IMPROVISATION

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Residents walk across a flooded street in Kampung Melayu, Jakarta, Indonesia, in January 2014.

Library shelves are filled with stories about disasters and how to cope and enhance the chance of survival in the face of a wide range of so-called natural hazards. Such hazards include but are not limited to earthquakes, tsunamis, floods, droughts, tornadoes, lightning strikes, forest fires, and even vector-borne diseases. Each natural hazard has societal aspects that abet or mitigate its socioeconomic consequences. The lead times from hazard warning to disaster response to one of these events vary considerably from minutes, hours, or days to weeks and even months, depending on the type of hazard and on a society's preparedness. There are numerous stories in books, articles, videos, and newsprint about how potential victims in life-threatening situations manage to survive hydrometeorological (hydromet) disasters. Those disparate, isolated stories about improvised, on-the-spot survival tactics from around the globe merit serious attention today

in the Time of Disaster

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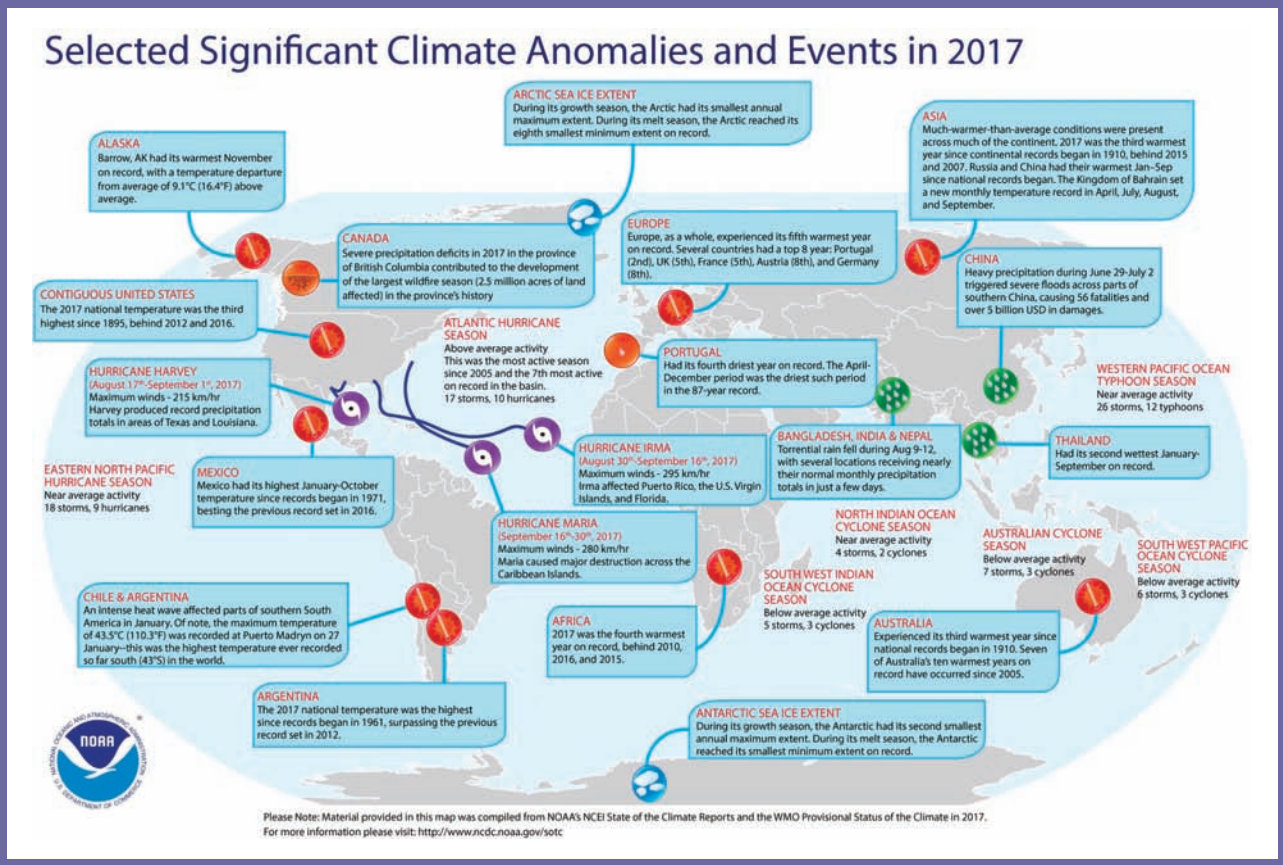
because of a warming global climate. Collectively, they can provide society with lessons about coping with extreme hydromet events.

Numerous authoritative governmental, intergovernmental, and nongovernmental scientific reports have been warning about the possible consequences of global climate change especially since the 1950s and how its effects would likely ripple through regional, national, and local climates and societies.[1] An Intergovernmental Panel on Climate Change (IPCC) scientific report entitled "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation" (referred to as the SREX Report) warned that a warmer global climate would likely cause a serious increase in the number, frequency, intensity, locations, and spatial extent of extremely anomalous hydromet events.[2]

In 2017, several climate- water- and weather-related disasters reminded us of the urgent need for resources and research on the enhancement of relevant hydromet information including

Figure 1. Global map of climate anomalies associated with disasters.



Source: https://www.ncdc.noaa.gov/sotc/global/201713.

early warnings to known at risk communities (see Figure 1 for a global map of 2017 climate anomalies and related disasters). Most recently, these include, among others, a "Season of Superstorms" in the United States and its territories (the Virgin Islands and Puerto Rico), Central America, and the Caribbean,[3] a surprising El Niño event (Niño Costero) off the northwest coast of South America,[4] deadly floods across southern Africa,[5] and wildfires in California.[6] In the United States alone, economic losses due to weather and climate disasters were estimated to exceed US$300 billion and to cause 362 fatalities.[7] Truly, no country is immune to the impacts of hydromet hazards and disasters, regardless of its level of economic development or level of preparedness. Surprises are to be expected.

