Disaster Risk Reduction through Digital Transformation in the Western Hemisphere

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Latin American and Caribbean countries encounter disasters each year, ranging from localized tragedies to region-wide catastrophes. These disasters are large, rapid-onset incidents, and they include hurricanes, earthquakes, fires, floods, droughts, volcanic eruptions, and pandemics. Catastrophes pose significant challenges for impacted countries as they attempt to recover from the damage done. Challenges from disasters are often exacerbated by lack of technological capabilities, weak infrastructure, and bureaucratic challenges, among other factors. Within this context, improved digital disaster warning and management systems could provide critical support to the region as it prepares for future disasters.

Countries across the Western Hemisphere grapple with the impacts of inevitable disasters. For example, Caribbean locations are often hit by hurricanes and experience significant flooding, the west coast of the region is the most likely to be devastated by earthquakes, and landslides are common occurrences in Andean countries. Additionally, given the rapidly increasing impact of climate change, these disasters are occurring at a heightened frequency, making disaster preparedness, mitigation, and recovery even more difficult and essential.

Designing and implementing disaster risk reduction (DRR) initiatives can help countries in the region prepare for and mitigate the impact of disasters. Digital transformation and related technologies can and should play an important role in DRR, and the region can benefit from lessons learned by other countries with significant experience in disaster preparedness, like Japan.

RECOMMENDATIONS

- ***Build a systemic response to disasters.*** The goal is to have disaster mitigation policies that remain in place regardless of changes in government and include a whole-of-government approach. This also includes ensuring that disaster responses are adequately funded, and that country budgets plan appropriately for disaster-resistant infrastructure, immediate relief, and rebuilding. This would streamline the DRR processes, increase DRR know-how, and prevent incomplete responses to individual disasters.

- ***Plan ahead.*** Advanced planning for disasters is always better than trying to mitigate a disaster after it has occurred. Governments should make certain that policies, procedures, and expected roles are identified in advance of a disaster, and that community networks are in place to adequately deploy disaster infrastructure ahead of time.

- ***Protect critical infrastructure.*** Traditional infrastructure, such as electricity or the internet, is the basis for newer technologies. Innovative digital solutions will need to rely on traditional infrastructure to work. Donors, especially development agencies, should keep this in mind when promoting technological solutions.

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- *Develop and put in place inclusive legal frameworks*. Legal frameworks that require governments to plan—informed through the public consultation of key stakeholders—will encourage and maintain advanced planning for disaster mitigation policies and help build a systemic response to disasters.

- *Prioritize addressing gaps in technological access as an area for international donor support.* Different populations have varying levels of access to technological tools, such as reliable internet or smartphones. Donors should recognize this gap and tailor their support to ensure maximum efficiency of implemented policies.

- *Learn lessons from other regions and strengthen a community of practice.* Asia-Pacific countries, in particular, have vast experience in disaster mitigation efforts, having experienced various disasters. Latin American and Caribbean countries could benefit from their experience and expertise as they prepare future DRR policies.

- *Involve the target population when building, designing, and testing mitigation technologies.* Donors (including the private sector), governments, and development partners should address the following questions: Can the community effectively use the technology we are designing and implementing? Is the technology accurately addressing the needs of the target population?

- *Balance private sector interests with the interests of the public.* In the event of a disaster, the private sector will be focused on economic losses, whereas the public may be focused on the loss of housing and basic infrastructure. Disaster mitigation policies should seek to balance these interests and maintain equitable procedures.

- *Build upon Indigenous knowledge*. Many Indigenous and traditional communities have unique knowledge about land management and earth cycles. Their deeper expertise is especially useful in instances of fire and floods, and governments should integrate Indigenous and traditional knowledge into disaster prevention and mitigation strategies.

RECENT DISASTERS IN THE REGION

Many disasters have long-term consequences that go beyond immediate destruction. Between 1970 and 2019, disasters in Latin America and the Caribbean impacted almost 300 million people, killed more than 500,000 people, and cost the region close to half a trillion dollars. In the last few years, the region has experienced several severe disasters, including hurricanes, earthquakes, forest fires, and disease.

- A magnitude 7.2 earthquake **hit western Haiti in August 2021,** killing almost 2,000 and leaving half a million people in need of emergency humanitarian assistance. Heavy rains from Tropical Storm Grace, which hit the island just a few days later, hampered relief efforts and triggered mud that has made some communities impacted by the earthquake unreachable.

