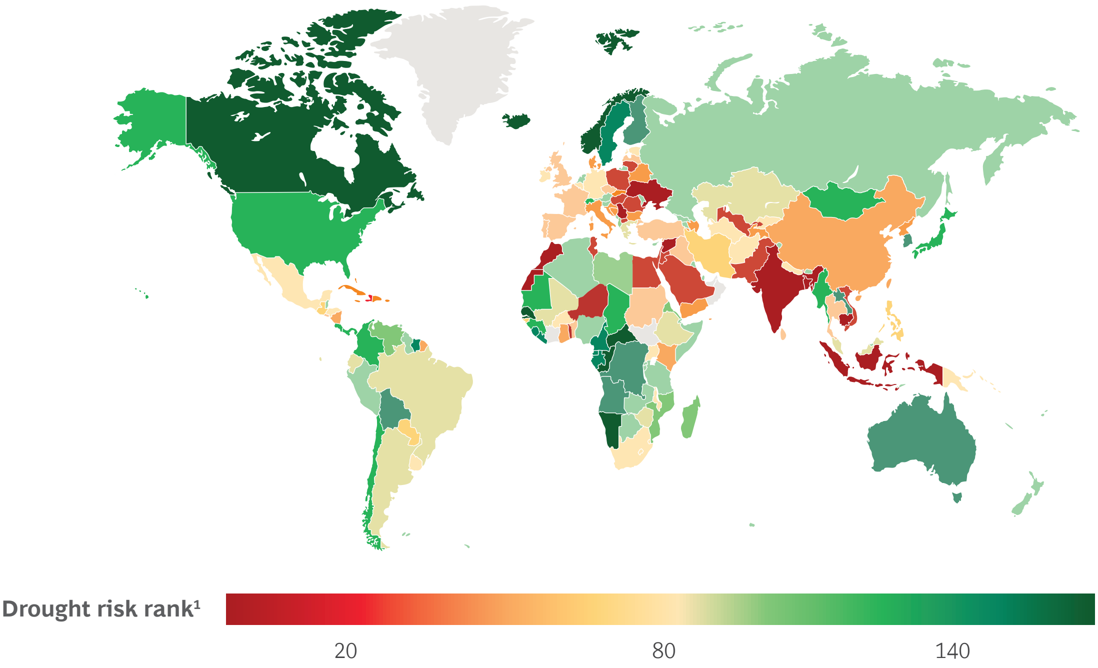
Too Little Water

People experience the effects of drought primarily through its influence on agriculture, in the form of crop yields, food prices, and other social, economic, and political consequences. In the period from 1979 to 2019, drought risk was largely concentrated in Europe, the Middle East, and Asia. (See Exhibit 3.) Nevertheless, the effects of drought are often local:

- Long-term drought in much of Mexico has lowered crop yields and driven up prices, notably in highly drought-sensitive primary crops such as beans and corn—an effect exacerbated environmentally by overuse of water and a decline in water quality. Analysts have estimated that a 10% reduction in crop yields in Mexico leads to a 2% increase in population emigration.
- The southwestern US experienced a particularly long and extensive drought from 1950 to 1960, with significant impacts on the region's agriculture, population distribution, and economy. As a result, five of the region's seven states saw above-average rates of urbanization, accompanied by a major consolidation of individual smaller farms and ranches into much larger ones.
- The relationship between drought and displacement is clear in Ethiopia, where extended drought has adversely affected agriculture and thus food prices, and led to massive internal displacement and famine. Every year as many as 5 million residents of Ethiopia have been forced to move.

Exhibit 3 - From 1979 to 2019, Drought Risk Was Highest in Eastern Europe, the Middle East, and Asia

Drought risk by country (1979–2019)



Sources: Aqueduct4.0; BCG analysis.

[1]Based on drought score, cumulative dry days and maximum temperature.

Too Much Water

All continents have experienced massive flooding in the past, and they face an increasing risk of more such events as the planet warms. Flooding can occur as a result of short-term heavy rain that overwhelms the built environment, or along rivers that cannot manage excessive rainfall or snowmelt, or along shorelines as a result of storm surges. As with drought, the primary impact of flooding is on agriculture, but the size and extent of major floods can have other far-reaching economic and social effects.

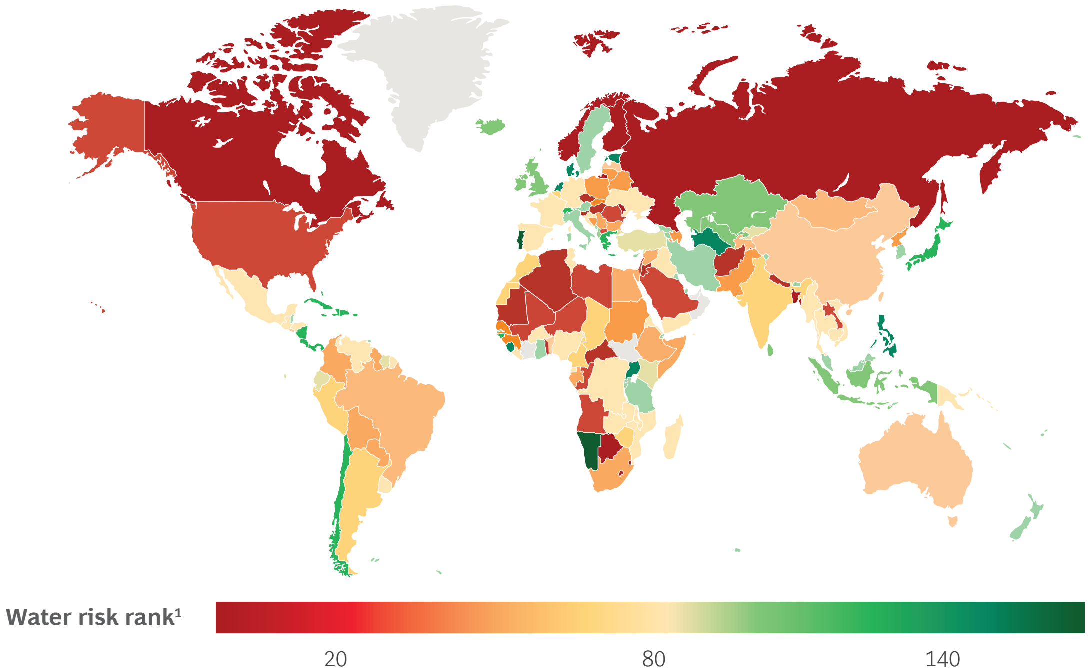
In recent decades, every inhabited region of the world has been affected by floods. (See Exhibit 4.) Yet flood events and their impacts are typically more localized than drought events, and countries must manage them locally:

- In July 2021, after parts of the region endured more than 200 millimeters of rainfall over the course of four days, widespread flooding inflicted some €46 billion in economic damage and loss throughout Europe, most of it in Germany, which endured losses of around €40 billion, and Belgium, close to €3 billion. In addition to its economic impact, the flooding displaced 16,000 people in Germany alone.