Given the already heightened international concern about climate change and its gradually increasing adverse impacts on regional climate, water, and weather thus far in this century, hydromet-related disaster survival tactics need to be viewed as more important now than ever before. In addition to climate-related increases in the number of identifiable trans-border and in-country refugees, there is a growing worry among governments and humanitarian organizations about their continued capability to help the increasing number of environment-related refugees worldwide who are in dire need of immediate assistance during hydromet crises. The burden is falling on national governments worldwide to better prepare their citizens for responding to and recovering from such threatening situations. The burden of providing assistance, however, continues to be transferred downscale to communities, families, and individuals. They are in large measure increasingly being expected, if not explicitly encouraged, to fend for themselves. This message is slowly seeping through to the general public through such popular "how to" magazines as *Popular Mechanics*. As an example, a recent issue was devoted to natural disasters, alerting its million-plus readers that "The number of natural disasters has steadily increased since the 1940s, and quadrupled since 1980" and offering a few ideas on "How to Survive a Natural Disaster."[8] A few years earlier *National Geographic* had published an "Extreme Weather Survival Guide" containing survival tactics for numerous natural geological, hydrological, and meteorological life- and property-threatening hazards.[9]

Media coverage of recent disasters in developing, emerging, or industrialized countries often highlights stories of specific survivors of disasters who had to tactically improvise for survival, until the officially labeled first responders arrived to provide their emergency services. News accounts, based on observations and interviews as well as video footage, are sure to contain usable lessons that could inform decision makers in at-risk communities and disaster risk reduction (DRR) planners in the public health and socioeconomic sectors about possible responses to future quick-onset hydromet hazards; to be of use, however, such isolated stories, past and present, must be collected, archived, catalogued, and shared with other communities at risk of hydromet hazards. This can be carried out through a lessons-learned, Web-based portal, such as the one suggested by the DRR Expert Forum in Antalya, Turkey, 2015.[10]

Who Are the People in Harm's Way?

While many people are directly or indirectly affected by hydromet disasters, this article focuses on those who live in a potential hydromet disaster zone. When a disaster strikes, most often they are referred to as victims. However, various terms are used besides victim: people at risk, survivors, surviving victims, frontline responders, and frontliners, among others. Each of these terms is subject to its own specific interpretation and can evoke different mental images of the kind of appropriate assistance that might be warranted. The current Federal Emergency Management Agency (FEMA) Administrator Brock Long recently referred to survivors of Hurricane Harvey (Houston, Texas) in late 2017 in a new way, calling them the "true first responders."[11] A few years earlier, previous FEMA Administrator Craig Fugate said in an interview that "When you step back and look at most disasters, you talk about first responders—lights and sirens— …. the first responders are

Humacao, Puerto Rico—December 16, 2017: A woman volunteer with Habitat for Humanity assists a man waiting in line at the Humacao Arena to receive a shelter repair kit more than three months after Hurricane Maria struck. Approximately 900 people attended two distributions, half in the morning and the other half in the afternoon.

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the neighbors. Bystanders. People that are willing to act."[12]

We refer to the "true first responders" collectively as zero-order responders (ZORs). We define ZORs as the subset of surviving victims who are on the proverbial front lines in combatting the unfolding consequences of a quick-onset climate- water- or weather-related disaster. Forced by nature, administrative policies, or "happenstance," they rely on their untested ability to improvise for survival and for the protection of life and property. In a hydromet crisis that threatens life, safety, and security, they take on personal responsibility, during the chaos that accompanies an ongoing hydromet disaster, for the well-being of self, family, neighbors, and if possible the affected community. Zero-order responders take on a survival mentality.

ZORs, as individual actors, are thrust into harm's way, and most do not have preset guidelines on how to respond. Many victims living in a disaster zone likely have not faced such threatening situations before. If they live in areas at high risk to extreme events, they may have been forced to do so a few times earlier in their lifetimes. Thus, before the onset of a hydromet disaster, we do not really know in advance which citizens in a given community will prove to be zero-order responders. Some individuals in society are known to be risk averse in general and stay that way in a crisis situation, waiting for outside help, while others become proactive risk takers when lives and/or properties are threatened.

It is important to note at the outset that the aim here is not to confer professional standing on ZORs, but rather to highlight ZORs, collectively, with status so that we can acknowledge their potential contribution to disaster risk prevention and response and recovery understanding. The lessons they offer for coping with quick-onset hydromet hazards and disasters can inform emergency managers and researchers as they seek to improve societal safety through their more informed policy-making process.

This article is meant to be tactical in that it introduces the notion of ZORs and highlights victims in disasters as the "true first responders." There is, however, a more comprehensive story to be told surrounding ZORs in a disaster's "gap in time." Once it can be shown there is value to looking at victims-as-ZORs on the frontline during a hydromet disaster, the stage will be set for in-depth research on broader issues and controversies raised, such as how the knowledge gained from ZORs can be integrated into experts' knowledge on disaster prevention and disaster response.

Official First Responders and ZORs

Putting ZORs aside for the moment, the critical indicator of a country's general level of preparedness to respond effectively to disasters is its officially designated first responder community. This encompasses emergency services drawn from formal structures of government, civil defense agencies, and even officially designated nongovernmental volunteer organizations. It also includes police, firefighters, search-and-rescue teams, the National Guard, medical service providers, and humanitarian organizations such as the Red Cross and the Red Crescent societies.

When a climate- water- or weather-related hazard becomes a disaster, these are the first responders either living within or coming from outside a disaster zone to aid survivors. In fact, official first responders living in the disaster zone are also victims, putting their efforts to help others before helping themselves. They search for survivors still in harm's way, provide basic water, food, medical, and shelter needs, repair damaged critical infrastructure such as shelters, roads, bridges, and power grids, and even engage in livestock and pet rescue. All the while, they are uncertain about their own families and homes. The arrival times of official first responders to a disaster zone, however, can vary from minutes to hours to weeks, depending on the type and severity of the hazard, the ease of access to the disaster zone, and the effective level of coordination among political and administrative jurisdictions.

According to Burton et al., responses to environmental threats depend on how individuals "recognize and describe a hazard," "consider how they might deal with it," and "choose among the actions that seem to them available."[13] In reality, as violent shocks of such crises unfold, some survivors may choose to wait for outside assistance, while others decide to be proactive and improvise. ZORs respond during the critical "gap in time," which is the time period between when a hazard morphs into a disaster until the time before a critical mass of outsider first responders arrive on the scene to help.