- Hurricanes Eta and Iota devastated Guatemala, Honduras, and Nicaragua in 2020, destroying critical infrastructure and agricultural systems as Covid-19 continued to run rampant.

- In Brazil, forest fires have been devastating the Amazon rainforest and the Pantanal wetlands, with more than **2,500 major fires** burning across the Brazilian Amazon between May and November of 2020. Though most of these fires began deliberately—lit either to clear agricultural fields or as a way for land grabbers to convert the land for private use—they are exacerbated by climate change and ongoing forest clearing. The fires reduce the Brazilian Amazon's natural absorption of greenhouse gases, which leads to rising carbon emissions, destroys livelihoods—particularly Indigenous and traditional livelihoods—and causes significant biodiversity losses.

- Puerto Rico is still struggling to recover from the deadly Category 5 Hurricane Maria that reached its shores in 2017; many residents still **lack access** to clean water and reliable electricity, destroyed homes have not been rebuilt, and the country's economy has lost over **$780 million** in agriculture yields.

- In 2017, Mexico City was hit by a **7.1 magnitude earthquake,** which demolished buildings, destroyed highways, and killed hundreds of people. This earthquake significantly damaged central Mexico and likely contributed to a subway collapse in **Mexico City in May 2021 that left 26 dead**.

- In 2015 and 2016, the region experienced an **outbreak of the Zika virus** that infected over a half million people. The virus was also connected to microcephaly in the babies of infected pregnant mothers and to cases of Guillain-Barré syndrome.

2017
PUEBLA
EARTHQUAKE

2017
HURRICANE MARIA

1999
VARGAS TRAGEDY

2010
TROPICAL
STORM AGATHA

2020
HURRICANES
ETA AND IOTA

2011-2012
PUYEHUE-CORDÓN
CAULLE ERUPTION

2020
SOUTH AMERICAN FIRES

Source: CSIS original creation based on public information.

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IMPACT OF COVID-19

The Covid-19 pandemic has hit South America **worse** than any other continent, with 21 percent of cases and 32 percent of deaths worldwide coming from the region. Brazil and Peru were particularly hard-hit, having the **second-highest** number of Covid-19-related deaths in the world and the **highest per capita death rate in the world**, respectively. Argentina and Colombia are also struggling to contain the spread of the virus, with over **5.1 million** and **4.8 million** infections as of August 2021, respectively. **Extreme levels of inequality** throughout Latin America and the Caribbean have caused a gap in access to Covid-19 tests and vaccines, as well as essentials like food and medicine. The region's economy **contracted by 7 percent in 2020** due to Covid-19, which furthers the region's inability to successfully recover from the pandemic. The region's vaccination rates vary widely from country to country due to factors such as healthcare infrastructure, population density, and vaccine availability. As of August 2021, **20 percent of the region has been fully vaccinated**, with Chile, Uruguay, Cuba,

and the Dominican Republic leading **immunization rates** in the region, but some countries have vaccination rates as low as five percent. Other countries, such as Nicaragua, Guatemala, Venezuela, and El Salvador, have barely begun administering doses to their populations.

MORE VULNERABLE POPULATIONS

Though disasters impact all levels of society, they have a greater effect on vulnerable populations. These populations—including women, rural residents, the elderly, and persons with disabilities—often bear the heaviest burden of dealing with the immediate effects of the disaster and with the subsequent ramifications of recovery.

Across the region, women spend less **time** doing paid work than doing unpaid work. According to a 2016 report by the UN Economic Commission for Latin America and the Caribbean, women spend on average **three times more hours** than men on unpaid work, highlighting that women are often the ones working in the home and carrying out domestic tasks. In the event of a disaster, women are likely the ones who will seek to ensure the safety of children and valuable materials and who will be responsible for disaster recovery tasks.

Rural residents often bear the brunt of disasters, as basic infrastructure, such as roads and hospitals, is often stronger in urban settings. If roads are blocked or otherwise unusable, rural residents cannot easily evacuate before, during, or after a disaster. Hospitals are typically located far from one another in rural locations, making it harder for hospitals to receive appropriate supplies and for residents to access care. Public transportation is often lacking in rural areas, creating another gap in sufficient access to resources and supplies. In rural areas, community members are often the first and only responders to the scene post-disaster.