- In the past 11 years, two major typhoons—Typhoon Haiyan in 2013 and Typhoon Haima in 2016—displaced millions of people throughout Southeast Asia. Typhoon Haiyan forced more than 9 million people from their homes, and caused $1.8 billion in damage to the Philippines alone. In fact, the Philippines has consistently been the nation hardest hit by flooding in the region; for example, of the 7.8 million people displaced in South East Asia in 2021, 5.7 million were displaced within the Philippines.

Exhibit 4 - Every Inhabited Continent and Region Has Been Subject to Flooding over the Past Several Decades

Flood risk by country (1979–2019)[1]



Sources: Aqueduct4.0; BCG analysis.

[1]Ranking by country of fluvial and coastal flooding risk with a 100-year return period. The rankings include a total of 162 countries.

Water That Is Too Dirty

Climate change and resulting storms, floods, and droughts can also harm water quality, which is already subject to degradation from by non-climate-related factors such as poor water management and pollution. Ingesting and using poor-quality water can lead to acute, long-term health problems, affect livelihoods, put food security at risk, and thus drive climate mobility. Poor water quality can also affect crop yields, increase the incidence of disease in livestock, and contaminate crops, making them unfit for consumption.

Floods can affect water quality by damaging infrastructure, contaminating water sources with sewage and chemicals, and increasing sedimentation, which clouds water and harms many forms of aquatic life. Droughts can worsen water quality through such mechanisms as washing excessive quantities of nutrients and salt into water bodies and reducing the flow of fresh water. In addition, droughts can impair the soil's ability to filter pollutants, further contaminating water sources.

Two recent examples of water quality damage at the regional level are illustrative:

- In 2022, two major cyclones struck Malawi, collapsing its water, sanitation, and hygiene infrastructure, and leading to an outbreak of cholera. And because—for several socio-economic and political reasons—a migratory pathway between Malawi and South Africa already existed, incidents of cholera rose dramatically in South Africa even though it was not directly affected by the storms.

- Sources of freshwater in Bangladesh's coastal regions face increased salinization as a result of declining freshwater flows, more frequent storms, and rising sea levels. Because 35 million people in Bangladesh are vulnerable to the effects of salinization, the risk of displacement there is significant.

These various examples of the impact of drought, floods, and dirty water demonstrate the many complex interdependencies that exist between climate mobility and sociopolitical and economic factors. As an example of the impact of water policy on economic growth, the Global Commission on Adaptation has estimated that GDP growth will decline significantly by 2050 in countries where water policy remains static in the face of global warming. In North Africa and South Asia, for example, the commission estimates that continued water risk, if coupled with no change in water policy, will result in declines in GDP growth of 10% and 6%, respectively. In contrast, improved water policies and more efficient water use would improve the overall economic outlook to 2050. If the regions reallocated 25% of water to better uses through policy adaptation, projected GDP growth in North Africa would decline by just 6% and improve in South Asia by 2%.

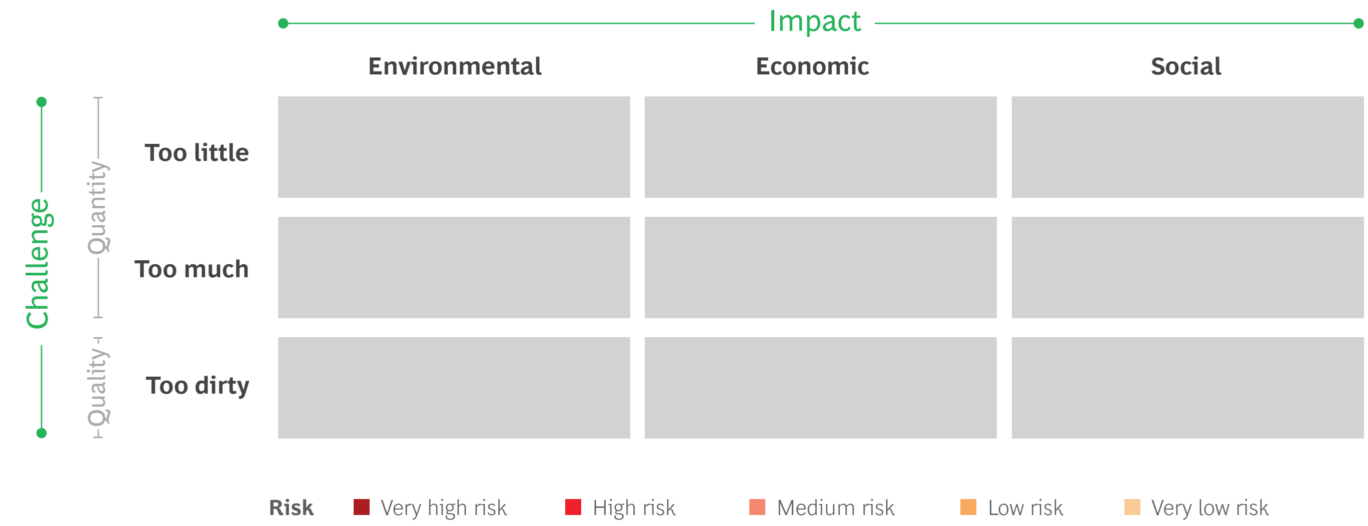
The BCG Water Impact Matrix provides a way to map the environmental, economic, and social impacts of various water challenges, including too little water, too much water, and too dirty water. (See Exhibit 5.)

Deep Waters

The potential for climate mobility depends largely on water abundance or scarcity, and water quality. For this reason, forecasting the likelihood of climate-change-related droughts, floods, and storms can provide a clearer picture of future patterns of climate mobility. To that end, we have created models of climate-induced changes in water patterns and the resulting internal and external movement of people for three of the five Shared Socioeconomic Pathways (SSPs)—detailed climate scenarios developed by the Intergovernmental Panel on Climate Change (IPCC)—over two time periods: 2020 to 2030 and 2020 to 2050. (See "Three Pathways Forward.")