ZORs improvise in the face of quick-onset hydromet threats. Their improvisations are increasingly important, because of science-based projections that the global climate will continue to warm throughout the rest of this century, regardless of societal activities to arrest it. Hydromet hazards that have a likelihood of causing societal, ecological, and environmental harm include seasonal hazards such as severe storms, hurricanes, and monsoons and even less known disruptive societal hazard instigators such as El Niño, La Niña, and the Indian Ocean Dipole.[14]

In fact, ZORs can be groups or whole communities as well as individuals. Some people are more likely than others to be true first responders, perhaps based on the preexisting social vulnerabilities and community contexts. For example, the United Nations (UN) and many nongovernmental organizations (NGOs) argue that women (e.g., mothers and caregivers) are indeed the real first responders, but often they are not recognized as agents of change during a disaster or humanitarian crisis.[15] During a UN panel entitled "Women as First Responders: Featuring Testimonies and a Visual Gallery Elevating Women's Voices in Humanitarian Action," several stories exemplified how women as ZORs took to action to

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Utuado, Puerto Rico—December 14, 2017: More than three months after Hurricane Maria struck, two women collect water in cat litter buckets from a pipe bringing untreated water from the mountainside just outside town. Essential services remain at a fraction of their pre-storm capacities throughout the island, with Utuado being among the hardest hit, still without municipal water.

salvage food and water and help the displaced during Cyclone Winston in Fiji, and how women in Liberia responding to the rampant Ebola epidemic created a rapid door-to-door education campaign for children because schools were closed for several months as a public health control measure.[16]

Optimally, communities are aware of hydromet risks and foreseeable impacts in their region. We have to assume that people generally know if the area they live in is prone to flooding, severe storms, or other hydromet hazards. Minor departures from average conditions are expected and are considered to fall in the range of normal. Communities adjust to them with little apparent need for special assistance. When departures from expectations are extreme, however, problems arise for communities.[17]

Decision makers have a responsibility, in theory at least, to listen to their publics and to treat their concerns as reliable input for community-level hydromet disaster-coping consideration. For their part, scientists, including the all-important forecasters, have an emerging responsibility that goes beyond their focused scientific research interests to make clear to nonscientists the value and use of their research efforts to monitor and, if necessary, correct any misinterpretations of media headlines and reports. In real life, however, communication between scientists and the public has been less than adequate for a very long time. At the turn of the 20th century, for example, H. G. Wells wrote, "Many of those scientific people understand the meaning of their own papers quite well. It is simply a defect of expression that raises the obstacle between us."[18]

Communication to the public, including ZORs, is also challenged by the perception of a climate-related hazard and "awareness of opportunities." Burton et al. wrote, "Perception and definition of the threat may differ markedly from the estimates of professionals and experts."[19]

ZORs' knowledge and experiences can be easily supplemented and adjusted by reliable and credible scientific knowledge that is expressed in ways for laypeople to understand. People-based

scientific communication is a necessary task of forecasters, if communities are to be able to adapt to hydromet changes that are expected to become more frequent and more intense than anticipated.[20]

Who Is Expected To Do What in a Disaster Situation?

"Improvisation is a significant feature of every disaster … [It] has had something of a checkered history in the emergency management field since its appearance in a disaster response seems to suggest a failure to plan for a particular contingency. Even scholars who have recognized the value of this capacity have tended to subordinate it to planning."[21] As a disaster unfolds around them, "victims" in a disaster zone react in different ways and at different times. The ZORs among those victims feel compelled to improvise without hesitation.

Improvisation, however, exposes an ongoing conflict between the officially acknowledged first responders and the ZORs as "true first responders." An official administrative view that responding to emergencies is first and foremost the responsibility of the official emergency response agencies and specialists was recently made explicit during a severe flooding episode in Quebec. A Canadian newspaper, the *Montreal Gazette*, reporting on the city's May 2017 floods, headlined an article as follows: "Quebec floods: Please, no 'personal initiatives,' 'improvisation' on flood relief, [Montreal Mayor] Coderre says." The article then reported that the mayor "is asking residents in the city's flood-stricken area to maintain their patience and keep up their morale … But we are asking people not to take any personal initiatives. When a state of emergency has been declared, [the city] is there to secure things, to help people and to protect them from themselves … No personal initiatives, no improvisation, there's work being done."[22]

In an interview with former FEMA Administrator Craig Fugate, Graham noted, "Within the emergency response community, however, [Fugate] is well known for his philosophy of 'whole community response' which seeks to decentralize disaster management from the federal government and involve the private sector, volunteers and private citizens. Before [Fugate] started talking about the whole community, there really was this view that there's emergency responders, and there's the rest of us, and ne'er the twain shall meet."[23] Nevertheless, that hierarchical separation between them was also reflected and therefore reinforced in a FEMA document on National Voluntary Organizations Active in Disasters (NVOD):

> *FEMA is advising people who want to help survivors affected by Hurricanes Irma and Harvey to do so through affiliation with the voluntary organizations that are active in the ongoing disaster operations. Those interested in volunteering are requested to do so through organized volunteer organizations and not to self-deploy to affected regions.*[24]

The separation of official first responders and official nongovernmental disaster response groups from ZORs seeking to improvise on their own before help arrives is not just an academic discussion. For example, more than a decade ago, Kendra and Wachtendorf observed an interesting management paradox: "Improvisation occupies a somewhat conflicted space in the realm of emergency and crisis management capacities: we plan in detail so that we don't have to improvise, knowing that we will have to improvise."[25] Fugate, commenting on the FEMA failure during Hurricane Katrina, noted, "The systematic problem was we planned for what we were capable of responding to, not what could happen."[26]

Another example of note involves a fictitious hurricane named Pam. In the summer of 2004 a hypothetical category 3 hurricane scenario called Hurricane Pam, making landfall along the U.S. Gulf Coast, was discussed in depth as a test run to identify hypothetical responses

Katy, Texas—September 3, 2017: Austin Pets Alive volunteers check a rescued dog's vitals in the wake of Hurricane Harvey. Rescued animals were taken in from many areas along the Texas coast and brought to this checkpoint. From there they were either put on a possible ownership hold, transferred to Austin, or transferred to another 'no kill' shelter in the United States.

by many U.S. government agencies from local to federal. This scenario was discussed over the course of several days. Thirteen months later Hurricane Katrina made landfall in late August 2005, centered on New Orleans.[27] In retrospect, history shows that many societal and individual responses to Hurricane Katrina forecasts and to its impacts had to be improvised. In large measure that was because of a crucially long "gap in time" when various government agencies failed to respond in a coordinated, effective, and timely way. For example, during Hurricane Katrina, there was a delay in the official response of up to 5 days, which was clearly not the case for their perfect (hypothetical) response in their Hurricane Pam exercise. The Pam scenario provides an example of the limits to emergency management planning. "Since real conditions are likely to differ, adjustment to plans will always be necessary."[28]

There is likely to be an expectable "gap in time" where plans do not matter and improvisation and innovation efforts take over, a gap in which individuals, groups, and communities no longer wait as hapless victims for outside help. Fugate suggested that emergency responders "Quit referring to people as victims and call them survivors … as long as you use the vocabulary like 'victims,' you are going to treat the public like a liability [as opposed to a resource] and you have to take care of them."[29] In that gap exist potential lessons to be learned about successful as well as not-so-successful improvised and innovative responses.