Throughout the Western Hemisphere, the **rapidly growing elderly population** is one of the most vulnerable and fragile groups of society. In addition to the increase in health challenges, the elderly are also the most likely to struggle with technology, like making appointments for Covid-19 testing or vaccination or accessing disaster warnings or information on disaster relief initiatives.

Persons with disabilities habitually encounter discrimination, **especially within the healthcare system**. In the aftermath of a disaster, this population is more likely to be overlooked for accessible rescue methods, appropriate medical treatment, and resources for recovery. The disruption of physical and mental support systems, and the delay in rebuilding these systems, can have a detrimental impact on persons with disabilities.

DISASTER RISK REDUCTION POLICY PRIORITIES

There are three "policy priorities" to attain disaster risk reduction: (1) pre-disaster investment in structural measures, especially in coastal cities; (2) establishing or strengthening DRR institutions to better understand and prepare for residual disaster risk; and (3) pursuing Build Back Better initiatives in disaster-prone areas after disaster strikes. Some disasters, like floods, landslides, and storms, are more easily predicted and mitigated, allowing pre-disaster hazard impact control through structural measures and communities to better prepare for them. Other disasters—like earthquakes and volcanic eruptions—are less predictable, but their impact can still be reduced through adequate disaster mitigation.

PRE-DISASTER INVESTMENT IN STRUCTURAL MEASURES

Disaster risk reduction through structural measures is the most important and effective part of a DRR strategy, but digital technologies can enhance and strengthen these structural measures. In this context, good governance and rule of law are key; unstable or corrupt governance is a major challenge for many disaster-prone countries in the region, as these governments are less likely to have the capacity to prioritize disaster mitigation efforts at the necessary level. Early-warning disaster mitigation systems can provide critical warnings in advance of a disaster and save hundreds of lives. Ideally, these systems would require remote sensing capabilities that are not under the exclusive control of the central government; in this way, populations will not be forced to rely on government goodwill to know whether a disaster is imminent. These systems will also need the ability to confirm what is occurring on the ground, a tool that could assist governments in acting sooner to identify needs based on factual information and in responding more appropriately to the disaster.

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will not only provide a clear path to recovery for everyone, but also balance the interests of the public and private sectors as countries repair the damage from the disaster.

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Pre-disaster investment in structural measures is also critical for eventual recovery; in fragile states, on average, for every $100 spent on emergency response, only **$1.30 is spent on DRR**. If governments invest and prepare for disaster recovery in advance, they will be better prepared to financially recover after disaster strikes.

ESTABLISHING DRR INSTITUTIONS

Developing and implementing legal frameworks related to DRR, particularly policies that require governments to plan and prepare for disasters in advance, would help provide a systemic response to disasters. These frameworks should clearly identify DRR procedures, and they will also allow government practitioners to familiarize themselves with their roles and know what is expected of them both during and after disasters. DRR institutions and frameworks also need to be well-funded and thoughtfully integrated into country budgets. It is helpful if countries also have a committee in their legislatures responsible for disaster relief, potentially overseeing or consulting with the executive branch on actions related to disasters and managing the financial resources for DRR initiatives. These committees could also play a role in raising awareness and informing the public on DRR initiatives and resources through public education campaigns, public hearings, and soliciting of input from citizens.