Although the risk of floods, droughts, and storms rises over time across all three SSP scenarios, the degree of risk varies significantly by region. (See Exhibit 6.)

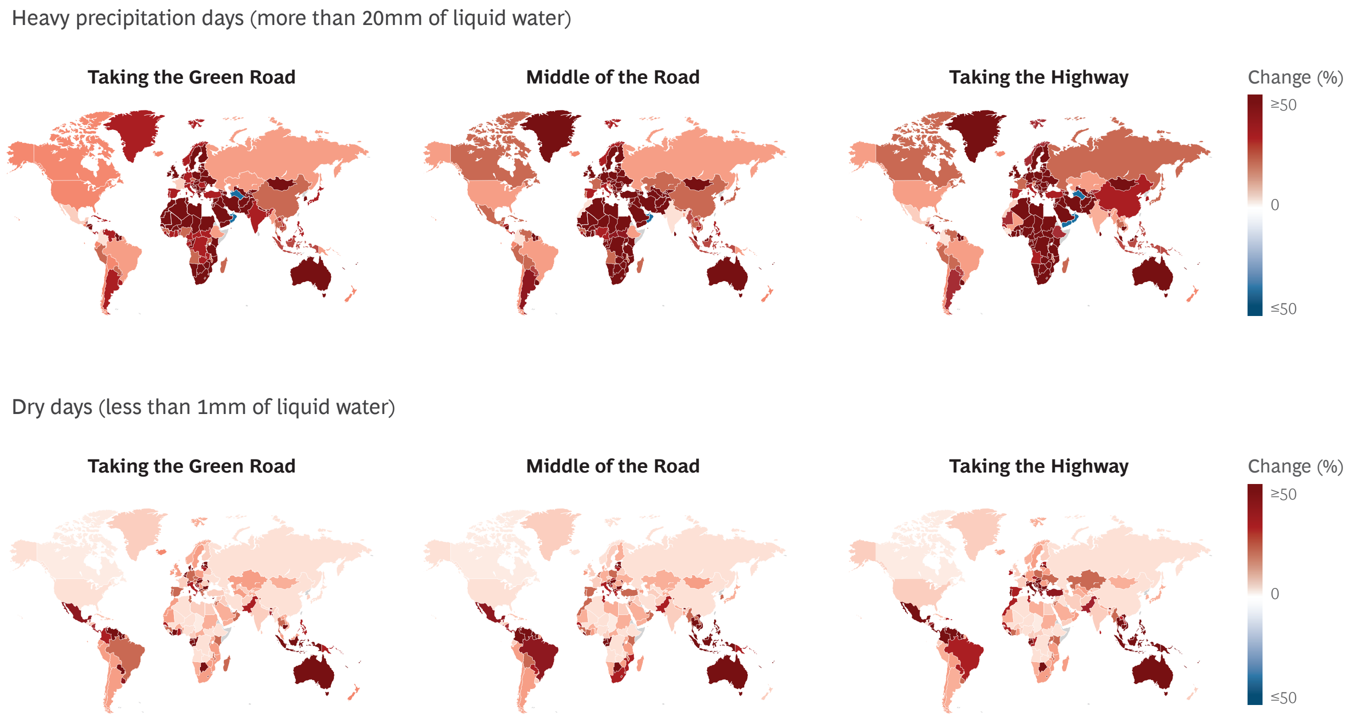
Exhibit 5 - The BCG Water Impact Matrix Can Reveal a Region's Impending Challenges as Climate Change Affects Water Patterns



Source: BCG and WWF analysis.

Note: Water challenges can be both acute (e.g., flash droughts) and chronic (e.g., long-term water scarcity); both are considered here.

Exhibit 6 - Water Risk In 2050 Will Vary Considerably Depending on Success in Slowing Climate Change



Sources: World Bank Group, Climate Change Knowledge Portal; BCG analysis.

Note: The three scenarios tracked in this exhibit are "Taking the Green Road" (strong and ongoing climate change mitigation efforts), "Middle of the Road" (a mix of global climate policies and moderate technological advances), and "Taking the Highway" (little or no climate change mitigation effort). Statistical downscaling applied using historical climate measurements.

Three Pathways Forward

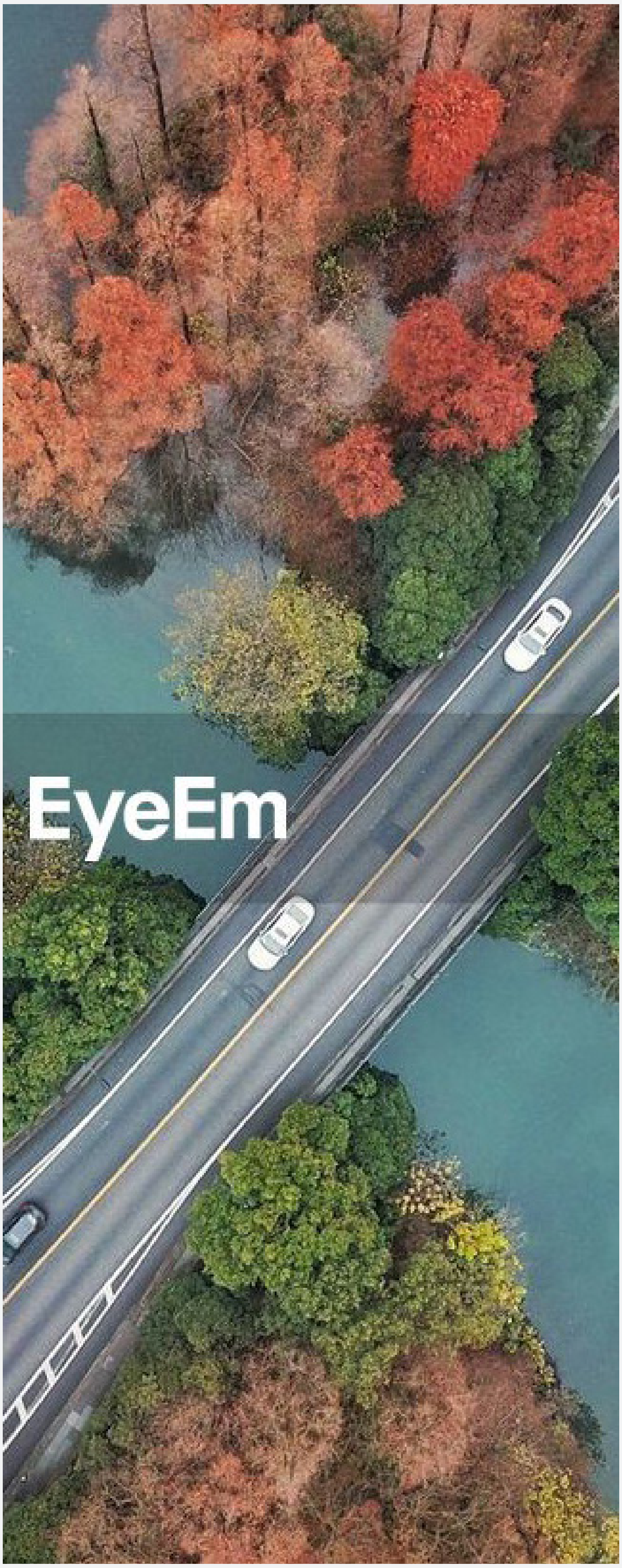
The IPCC's socio-economic pathways (SSPs) are scenarios used to project the possible future impacts of climate change on the basis of different socio-economic developments. They help illuminate how global society, demographics, and economics might change over the next century and how these changes might affect greenhouse gas emissions and climate change.