ZORs are apparently what one study referred to as a "second line rescue" in a book about Hurricane Katrina survivor responses.[30] Second line rescues are "vernacular responses" and "creolized solutions" by ordinary people, who "instinctively react in extraordinary ways to solve problems," usually because the first line of rescue failed (that is, the official first responders).[31] Those responses may include emerging coping mechanisms for an imminent hazard, as the disaster unfolds (for example, with rising waters), or rebuilding efforts following the disaster, which the *Washington Post* Editorial Board labeled *self-recovery*. Hydromet-related hazard planners should actively seek, explicitly identify, and incorporate feedback from those proactive survivors who improvise on the disaster frontline.[32]

Actions taken in desperation by at-risk people are responses to actual near-term threats, using whatever items they can find at hand, as has been the case most recently with the U.S. government's poor response to the devastation caused by Hurricane Maria in Puerto Rico and the Virgin Islands.[33] ZORs are forced to do so, because the assistance of first responders has been delayed or was inadequate or minimally useful given the high-level destruction of basic infrastructure. The humanitarian crisis in Puerto Rico, though off the front pages of newspapers, sadly continues to be an ongoing crisis even a year later.[34]

Improvisation Lessons by ZORs

Case studies support the value of learning from ZORs about human ingenuity in the face of hydromet disasters. Many stories emerge. While some have been compiled, others remain scattered, isolated, and forgotten. This is understandable. Take Atlantic hurricanes that can adversely impact several countries in addition to the United States. With an average of seven hurricanes making landfall in a given Atlantic hurricane season, there are sure to be several stories of people taking action to survive. Natural and social conditions force them to improvise successful responses, becoming disaster superheroes. For example, look at one zero-order responder, Kurt Barnes, during the onset of the forgotten Hurricane Floyd in 1999.[35]

With water rising rapidly around his home, Barnes noted in an interview that

> *I really didn't know what the circumstances were for other people around there, other than I knew that water was going to be in a lot of people's houses. So I sat there a few minutes, and I looked over there at my Jeep [on a hill in the distance], and I said "Lord, if you'll just let me get over to that Jeep then I know I can help that boy." … I put my face in the water and swam as hard as I could. … Things were floating by me—trash cans, big doghouses—the wind was howling, [electric] wires were popping all around us. I was so tired when I got to that Jeep. I could not leave. But started thinking about my neighbor, and I said "I've got to go down there and get that guy."*[36]

He then got to his boat that set him on his improvised journey to save a neighbor. However, with each subsequent rescue, people knew of others stranded in their flooding homes in truly life-threatening situations. He continued his unplanned odyssey that led him to rescue whomever he could in random searches of flooded homes.

Barnes received an award for his rescue efforts. He commented on the award: "It was something that I really didn't expect. I mean I'm proud of it, but I think I did what anybody else would have done. It was scary, though. It was lucky that we got them out. I was just at the right place at the right time, and luckily things just worked out."[37]

In Houston, Texas, where more than 1,200 millimeters of rainfall fell within 5 days in late August 2017, some ZORs responded during Hurricane Harvey by forming human chains to rescue their neighbors, including a pregnant woman, and to save pets from drowning.[38] Following Hurricane Maria, during which an estimated 520 millimeters of rainfall caused flash floods in Puerto Rico, residents in San Juan improvised when the energy system collapsed: Survivors—lacking previous experience—made bonfires out of fallen trees and turned kitchen sinks into baths.[39] They also exploited various sources of water, including untreated water from the mountainside. Inspired by such events, Massachusetts Mutual Life Insurance collected and incorporated cases of true first responders during Hurricane Harvey in its print and electronic ads, such as the video "The Unsung:

Getty Images

Improvised raft in front of the roadside at the Don Mueng Airport, Bangkok Province, Thailand, in November 2011.

Strangers rush to help strangers in the wake of Hurricane Harvey."[40] The insurance company's social message was clear: "Hurricane Harvey hit and devastating, dangerous flood waters rose … but so did people's support for one another. And the strength that came from that support helped many weather the storm."

In the Indian city of Chennai, communities lived through catastrophic floods in November and December of 2015, when two low-pressure systems moved through the region, dumping 550 millimeters of rain in a week.[41] This flood episode surprised the residents in the middle of the night. Overtaken by this emerging hydromet calamity, the population had been forced to improvise. According to one report, residents "went about organising [sic] their own rescue. They took whatever junk material they could lay hands on … They stuffed big polythene bags with discarded foam and empty plastic bottles and created their own floats. For people to sit on them, they appropriately placed planks underneath the polythene bags."[42] In 2011 Thailand experienced one of its worst flooding episodes in more than 50 years. Extreme monsoon rains coupled with the "remnants" of several tropical storms along with high tides and urban vulnerability contributed to significant disaster loss, affecting an estimated 8.2 million people.[43] Many people struggled, including the elderly, to make it out of harm's way or traveled in deep waters to provide food for their families. Thai images posted on social media illustrated creative ways that people coped with those flood waters, for example, raised tuktuks and bicycles, rescue boats made of strung-together plastic water bottles, or pipes and wood, and shopping carts holding up makeshift bridges.[44]

We are almost two decades into the 21st century, during which there has been a growing number of impressive costly hydromet disasters. One can only wonder whether today's governments are preparing for foreseeable, climate change-related impacts over the next eight decades of this century.