The public and private sectors should work together to ensure that DRR policies reflect the interests of all levels of society. In the event of a disaster, having policies in place to support the private sector as it recovers financially and assist citizens as they attempt to rebuild their livelihoods
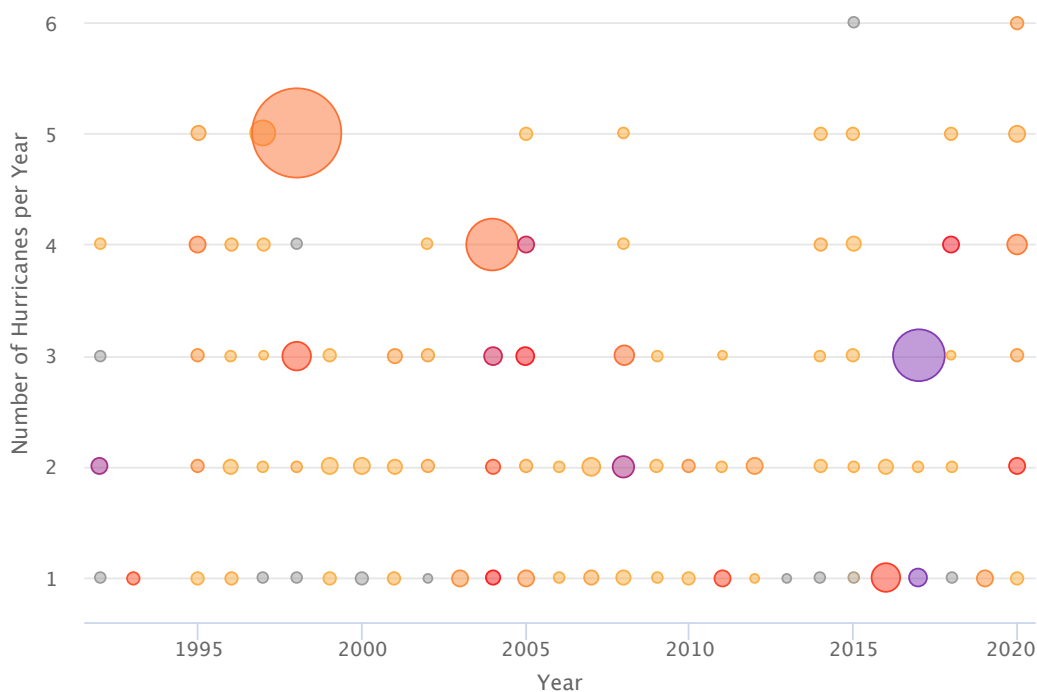
BUILD BACK BETTER INITIATIVES

Digital solutions and infrastructure can prove critical to helping disaster-prone countries prepare for and recover after disasters, but they are not useful if governments cannot deploy them on a significant scale and engage civil society to adequately promote the use of DRR infrastructure. There is ample evidence across the globe of this. For example, the **2018 Cauca floods** in Colombia exposed the country's inability to categorize affected communities correctly, severely limiting access to relief efforts. It also highlighted the disconnect between the private sector and the government, as the broken dam that caused the floods was under the purview of a private company, therefore placing the burden of repair and recovery on the company and not the government. Additionally, at the initial onset of the Covid-19 pandemic, China **did not provide adequate early warnings** to other countries and lacked transparency about the early days of the outbreak. This contributed to the lack of preparedness in other countries as the pandemic spread.
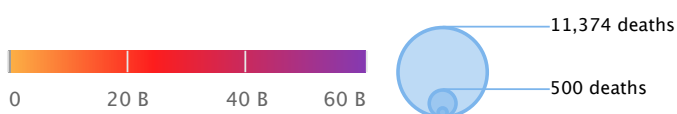
Disaster recovery systems, which ensure the recovery and functionality of critical infrastructure after a disaster, are also essential to broader recovery procedures. Without critical infrastructure like electricity and internet, most recovery policies and plans cannot be effectively implemented. For example, a U.S. Agency for International Development initiative titled "**Volcano Disaster Assistance Program**" uses mobile volcanic monitoring equipment to rapidly assess risks that help local agencies respond to eruptions. Without the internet,

Hurricanes 1992–Present

Size of Bubbles: Deaths
Color of Bubbles: Damage in USD

Damage in USD

0   20 B   40 B   60 B

11,374 deaths

500 deaths

Source: Authors' analysis based on multiple sources.

There are ample ways in which digital solutions can play a role in disaster mitigation efforts. There are certain limitations to digital transformation. Its role is limited in the most crucial part of DRR, pre-disaster investment in infrastructure. However, expanding the technological capabilities of the tools used in each of these steps would considerably increase a country's ability to lessen the impacts of a disaster and would offer an accelerated recovery pace after disaster strikes.

Technology is critical in the DRR space, as it helps identify and analyze data faster. For example, using data from Twitter feeds or even from satellite imagery has helped **map the spread of disasters**, especially with pandemics. For example, there is **evidence** that Chinese citizens were using Twitter and other forms of social media to discuss symptoms of Covid-19 as early as August 2019, and satellite imagery showed an **increase in visits to health clinics** at the same time. These exchanges also helped experts later determine where the Covid-19 virus originated and how it had spread.