We use three pathways as the basis for our analysis of the likely extent of climate mobility:

- **SSP1-2.6: Taking the Green Road—Sustainability.** This scenario assumes strong and ongoing mitigation efforts to reduce greenhouse gases, an emphasis on sustainable development, and high levels of technical innovation. It emphasizes respect for environmental boundaries and improved management of the global commons. Additional benefits include lower resource energy intensity and improved education and health.

- **SSP2-4.5: Middle of the Road—Business as Usual.** This scenario assumes a peak emissions year of 2040, a mix of global climate policies, and moderate technological advances. Development and income growth will be uneven, and the environment will continue to degrade, but some improvements in resource and energy intensity will occur.

- **SSP5-8.5: Taking the Highway—Fossil-Fueled Development.** This scenario assumes little or no effort toward emissions mitigation, high dependence on fossil fuels, and limited advances in and adoption of green technologies. Technological process will be rapid, with considerable development of human capital. Population growth will be high, and reliance on new climate solutions such as geo-engineering will increase.



In every climate change scenario, the risk of both internal and external involuntary displacement will increase over the coming decades.

Floods

The expected number of days with more than 20 millimeters of precipitation serves as a proxy for the risk of flooding in 2050. Africa, Australia, the Middle East, and Central Europe are most at risk of increased flooding across all three scenarios. Not surprisingly, under the Take the Highway scenario—the scenario envisaging little or no effort to mitigate the worst effects of climate change—every continent will experience an increase in flood risk of more than 50%. These sharp increases in the risk of flooding globally demonstrate the urgency of the situation, and the need to increase adaptation and water management measures in many parts of the world.

Droughts

We measured drought risk in 2050 by the number of projected dry days per year. Central Europe, Latin America, and Southeast Asia are at highest risk for increased dry days, leading to more exposure to water scarcity and drought; but West, Central and Southern Africa are also at significant risk. In contrast to floods, droughts are slow-onset events that take place over larger areas, making them more likely to cause external displacement.

Water Quality

The fact that both floods and droughts drive the quality of water in a given locality complicates attempts to assess likely future changes in water quality. Flooding adversely impacts water quality mainly by damaging regional water supply and sanitation infrastructure. Droughts, on the other hand, put stress on water flows and increase the concentration of pollutants, minerals, and salinity in water. Areas with high population growth and urbanization rates, such as Nairobi and Mumbai, are likely to experience declining water quality, especially in neighborhoods or districts where water treatment facilities cannot keep up with increased demand, and where rapidly growing populations create more demand for food, and thus for increased agricultural activities.

Rising temperatures and the overall impact of climate change on regional ecosystems can also affect water quality. Among other phenomena, algal blooms and other biological changes can degrade water quality and hinder an ecosystem's capacity to filter water and support life. The Nordics and Central Asia are likely to experience extreme temperature changes, especially under the Take the Highway scenario, exacerbating both climate-related hazards and disruption of the natural water cycle, leading to degraded water quality.

Who Will Be Displaced?

Even under the most positive climate change scenario—Taking the Green Road—we project that the risk of both internal and external involuntary displacement will increase over the coming decades. But how much, and where it increases will vary considerably depending on the success of global efforts to mitigate and adapt to global warming.