ZORs and Ordinary Knowledge

Lessons generated by ZORs in the wake of hydromet disasters can support awareness-raising opportunities. They are "teachable moments" derived from the tactical use of *ordinary knowledge* that can educate governments, communities, and individuals about ways to mitigate if not prevent losses from climate-related disasters.[45] Lindblom and Cohen defined ordinary knowledge as "knowledge that does not owe its origin, testing, degree of

verification, truth, status, or currency to distinctive … professional techniques, but rather to common sense, casual empiricism, or thoughtful speculation and analysis."[46] Warfield highlighted the value of such knowledge, and captured the conflict between ordinary and expert knowledge, in a review of Lindblom and Cohen's book entitled *Usable Knowledge, Social Science and Social Problem Solving*:

> *It appears that it is commonplace to try to solve problems using only scientific methods and knowledge, to ignore or fail to legitimize important modes of problem solving, to avoid interaction in the belief that it is necessarily competitive with analysis, and to preclude normative research because incorporation of values work against authoritativeness. Problem solving is confused with problem understanding. It is argued that it is often possible to substitute action for thought, understanding and analysis, and that social learning should be given serious exploration and consideration as a means of problem solving. Often interaction can lead to problem solution or resolution even without full understanding of the problem. The inventory of problem solving modes should be enlarged and legitimized, to face up to the fact that ordinary knowledge is often more important than scientific knowledge in problem solving.*[47]

There are various kinds of ordinary knowledge, such as "traditional," "indigenous," or "local," that have been widely discussed in environmental, disasters, and climate change-related studies.[48] In the context of ZORs, ordinary knowledge in the present study refers to a type of vernacular knowledge, which is unplanned and hands-on, that emerges in response to a quick-onset event. It can also be described as a learning associated with what one might call "street knowledge," which we suspect ZORs possess and draw upon in a time of crisis. Corburn described street knowledge or rather street science as "contextual intelligence" that is both a practice and process that local residents and communities engage in.[49] Although his use of the concept was applied to urban environmental hazards (e.g., air and water pollution), the author's study offers some useful insights for understanding and conceptualizing ZORs' knowledge, including the importance of improvisation and creativity (for environmental problem solving) and place-based knowledge (i.e., local perspective). Furthermore, it demonstrates how ordinary knowledge

Bangkok, Thailand—November 5, 2011: A woman with food supplies making her way through a heavily flooded area of Arun Amarin, Bangkok. Unusual heavy rains in July 2011 combined with high tides of the sea triggered massive flooding in Thailand. Approximately one third of all provinces were affected.

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contributes significantly to environmental decision making and broader goals of environmental and social justice by valuing the experience of those most directly affected by hazards, particularly disadvantaged communities.[50]

Can Improvisation Lessons Be Captured, Collected, and Shared?

The need to educate governments, communities, groups, and individuals about the importance and value of proaction in the "gap of time," as well as of disaster risk reduction, has become urgent for many of reasons, not the least of which are the apparent increases in the number and intensity of extreme hydromet events. Furthermore, local budgets are so constrained that effective timely assistance to all those in need of emergency help is not possible. Even international humanitarian organizations' budgets have been stretched to their limits with demands, including survivor demands for basic necessities of water, food, shelter, sanitation, and clothing, for help that outstrips by far their available resources.

Some governments have actually told their at-risk populations that help from the government would not be forthcoming: for example, Zimbabwe, about an imminent drought.[51] Following Super Hurricane Maria that devastated Puerto Rico, the U.S. government informed its people that support for the survivors would not be able to match their needs (see the tweet from President Trump in Figure 2).[52] There are also instances when a government chose not to issue early warnings about foreseeable adverse climate extremes associated with the 1997–1998 El Niño. It was hoping that foreseeable adverse anomalies would not occur or if they were to occur they might be weak, despite having received timely, science-based warnings from its national meteorological service, as in Costa Rica.[53]

Successful improvisations by disaster victims are distinct capacities[54] that

Bangkok, Thailand—November 3, 2011: Two men helping an elderly woman to get through a heavily flooded area of Arun Amarin, Bangkok.

could be useful for the management of hydromet emergencies and could in turn lead to community innovation for future disaster prevention and community resilience. Improvisation techniques learned from ZORs and others about coping measures in dealing with flood, flash flood, severe storms, and other extreme climate water and weather events can be shared with and taught to at-risk communities on how to better enhance their resilience capabilities. In any given community, various individuals will likely resort to improvising or innovating in a time of crisis. The effectiveness of responses could be enhanced by an increase in awareness about the benefits of preparedness and readiness. Disaster-related improvisational skills can be taught.

"Innovation (often) comes from constraint. If you've got very few resources, you're forced to be very creative in using and reusing them."[55] This is the so-called MacGyver effect, named after the fictitious character of a popular American TV show of the 1980s. "If you're MacGyver, the famous American television spy from the late '80s, you'd do something dramatic like whip up a defibrillator using two candlesticks and an electrical cord, fight off snakes with nothing but kerosene or use chocolate to stop a sulfuric acid leak."[56]

Leaders can devise approaches to educate at-risk populations about near-term changes in hydromet hazards that are likely to occur as a result of global warming. This is particularly important as new knowledge, including lessons from ZORs, is identified, learned, and shared based on current and past experiences. Repeated educational practices serve to remind communities of the need to stay vigilant. Lessons identified and learned by ZORs must be gathered, evaluated, saved, catalogued, and openly shared. Communities known to be at risk can identify individuals or groups to act as volunteer "scribes" to record such survival acts of the ZORs for later evaluation, archiving, and sharing.[57]

Figure 2. Tweet from President Trump in reference to Puerto Rico and first responders on October 12, 2017.

A Portal for Lessons Identified From ZORs

A user-friendly, innovative prototype Web-based, open-access ZORs knowledge portal could be designed to focus specifically on identifying ZORs' responses during the "gap in time" and collecting, verifying, cataloguing, archiving, transferring, and sharing both positive and negative hydromet-related lessons identified. Such lessons can serve as the basis for more efficient and effective future responses by the official first responder organizations.

The portal would be a platform for exposing and sharing information, whether anecdotal stories or experience or concrete data. Knowledge portals also have the potential to connect actors working on similar problems or in similar contexts to each other.[58]

A potential weakness of a ZORs lessons portal is that it can only gather knowledge that has already been captured by someone and written down. Many unexpressed potential solutions to common hydromet disaster problems (as well as lessons, best practices, and experiences) are likely to be stored in practitioners' heads but never explicitly written or shared on paper. This underscores the importance of fostering dialogue between practitioners in order to ensure that tacit knowledge relevant to learning from lessons is transmitted to experts in addition to the details that make it into their formal reports. Not to search for and make explicit such lessons of ZORs would be a loss of practical knowledge. Thus, a ZORs knowledge portal is a specific approach to knowledge management and sharing.

Can People Be Taught To Improvise?

At the community level, an "improvisatory," in essence, is a laboratory-like place where disaster-related improvisation could be taught and practiced. It could also serve as a repository for ZORs stories that have been collected, catalogued, and shared based on the recorded observations of "scribes" and on personal interviews and memories. An improvisatory serves as a participatory training space where collaboration among community members, scientists, and emergency and other disaster practitioners can be practiced. Here, people can act out innovative, disaster-related scenarios. It can also be movable, carried out using electronic media, social networks, and "roving improvisatory workshops" that travel from community to community with local trainers that could spark interest in a community to develop its own self-designed grass-roots disaster risk reduction measures. In sum, an improvisatory promotes the sharing of ordinary and community-based knowledge about local hydromet hazards for disaster-related decision making.