Sharing data across a region affected by a disaster—especially quick data sharing—is another crucial piece of disaster mitigation that could benefit from improved technology. Disasters tend to hit swiftly, and the faster that information can be exchanged, the higher the chance of appropriate and effective mitigation efforts. If countries work together, efficient exchange of information is especially useful. Data sharing is also critical after a disaster, as countries can analyze data gathered before and during the disaster to learn lessons

this program would not be able to function, and effective relief distribution would be delayed or even halted. Disaster recovery systems should also incorporate lower-tech solutions like radio, which can be critical when internet is not easily accessible.

Many countries in the region are already committed to DRR policies and have signed onto international frameworks and agreements like the **Sendai Framework**. The Sendai Framework is an agreement under the UN **Sustainable Development Goals,** which provides a roadmap for countries to better prepare for and recover after disasters. The framework highlights four priority areas for disaster preparedness: understanding disaster risk, strengthening disaster risk governance, investing in DRR measures, and a "Build Back Better" approach to post-disaster recovery.

and better prepare for future disasters. For example, **Japan and Mexico** are working together to analyze data from megathrust earthquakes, which often cause tsunamis, to better understand the physics of these earthquakes. Decisionmakers must also be able to anticipate what kind of information they will receive when the disaster hits so that they can best manage their limitations in drafting disaster mitigation policies. Prior cooperation is similarly essential for planning disaster responses, as there should be an understanding of what each entity's role in disaster response will be before the disaster strikes.

There is a strong need to develop systems and protocols that integrate data from diverse sources, as well as to establish standard agreements in the Western Hemisphere to allow data sharing to occur. However, applying advanced technologies to these efforts will not automatically translate to more effective DRR solutions. Those involved in DRR policy will need to know how to use the upgraded technology in implementing DRR solutions and policies, which requires specific training. Additionally, the accumulation of knowledge from diverse sources should build upon local and Indigenous practices; **many Indigenous communities have unique knowledge** about land management and natural earth cycles, among others, and they can be an integral part of solutions for how to best prevent and respond to disasters.

Detection and early warning systems for disasters are vital in helping countries prepare for disaster mitigation efforts in advance. Introducing new technologies and digital solutions to these systems is essential to the continued improvement and efficacy of DRR efforts.

CHALLENGES

The introduction of advanced technology to already-existing disaster mitigation tools and policies comes with challenges to effective implementation. First, as discussed earlier, systemic corruption and lack of government planning often lead to an inability to implement disaster mitigation policies. Government unpreparedness—or sometimes even mismanagement—prolongs the negative consequences of a disaster and delays recovery. Unprepared governments are also less likely to adopt new digital measures for existing disaster mitigation policies, further limiting their ability to respond effectively when disaster strikes.

Second, government agencies tasked with DRR policies are often not accustomed to using technology for data collection and analysis, meaning that decisionmakers

lack the information they need to make the best policy decisions. Thorough training for both policymakers and policy implementers is crucial. The technology used must also not exceed the capacity and capabilities of the users; technology is not helpful unless users and institutions know what to do with the information it provides. Oftentimes, government officials in Latin America **do not always know what information is available,** nor do they have the capacity to put that information into a practical format in a timely manner.

Just as crucial is the involvement of the target population in the design and testing phases of technology creation. In many cases, communities on the ground are either the first or the only responders in rural or resource-lacking areas, so it is vital to equip these communities with the necessary disaster response resources. Consistent and effective training will reduce the resources needed for disaster response and recovery phases.

Third, digital solutions must be relevant for the context in which they exist. The context of the country in which technology is to be implemented is often overlooked when designing digital solutions. For example, in the Caribbean, officials often struggle with getting relief to multiple islands, an issue that distinguishes it from other countries in the region and necessitates a different approach to disaster relief policies. A tool that might work in other countries could be totally ineffective in the Caribbean context. DRR tools are also often unclear and difficult to implement. Each country and each context requires different solutions, so all digital solutions should address specific needs and be consistent within the humanitarian infrastructure.