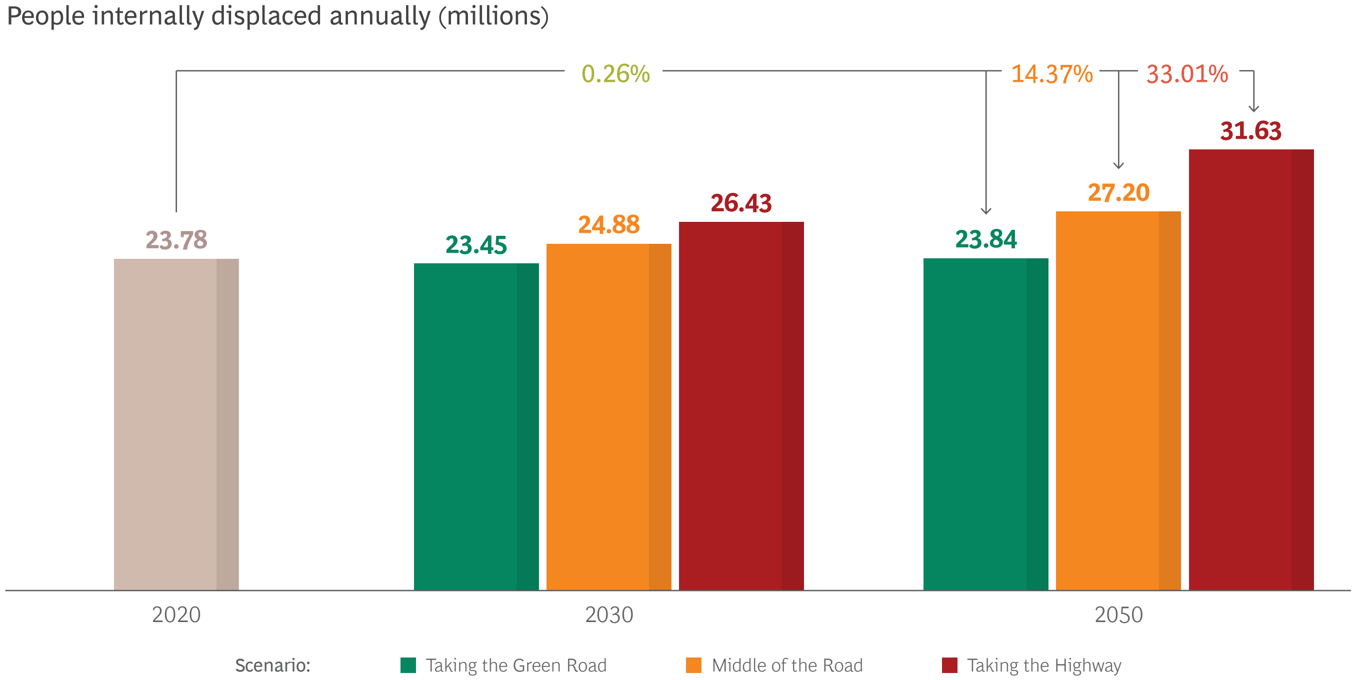
Internal Displacement

Already, climate change, together with geopolitical upheavals and other causes, has increased the internal displacement of large numbers of people. From 2014 to 2020, the number of people forced to move within their countries' borders every year increased by 14%, to almost 24 million. Under the worst-case Taking the Highway scenario, that figure would increase by up to 3% by 2030 and up to 33% by 2050, meaning that close to 32 million people would be forced to move annually. (See Exhibit 7.)

In all three scenarios, the largest percentage increases in water-driven internal displacement are projected to occur in Asia, Northern Africa, and South America. Surprisingly, the scenarios project a decrease in relative internal displacement across central Africa, perhaps because of the availability of rivers that people can tap into as a stable water resource. India's relative displacement is likely to decrease as well, but that is due to comparison to high baseline levels of displacement in 2020.

Overall, the Global South will likely be more vulnerable to climate-change-induced displacement than the Global North. In absolute terms, however, the most populous countries will face the highest number of internal displacements. This group includes the US, China, and India, all of which face the risk of more than 1 million annual displacements by 2050 under both the Middle of the Road and the Take the Highway scenarios. Small changes in relative displacement can have large absolute effects in very populous countries—even if, like the US, they are developed countries with strong resilience measures.

Exhibit 7 - The Number of People Displaced Internally Each Year Because of Climate Hazards Could Increase by More Than 30% by 2050



Source: BCGX model output.

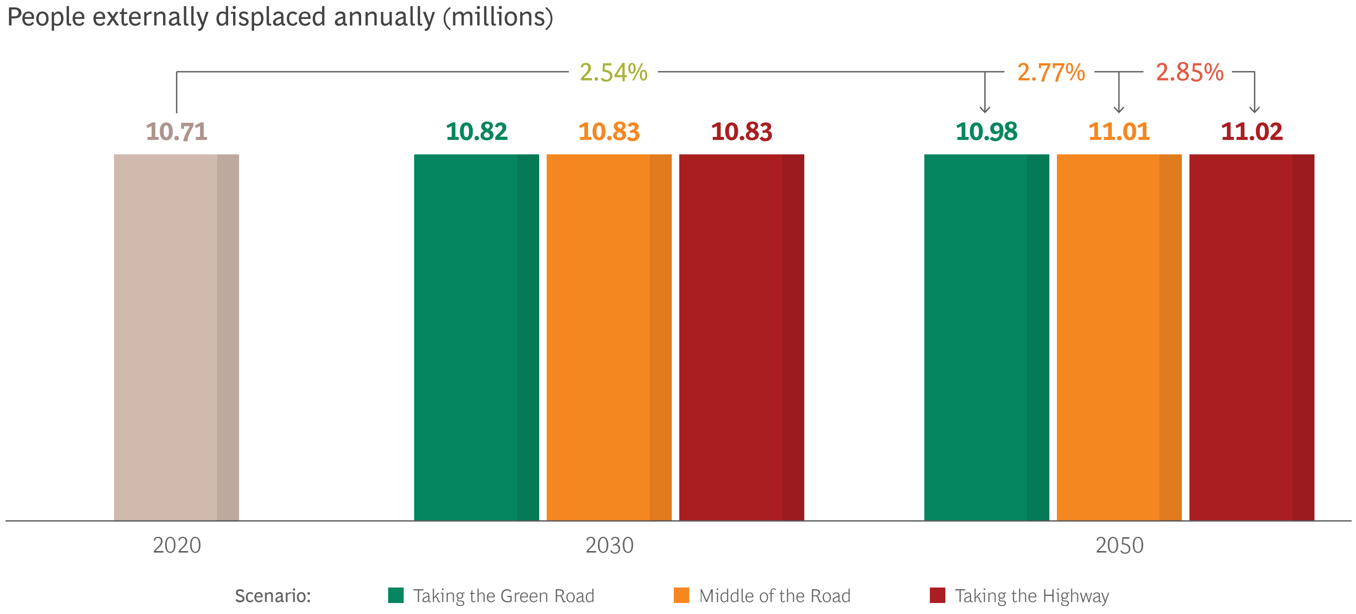
Note: Model output: internal displacement relative to population; we estimate the population displaced by multiplying the model output by total country population. Final results obtained on 199 countries (data complete).

External Displacement

More than 10 million people had to leave their countries in 2020, capping an overall increase in external displacement outflow of 2% since 2010. Looking forward, we expect external displacement outflow due to climate-related changes in water patterns to increase by as much as 2.8% by 2050, suggesting that more than 11 million people would be forced out of their home countries under the most severe climate scenario. (See Exhibit 8.) As significant as that figure is, it is considerably less than the corresponding projections for internal displacement. And this is not surprising, since most water-related displacement occurs internally because of the typically local extent and impact of water issues.

The largest numbers of externally displaced people will leave the US, India, China, and Venezuela—no surprise given their sheer size. But when weighted for total population, Europe, Western Asia, and Greenland face the highest rates of external displacement. Globally, external displacement is likely to extend across many regions, with a high percentage also coming from Central Africa, Latin America, and New Zealand. Indeed, the global spread of water-related external displacement disrupts the narrative that water-related mobility is chiefly a problem of the Global South. We expect external water-driven displacement to be highest in regions that permit relatively free movement of people across borders and in regions with numerous smaller countries, such as the EU.