Concluding Thoughts

Identifying how various at-risk people in a disaster zone might be labeled may seem like a hairsplitting exercise, but in reality it is much more than that. Introducing the notion of zero-order responders is an attempt to reframe the

notion of disaster "victims" as "agents of survival." It improves awareness as well as understanding of actions taken by "victims" in the face of life-threatening hydromet hazards. While the official first responders have well-defined roles and responsibilities, as do various bureaucracies and administrative and political jurisdictions, potential victims have no playbook, usually responding on their own initiative. Their responses depend on their own perceptions of the immediate dangers to life and property that they face and on the expectation they have about when first responders might arrive. They may be on their own during the "gap in time" between disaster onset and impact, which means they must choose to improvise in their situation with survival techniques in order to make it through the disaster.

The survival lessons of zero-order responders can be used by first responder organizations to complement their expert knowledge in preparation for future hydromet crises. The proposed three next steps can be used to encourage pro-action by civil society at the community level.

1. A call to identify lessons about ZORs for the purpose of collecting, cataloguing, and sharing them with other at-risk communities and with first responder organizations and various administrative and political agencies.
2. A call to develop with the assistance of first responder organizations a "lessons learned" Web-based portal to share the lessons identified and learned by individuals in life- and property-threatening situations.
3. A call to consider the benefits of developing, again with the assistance of first responder organizations, an "improvisitory" (defined here as a community-level lab-like space to generate on a continual basis; once is not enough) hazard awareness center, to educate people about zero-order coping tactics through the proposed ZORs portal, and to train on a continual voluntary basis those in the community who choose to be better prepared to act on their own in the face of a hydromet disaster. As observed earlier: "Improvisation occupies a somewhat conflicted space in the realm of emergency and crisis management capacities: we plan in detail so that we don't have to improvise, knowing that we will have to improvise."[59]

While the authors were searching for photos of true first responders in action, it became clear that many of their actions taken were often not captured by the media, still photos, or video. As a result, the images of improvised actions taken under life-threatening conditions are relatively few. In retrospect, those snapshots at a moment in time of ordinary people seeking refuge by whatever means possible are of life-saving improvised tactics. As for the official first responders, they usually enter a disaster zone accompanied by media and communications personnel, after the "gap in time" has passed. Official photos often focus on physical destruction and on successful recovery processes (e.g., refugee centers) after the hydromet disaster has peaked or passed. Their images greatly outnumber those of ZORs. Society must find ways to capture ZORs' lessons for future use, the stories of frontliners who managed to survive by through improvisation and innovation.

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NOTES

1. R. Revelle, and H. E. Suess, "Carbon Dioxide Exchange Between Atmosphere and Ocean and the Question of an Increase of Atmospheric CO_2 During the Past Decades," *Tellus* 9, no. 1 (1957): 18–27; SCEP (Study of Critical Environmental Problems), *Man's Impact on the Global Environment. Assessment and Recommendation for Action* (Cambridge, MA: MIT Press, 1970); SMIC, *Inadvertent Climate Modification: Report of the Study of Man's Impact on Climate* (Cambridge, MA: MIT Press, 1971), https://libpatent.com/ptab/docket/432358/PGR2016-00012/MatthewsStudyofMansImpacton ClimateSMICReport (accessed 16 March 2018); IPCC, "Summary for Policymakers," in O. Edenhofer et al., eds., *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge, UK: Cambridge University Press, 2014).

2. C. B. Field et al., eds., IPCC, *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX). A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change* (Cambridge, UK: Cambridge University Press, 2012), 582.

3. G. Thorne, "The 2017 Hurricanes Didn't Just Hit Puerto Rico—They Hit the Caribbean," *The Nation*, 16 October 2017, https://www.thenation.com/article/the-2017-hurricanes-didnt-just-hit-puerto-rico-they-hit-the-caribbean (accessed 10 November 2017).

4. I. J. Ramírez, and F. Briones, "Understanding the El Niño Costero of 2017: The Definition Problem and Challenges of Climate Forecasting and Disaster Responses," *International Journal of Disaster Risk Science* 8, no 4 (2017): 489–92, doi:10.1007/s13753-017-0151-8, https://DOI.org/10.1007/s13753-017-0151-8.

5. ReliefWeb, *Southern Africa: Floods—Jan 2017*, https://reliefweb.int/disaster/fl-2017-000012-moz (accessed 1 December 2017).

6. J. Medina, L. Stack, and J. E. Bromwich, "Tens of Thousands Evacuate as Southern California Fires Spread," *New York Times*, 5 December 2017, https://www.nytimes.com/2017/12/05/us/california-fire.html (accessed 6 December 2017).

7. NOAA, *Billion-Dollar Weather and Climate Disasters: Overview*, https://www.ncdc.noaa.gov/billions (accessed 13 March 2018).

8. Popular Mechanics Staff, "How to Survive the Next Disaster," *Popular Mechanics*, March 2018.

9. T. M. Kostigen, *Extreme Weather Survival Guide: Understand, Prepare, Survive, Recover* (Washington, DC: National Geographic Society, 2014).

10. DRR Expert Forum: The Antalya Statement, Statement Before the Expert Forum on Disaster Risk Reduction in a Changing Climate: Lessons Learned About Lessons Learned, convened by U.S. Agency for International Development, Consortium for Capacity Building, World Meteorological Organization, Turkish State Meteorological Service, National Oceanic and Atmospheric Administration, Global Facility for Disaster Reduction and Recovery (Antalya, Turkey, 2015), http://www.ccb-boulder.org/drr-expert-forum-2015-antalya-statement (accessed 6 June 2018).

11. W. B. Long, *The Federal Emergency Management Agency's Supplemental Disaster Recovery Appropriations Request*, Statement Before the House Appropriations Subcommittee on Homeland Security, U.S. House of Representatives (Washington, DC, 2017), https://www.theatlantic.com/national/archive/2015/09/we-are-all-first-responders/402146 (accessed 13 March 2018).

12. D. A. Graham, "Whole-Community Response: How FEMA Director Craig Fugate Wants to Reshape Disaster Management," *The Atlantic,* 3 September 2015, 4/9.

13. I. Burton, R. F. Kates, and G. White, *The Environment as Hazard*, 2nd edition (New York, NY: Guildford Press, 1993), 19.