Many countries in Latin America and the Caribbean have made great advancements in technology to identify the susceptibility of geographic locations and infrastructure to severe hazards. For example, the use of **drones** in both St. Maarten and Dominica were critical in collecting information after Hurricanes Irma and Maria, respectively, as they were used to show damage to houses and roads. This data was then translated into more efficient deployment of resources and aid. However, this kind of data often does not take into consideration other physical, economic, and social factors (like gender, age, and income level) that can severely limit people's capability to anticipate, cope with, withstand, and recover from the impacts of disasters. Improved detection and warning systems, particularly those that address the additional factors that may cause increased vulnerability in the event

of a disaster, would help inform DRR policies that apply to a greater number of people.

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EXISTING DIGITAL INITIATIVES

Many countries in Latin America and the Caribbean have already begun using innovative technological solutions to inform and train communities on appropriate disaster relief strategies and guidelines. Countries in the Caribbean have been using virtual reality tools to raise disaster awareness and to demonstrate models of how disasters impact businesses, households, emergency routes, shelters, and other aspects of everyday life. Another example is the introduction of a **mobile payment network**, a tool that allows individuals who don't have access to official banking to access financial services. Through this tool, governments can distribute cash during and after disasters that residents can easily access, an especially critical necessity after disasters.

Since 2011, California has used a **geographic information system** (GIS) mapping tool to help create and update local hazard mitigation plans. This mapped data is housed in one location, making it easier to access all relevant information. Japan has also demonstrated success in implementing **digital solutions** to disaster mitigation efforts, most notably by updating policy and legal frameworks and upgrading relevant DRR technology after major disasters. Improving access to **disaster risk finance** has helped Southeast Asian countries receive and use recovery funds in an accelerated manner post-disaster by implementing digital solutions to disaster mitigation strategies.

THE ROLE OF THE INTERNATIONAL COMMUNITY

There are many opportunities for donors and the international community to support countries in Latin America and the Caribbean as they continue to develop disaster mitigation policies and technologies.

Donors must consider the protection of traditional infrastructure, such as electricity and the internet, as they develop and promote technological solutions for DRR. Traditional infrastructure is critical for the use of many digital solutions, and its protection will be the foundation for the effective implementation of any digital strategy. Many DRR solutions rely on the internet to be carried out effectively, like the use of drones to detect damage post-disaster. Other relief opportunities, such as mobile payment networks, also depend on the internet. Additionally, any solutions involving smartphones will require consistent electricity to charge phones. Traditional infrastructure is especially critical for donors such as development agencies to keep in mind when developing digital solutions. Many countries cannot reallocate already limited resources into traditional infrastructure. Donors should look for cost-effective policy solutions that can be easily scaled and should not just rely on expensive infrastructure projects. Again, technology can play a role in identifying these policy solutions and allowing donors to share data and transfer knowledge to countries in the region.

It is also important for donors to note that different populations will have different levels of access to technology, limiting some access to DRR policies and relief. Though **66 percent** of the population of Latin America and the Caribbean uses the internet, there are **significant gaps** in internet access; while 71 percent of urban residents have connectivity options, only 37 percent of rural residents do. Effective DRR strategies should address these gaps and ensure that disaster resources and relief can be accessed accordingly.

The Asia-Pacific region is one of the most disaster-prone regions in the world, and thus countries in the area have vast experience in disaster mitigation efforts. For example, with support from the Asian Development Bank, the region developed a **comprehensive historical hazard catalog and historical loss database for major disasters**, streamlining the information-sharing process and allowing other countries in the Pacific to compare DRR strategies post-disaster. This database also translated to a more comprehensive disaster-related insurance scheme.

As Latin America and the Caribbean develop their own DRR measures, they should consider the many initiatives implemented by Asia-Pacific countries and tailor them to their own country and regional needs.

A systemic response to disasters is key to establishing faster and more efficient response mechanisms and procedures. Having legislative frameworks that identify each organization's role in disaster prevention, response, and relief will significantly help streamline DRR procedures when disaster strikes. It will also identify existing gaps in DRR responses and offer the opportunity to fill those gaps before there is an emergency. Some multilateral organizations, like the Inter-American Development Bank, are **already working with countries in the Latin American and Caribbean region** to design and implement a systemic disaster response, which provides support before, during, and after an emergency. Meanwhile, initiatives like the Sendai Framework provide a roadmap for countries to build DRR institutions and infrastructure. A systemic response will also help curb the ideological shifts that accompany changes in government and leadership as they respond to disasters. Lastly, a systemic response will allow leaders to focus on their other policy priorities, knowing that in the event of a disaster, mitigation and relief strategies are already in place. ■

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