Exhibit 8 - Annual External Displacement Could Increase by 3% by 2050



Source: BCGX model output.

Note: Model output: cumulative migration outflow over five years range from bilateral international migration flow estimates updated and refined by sex; Guy J. Abel and Joel E. Cohen. Final results obtained on 199 countries (data complete).

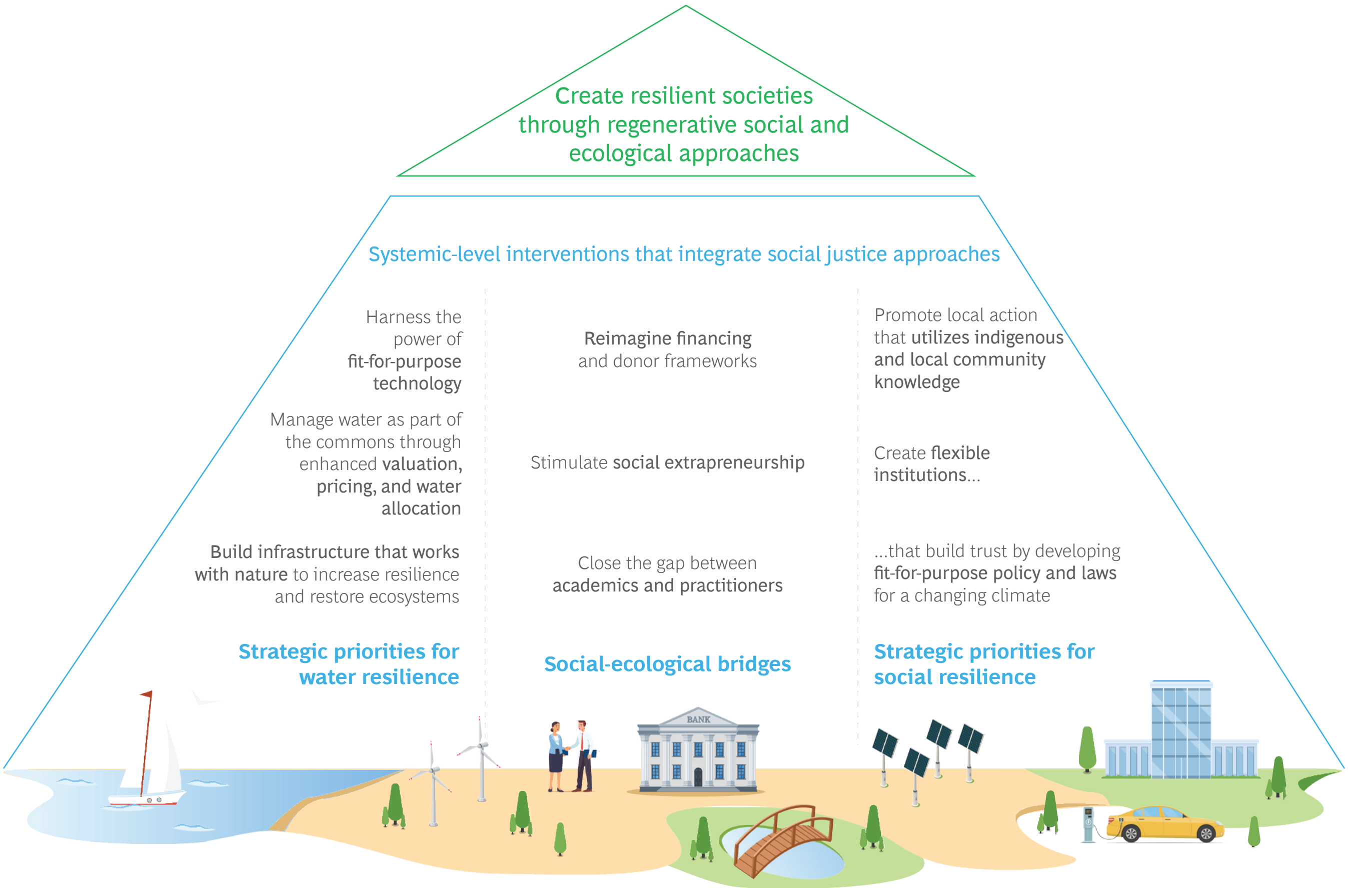
Three Interdependent Solutions

Because the driving force behind climate mobility is largely water risks exacerbated by climate change, mitigating those risks is essential to developing a resilient society that can limit displacement. But focusing on water alone will not effectively mitigate the problem of climate mobility, because such a focus ignores the interdependencies between water and various economic, political, and social factors. Consequently, effective solutions must also address how to improve social resilience—the combination of economic, political, and social conditions that enable a society to alleviate the circumstances that force people to move.

Achieving this goal will entail satisfying three strategic priorities, each of which requires systemic implementation as part of an overall social justice approach to the challenge (see Exhibit 9):

- **Strategic Priorities for Water Resilience.** Solutions that focus on mitigating water risks
- **Social-Ecological Bridges.** Solutions that can improve both water resilience and social resilience
- **Strategic Priorities for Social Resilience.** Solutions that can specifically improve social resilience

Exhibit 9 - Prioritizing Both Social Approaches and Ecological Approaches Is Critical to Creating Resilient Societies



Source: BCG analysis.

Strategic Priorities for Water Resilience

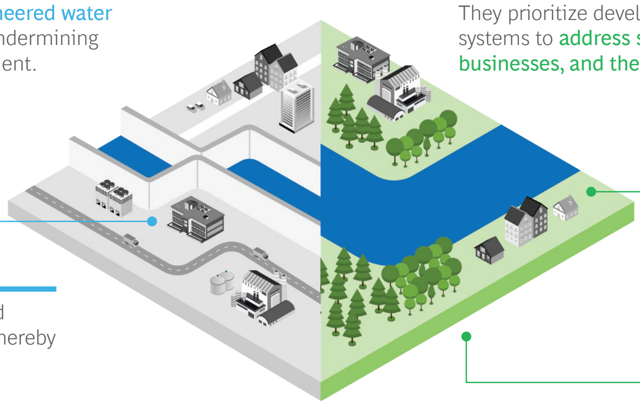
Mitigating the impact of changes in water patterns on climate mobility isn't simply a matter of trying to reduce the extent of flooding or counter the immediate physical impacts of storms and droughts. Building levees and engineering massive irrigation projects are stopgap measures that do little to promote true water resilience.