14. An increasing number of studies are now focusing on the Indian Ocean Dipole pattern and its regional effects on wildfires, drought and even infectious disease outbreaks. See W. Cai, X.-T. Zheng, E. Weller, M. Collins, T. Cowan, M. Lengaigne, W. Yu, and T. Yamagat, "Projected Response of the Indian Ocean Dipole to Greenhouse Warming," *Nature Geoscience* 6 (2013): 999–1007, doi:10.1038/ngeo2009; and M. Hashizume, A. S. G. Faruque, T. Terao, Md. Yunus, K. Streatfield, T. Yamamoto, and K. Moji, "The Indian Ocean Dipole and Cholera Incidence in Bangladesh: A Time-Series Analysis," *Environmental Health Perspectives* 119, no. 2 (2011): 239–44, doi: 10.1289/ehp.1002302 (accessed 16 March 2018).

15. A. Periyasamy, *Women as First Responders*, Global Citizens Press, http://www.globalcitizenspress.com/africa/women-as-first-responders (10 March 2018); ReleifWeb, *She Is a Humanitarian: Women's Participation in Humanitarian Action Drawing on Global Trends and Evidence From Jordan and the Philippines*, https://reliefweb.int/report/world/she-humanitarian-women-s-participation-humanitarian-action-drawing-global-trends-and (accessed 10 March 2018).

16. See Periyasamy, note 15.

17. M. J. McPhaden, S. E. Zebiak, and M. H. Glantz, "ENSO as an Integrating Concept in Earth Science," *Science* 314, no. 5806 (2006): 1740–45, https://www.pmel.noaa.gov/pubs/outstand/mcph2969/mcph2969.shtml (accessed 16 March 2018).

18. H. G. Wells, *The Food of the Gods and How It Came to Earth* (London, UK: Macmillan, 1904).

19. See Burton et al., note 13, p. 34.

20. V. Gianni, A. Bellucci, and S. Torresan, "Sharing Skills and Needs Between Providers and Users of Climate Information to Create Climate Services: Lessons from the Northern Adriatic Case Study," *Earth Perspectives* 3, no. 1 (2016), doi:10.1186/s40322-016-0033-z, https://link.springer.com/content/pdf/10.1186%2Fs40322-016-0033-z.pdf (accessed 8 March 2018).

21. J. Kendra and T. Wachtendorf, *Improvisation, Creativity, and the Art of Emergency Management*, Preliminary Paper 357, University of Delaware, Disasters Research Center (Newark, DE, 2006), http://udspace.udel.edu/handle/19716/3054 (accessed 10 November 2017), p. 1.

22. P. Cherry, "Quebec Floods: Man Arrested for Sandbags to Spend Another Night in Jail," *Montreal Gazette*, 10 May 2017, http://montrealgazette.com/news/local-news/quebec-floods-please-no-personal-initiatives-improvisation-on-flood-relief-coderre-says (accessed 16 March 2018).

23. See Graham, note 12, p. 2.

24. FEMA, *Volunteers Play Integral Role in Disasters Relief and Recovery Efforts* (September 18, 2017), www.fema.gov/news-release/2017/09/18/volunteers-play-integral-role-disaster-relief-and-recovery-efforts (accessed 10 December 2017), p. 1.

25. Kendra and Wachtendorf, note 21, p. 1.

26. Graham, note 12, pp. 8–9.

27. The Senate Committee on Homeland Security and Governmental Affairs, *Hurricane Katrina: A Nation Still Unprepared—Executive Summary* (May 2006), http://www.nytimes.com/packages/pdf/national/ExecSum.pdf?mcubz=3 (accessed 10 March 2018); M. H. Glantz, "Hurricane Katrina as a 'Teachable Moment,'" *Advances in Geosciences* 14, (2008): 287–94. https://www.adv-geosci.net/14/287/2008/adgeo-14-287-2008.pdf (accessed 1 October 2017).

28. Kendra and Wachtendorf, note 21, p. 1.

29. Graham, note 12, pp. 4–5.

30. B. J. Ancelet, M. Guadet, and C. Lindahl, *Second Line Rescue: Improvised Responses to Katrina and Rita* (Jackson, MS: University Press of Mississippi, 2013), 10.

31. Ancelet et al., note 30, p. 1.

32. Washington Post Editorial Board, "The Government Needs to Get Its Act Together in Puerto Rico," *Washington Post*, 24 October 2017, https://www.washingtonpost.com/opinions/the-government-needs-to-get-its-act-together-in-puerto-rico/2017/10/24/a52c2e1e-b8db-11e7-a908-a3470754bbb9_story.html?utm_term=.31f4b6371276 (accessed 29 November 2017).

33. Washington Post Editorial Board, note 32; A. Dietrich, A. Garriga-López, and A. Luthra, *An Ongoing Disaster: Hurricane Maria's Potential Effects on Public Health*, Research Counts, Natural Hazards Center (Boulder, CO, 2017), https://hazards.colorado.edu/news/research-counts/an-ongoing-disaster-hurricane-maria-s-potential-effects-on-public-health (accessed 30 November 2017); R. Jervis, "5 Months Without Power': Blackout Is Latest Snag in Puerto Rico's Long Recovery From Hurricane Maria," *USA Today*, 12 February 2018, https://www.usatoday.com/story/news/2018/02/12/power-outage-puerto-rico-latest-snag-islands-long-recovery-hurricane-maria/329322002 (accessed 13 February 2018).

34. S. Fink, "Puerto Rico's Hurricane Maria Death Toll Could Exceed 4,000, New Study Estimates," *New York Times*, 29 March 2018, https://www.nytimes.com/2018/05/29/us/puerto-rico-deaths-hurricane.html (accessed 5 June 2018).

35. R. Moore and J. Barnes, *Faces from the Flood: Hurricane Floyd Remembered* (Chapel Hill, NC: University of North Carolina Press, 2004), 27–35; B.J. Ancelet et al., note 30, p. 10.

36. Moore and Barnes, note 35, p. 30.

37. Moore and Barnes, note 35, p. 35.

38. M. Bowerman, "Human Chains Are Among Viral Stories Inspiring Us Out of Hurricane Harvey," *USA Today*, 30 August 2017, https://www.usatoday.com/story/news/nation-now/2017/08/30/human-chains-among-viral-stories-inspiring-us-out-hurricane-harvey/615479001 (accessed 1 October 2017); E. S. Blake and D. A. Zelinsky, *Tropical Cyclone Report Hurricane Harvey (AL092017)*, National Hurricane Center, https://www.nhc.noaa.gov/data/tcr/AL092017_Harvey.pdf (accessed 5 June 2018).