Instead, long-term solutions must work toward strengthening natural resilience to the increasing impacts of changing water patterns and managing available water differently, with the help of a range of promising new technologies.

Embrace nature-based solutions (NbS). The NbS category encompasses a variety of actions intended to restore, protect, and sustainably manage natural or modified ecosystems while also addressing societal challenges and providing benefits to human well-being and biodiversity. Because nature-based solutions aim to solve societal challenges and benefit human well-being, they are generally inclusive solutions. (See Exhibit 10.)

In contrast to engineered water projects, NbS projects use the power of nature to adapt in the face of water-related events. For example, restoring the natural buffering capacity of mangrove swamps and wetlands can reduce the impact of storm surges and floods, and rebuilding floodplains along rivers can improve flood risk management by enhancing floodwater storage and conveyance. NbS can also lower the risk of harmful climate-change-induced water patterns by mitigating the process of global warming itself. Reforestation projects and conservation of existing forests can help absorb excess water while increasing carbon intake and storage.

Exhibit 10 - In Many Cases, Nature-Based Solutions Can Build Resilience Better Than Engineered Water Solutions Can



Source: Adapted from the WWF report *Waterways to Resilience* (2021).

In addition to reducing the direct causes of climate mobility, NbS can improve social resilience by helping provide the means to sustain and diversify livelihoods. For example, sustainable management of natural resources such as forests provides multiple streams of income for communities, including the use of local labor to plant trees and restore and maintain habitats. Enhancing the natural water cycle through reforestation of watersheds increases the amount of water available for agriculture, thereby increasing food security. Maintaining the health of natural systems can also help preserve a community's cultural and spiritual ties to its surrounding ecosystem, and improve social resilience when planners integrate and co-develop NbS efforts with local communities, using local knowledge.

Treat water as part of the commons. Like the open, communal pasturelands of old, *the commons* refers to any shared but limited resource—such as wildlife, biodiversity, and even air—that is accessible to all members of a community or society. Water is a perfect example. Safe and usable water should be accessible to all, and accordingly the UN has declared water access a human right; but water is limited, and exploitation or pollution of water by some users can restrict or deny access to the resource by others. The solution is to manage water as a commonly held resource rather than as a commodity to be exploited for private profit. In doing so, those responsible for water management can benefit from using a local or regional lens—although global targets can also foster transboundary or regional collaboration.

Managing water as a common resource requires implementing socially equitable water pricing to ensure that all members of the community have access to it and to avoid water exploitation, even if this means exercising some degree of price discrimination based on capacity and volume.

Accounting for the true value of water ensures that it will be appreciated properly and allocated fairly, and discourages its overextraction by industry or agriculture. Innovative, socially equitable pricing structures tailored to their contexts already exist, but they must be implemented in order to build trust in governance structures.

Focus on fit-for-purpose technology. Various digital tools and platforms can enhance the efficiency, productivity, and innovation of resilience and adaptation solutions across the water value chain. These include sourcing and distribution technologies, such as water storage and streamflow forecasting, real-time water quality monitoring, cost-effective desalination, and digital leak detection and monitoring; precision irrigation and farming techniques and connected water meters to monitor usage; and cost-efficient wastewater processing and reclamation.

Strategic Priorities for Social Resilience

Improving water resilience alone will not solve the challenge of water-related climate mobility. Boosting social resilience is key to ensuring that gains in water resilience are long-lasting and that the benefits are shared throughout communities. Gaining these benefits requires creating flexible institutions, developing policies to manage climate change, and promoting action at the local level.

Create flexible institutions. Changes in water patterns are unpredictable, and could become even more so as the planet continues to warm. In response, public institutions must respond more dynamically and flexibly to a changing climate and to sudden water-related events that could trigger climate mobility.

This entails reviewing policies and regulations regularly to detect and mitigate unnecessary bureaucracy and unduly stringent regulations that could hamper a rapid response as conditions change in both the short and the long term, or that could slow the implementation of new social or technological solutions. Reducing bureaucratic hurdles, in particular, can facilitate the development of market-based solutions. Likewise, considering technologically innovative solutions to water problems, rather than viewing water management exclusively through the traditional engineering lens, can encourage more investment in private sector R&D.

Develop fit-for-purpose policies. Given the uncertain but dramatic impacts of a changing climate, policies must be fit-for-purpose to respond consistently and effectively. That means designing them to avoid situations in which solutions have conflicting goals, such as subsidies that prioritize economic gains over environmental and social needs. It also means ensuring that they are adaptable, arise out of collaborative development with all stakeholder groups, and actively promote R&D and innovation. Starting from a climate justice perspective can facilitate the development of fit-for-purpose policies.

To avoid conflicts and ensure effectiveness, policymakers could avoid policy and organizational fragmentation across climate mobility, development, natural resource management, and water services, and they could ensure consistent policy implementation in light of mandates of all institutional actors. Finally, they could explicitly integrate climate mobility issues into all relevant policy frameworks.

Promote local action. The adverse effects of water-related disasters are typically very localized, so reducing their impact on climate mobility requires understanding, guidance, and action at the local level. To maximize local input, policymakers could embrace local forms of governance that integrate indigenous and community knowledge across planning, policy, and infrastructure implementations. Local and informal community governance can be integrated into formal governance structures, and measures to promote innovation and resilience can consider historical indigenous solutions and seek to integrate them into modern practices and technology, leading to greater trust and broader local uptake of initiatives and solutions.

Social-Ecological Bridges

This category of solutions, which includes remedies applicable to increasing water resilience and to boosting social resilience, aims to encourage collaboration by all stakeholders.

Close the gap between academics and practitioners. Research and new knowledge should end up in the hands of those on the ground who are responsible for delivering results. But researchers and practitioners who are directly involved in water-related action and policy often speak a different language and have different methods and goals. Collaboration and practitioner-informed research is necessary to improve communication between the two groups. To that end, academics could craft their findings and results to maximize their practical applicability, and practitioners could offer guidance to academics regarding research priorities that are most likely to enhance impact in the field. An explicitly community-centric approach that promotes collaboration between academics and practitioners from the community is essential to identifying and meeting specific community needs.

Stimulate social extrapreneurship. Complex problems demand a multisectoral approach. To that end, the concept of social extrapreneurship has evolved to encourage collaboration beyond and between company and industry boundaries, as a “coalition of doers” engaged in a partnership that does more than simply coordinate different sets of activities.

Reimagine financing and donor frameworks. Innovative financing mechanisms will be necessary to fund the new technologies and NbS actions needed to limit the impact of water-related issues on climate mobility, since traditional modes of finance may not be applicable. The effort will require a combination of financial instruments, including loans, grants, banking products, government guarantees, and alternatives such as biodiversity and carbon credits. Aggregated financing mechanisms will be necessary to drive impact at the scale needed.

In addition the financing must reach local, community-based institutions to improve agency, build trust, and deliver local impact, while avoiding unintended consequences such as microfinancing programs pushing communities into debt. Getting this aspect of planning right will require mandates that provide the flexibility needed to deliver adequate financing to those who need it.

Finally, climate financing must be patient enough to allow for payoffs that may not occur until years in the future, and it must be oriented to the needs of those executing the projects, not just to the financial outcome of the funded projects.

Taking Action

To achieve these solutions, actors across the public and private sectors, financial institutions, NGOs, academia, and civil society could consider taking a number of key actions, which will require collaboration across all sectors.

Public Sector Actors

Governments can strive to strengthen the legal and policy frameworks needed to integrate NbS into national policy and to accelerate their implementation. At the local level, systemic, community-centric policy frameworks and funding instruments will be necessary to further solutions, including the implementation of equitable water pricing reform. Governments can also work across borders to form regional macro-level policy frameworks that support ground-level action.

Private Sector Actors

Companies in the private sphere could consider investing in new adaptation and resilience technologies to de-risk investments in NbS. As water issues gain in importance, companies could integrate water into their business strategy, with specific targets for its use and programs for reporting progress against the targets. Companies that depend heavily on water could prioritize water-focused R&D, set science-based targets for its use, and disclose its water-related risks.

Financial Institutions. Banks and international financial institutions could work with governments, the private sector, and local communities to develop new fit-for-purpose financing instruments tailored to the specific needs of NbS and water resilience-related technologies.

Nongovernmental Organizations. NGOs can take advantage of on-the-ground learning and experience to provide guidance on key areas of academic research and then implement the systemic solutions developed in collaboration with academics and community practitioners. They can work through existing local and traditional governance structures to maintain community engagement, and coordinate their donor networks to aggregate and channel financing to the most effective water-related solutions, reaching those who need it most.

Academics. Academics can conduct localized research, in collaboration with other actors, to steer and inform their work, such as by helping to guide governments in selecting the most effective and appropriate form of water price differentiation for a given region. By highlighting local and indigenous knowledge as a credible and important resource, they can help promote community-centric approaches to solving water problems.

Civil Society and Communities. Local communities could actively engage in policymaking as co-developers policy and potential solutions that reflect their particular needs, using local community governance structures. Local and indigenous knowledge is an invaluable resource, and local communities can gather and share it with other social extrapreneurs.

Common Problems Require Common Solutions

No one anywhere in the world is truly safe from changes in water patterns as a result of climate change. Floods, droughts, and storms can affect anyone at any time, and their likely increase in frequency and severity will only heighten the risk. Although the immediate causes of water issues may be local, their effects can be far-reaching, in the form of pollution, food insecurity, and rising sea levels—all of which can lead to further displacement.

In short, climate mobility is everyone's problem. And the only way to mitigate its causes and effects is through wider cross-sector collaboration to develop, fund, and carry out the solutions needed.

Wider cross-sector collaboration is essential to develop, fund, and carry out solutions to mitigate the causes and effects of climate mobility.

Appendix: Methodology

A key goal of this report is to identify high-risk countries where water risk (too much, too little, or too dirty) is significant and where we project high levels of internal and external mobility. The methodology included two steps. First, we used historical data to find areas of high correlation between mobility and water risks. Second, we used machine learning tools to predict areas of future water risk, in order to identify where mobility is likely to be highest.

Step 1: Historical Correlation Mapping

We began by mapping country-by-country flood, drought, and water quality risks based on an aggregate score that we derived from the BCG Water Matrix. We used this aggregate score to determine which countries are at high risk overall. Flood risk combines both riverine and coastal flood risk. We computed drought risk on the basis of the World Resources Institute's Aqueduct drought risk exposure index. We measured water quality by aggregating wastewater quality metrics and coastal eutrophication potential measurements.

We correlated our findings with historical internal and external mobility data from 2014 to 2022. We measured internal mobility at a country level, based on computations of actual and relative internal displacements by climate hazards, in line with the Internal Displacement Monitoring Centre's disaster definitions (storms, floods, droughts, wildfires, and extreme temperatures). We based our calculations of external mobility on actual and relative country-level outflows from 2014 to 2022.

Step 2: Predictive Mapping

To predict future climate mobility related to changes in water patterns, we applied a Random Forest machine learning approach, using three IPCC scenarios: Taking the Green Road, Middle of the Road, and Taking the Highway. (See "Three Pathways Forward.") We considered both climate and socio-economic factors in analyzing internal and external displacement. From this analysis, we compiled internal and external displacement results at a country level, making relevant assumptions to correct for any limitations of the data sets. Although the report incorporates modeling, it does not aim to advance a deterministic account of future climate mobility.

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At the University of Cambridge's Peaceshaping and Climate Lab, we aim to stimulate versatile research, facilitate effective knowledge transfer and support informed practitioner action.

The Lab fosters an interdisciplinary space which prioritises bridge-building and collaborative action to address the overlaps in climate change and human conflict. We explore cutting edge research and coordinate partnerships within and beyond academia in order to support the work of the wider peaceshaping community. We take a proactive approach, encouraging the pursuit of opportunities for resilience building and adaption that prevent the need to rely on outdated and inadequate 'reactive' policy and action.

Our activities are guided by the belief that inclusive social innovation, which is suited to and inspired by local knowledge, will ensure that societies are equipped to deal with climate shifts across a variety of contexts.

The Cambridge Peaceshaping and Climate Lab is part of the Cambridge Centre for Social Innovation . We nurture research opportunities by refining our understanding of social innovation and implementing approaches to address social, cultural, economic, and environmental challenges and opportunities. A central tenet of the Centre is to bring academics and practitioners together to enhance understanding of, and the impact of social innovation. Our core aim is to facilitate meaningful real-world impact.

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