39. C. Dickerson and L. Ferre-Sadurni, "'Like Going Back in Time': Puerto Ricans Put Survivor Skills to Use," *New York Times*, 24 October 2017, https://www.nytimes.com/2017/10/24/us/hurricane-maria-puerto-rico-coping.html (accessed 28 November 2017).

40. MassMutual, *The Unsung: Strangers Rush to Help Strangers in the Wake of Hurricane Harvey*, https://www.massmutual.com/planning/videos/unsung-hurricane-harvey (accessed 16 March 2018).

41. NASA, NASA Measures India's Deadly Flooding Rains, 17 November 2015, https://www.nasa.gov/feature/goddard/97b-north-indian-ocean (accessed 16 March 2018); P. P. Mujumdar, B. Narasimhan, S. M. Bhallamudi, A. Mondal, and S. Ghosh, *Chennai Floods: A Rapid Assessment*, Interdisciplinary Center for Water Research, Indian Institute of Science (Bangalore, India, 2016), http://www.igcs-chennai.org/chennai-floods-rapid-assessment-report (accessed 1 March 2018).

42. "Innovation in the Times of Flooding," *The Hindu*, 4 December 2017, http://www.thehindu.com/news/cities/chennai/innovation-in-the-times-of-flooding/article7943017.ece (accessed 3 March 2018).

43. E. L. Gale and M. A. Saunders, "The 2011 Thailand Flood: Climate Causes and Return Periods," *Weather* 68, no. 9 (2013): 233–37, doi:10.1002/wea.2133; UN News, *As Flood Disaster Worsens in Thailand, UN Steps Up Relief Efforts*, Global Perspective Human Stories, 28 October 2011, https://news.un.org/en/story/2011/10/393362-flood-disaster-worsens-thailand-un-steps-relief-efforts (accessed 2 February 2018); A. Taylor, "Worst Flooding in Decades Swamps Thailand," *The Atlantic*, 12 October 2011, https://www.theatlantic.com/photo/2011/10/worst-flooding-in-decades-swamps-thailand/100168/ (accessed 12 December 2017).

44. S. Daniels, "Thai Hackers Adapt Vehicles and Buildings to the Flood," *The Atlantic*, 14 November 2011, https://www.theatlantic.com/technology/archive/2011/11/thai-hackers-adapt-vehicles-and-buildings-to-the-flood/248467/#slide6 (accessed 10 February 2018).

45. M. H. Glantz, note 27.

46. C. E. Lindblom, and D. K. Cohen, *Usable Knowledge: Social Science and Social Problem Solving* (New Haven, CT: Yale University Press, 1979), 12.

47. J. N. Warfield, "A Review of Lindblom and Cohen's *Usable Knowledge: Social Science and Social Problem Solving*," *IEEE Transactions on Systems, Man, and Cybernetics*, SMC-10, no. 5 (1980): 281.

48. F. Fischer, *Citizens, Experts, and the Environment: The Politics of Local Knowledge* (Durham, NC: Duke University Press, 2000); J. Mercer, I. Kelman, S. Suchet-Pearson, and K. Lloyd, "Integrating Indigenous and Scientific Knowledge Bases for Disaster Risk Reduction in Papua New Guinea," *Geografiska Annale: Series B, Human Geography* 91, no. 2, (2009): 157–83; B. Orlove, C. Roncoli, M. Kabugo, and A. Majugu, "Indigenous Climate Knowledge in Southern Uganda: The Multiple Components of a Dynamic Regional System," *Climatic Change*, no. 100 (2010): 243.

49. J. Corburn, *Street Science: Community Knowledge and Environmental Health Justice* (Cambridge, MA: MIT Press, 2005), 4.

50. Corburn, note 49, p. 216; see also I. J. Ramirez, A. Baptista, J. Lee, A. Traverso-Krejcarek, and A. Santos, "Fighting for Urban Environmental Health Justice in Southside (Los Sures) Williamsburg, Brooklyn: A Community-Engaged Pilot Study," in I. Vojnovic, A. Pearson, A. Gershim, A. Allen, and G. DeVerteuil, eds., *Handbook of Global Urban Health* (New York: Routledge, forthcoming 2019).

51. "No compensation for Farmers," *The Financial Gazette* [Zimbabwe], March 14, 2018.

52. @realDonaldTrump, "… We cannot keep FEMA, the Military & the First Responders, who have been amazing (under the most difficult circumstances) in P.R. forever!," Twitter, 12 October 2017, 7:07 a.m., https://twitter.com/realdonaldtrump/status/918432809282342912?lang=en (accessed 16 March 2018).

53. M. H. Glantz, P. Ramirez-Obando, G. A. Zapata-Velasco, I. J. Ramirez, and F. K. Karanja, "Peru, Kenya and Costa Rica: An El Niño Tale of Three Countries," unpublished manuscript based on the 16-country study of the 1997–98 El Nino in M. H. Glantz, ed., *Once Burned, Twice Shy? Lessons Learned From the 1997–98 El Niño* (Tokyo, Japan: United Nations University Press, 2001).

54. Kendra and Wachtendorf, note 21.

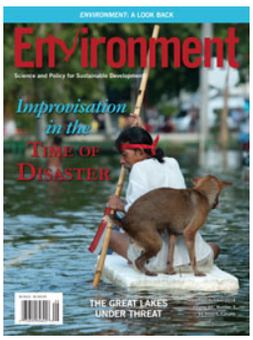
55. E. Zuckerman, "Innovating From Constraint in the Developing World," *Harvard Business Review*, 23 January 2009, https://hbr.org/2009/01/innovating-from-constraint-in (accessed 28 November 2017).

56. D. Ronca and C. Warren, *Top 10 Everyday Items You Can Repurpose in a Survival Scenario,* https://adventure.howstuffworks.com/5-everyday-survival-items.htm (accessed on 16 March 2018).

57. M. H. Glantz and M.-A. Baudoin, *Working with a Changing Climate, Not Against It: Hydro-Meteorological Disaster Risk Reduction; A Survey of Lessons Learned for Resilient Adaptation to a Changing Climate* (Boulder, CO: Consortium for Capacity Building, 2014), http://www.ccb-boulder.org/wp-content/uploads/2012/11/Lex_Sum_03-17a-14_150p.pdf (accessed 30 December 2017), pp. 110–11.

58. A. Hejazi, "Empowering Role of Enterprise Information Portals in Knowledge Management," *International Journal for Infonomics*, no. 1 (January, 2005), 56–64.

59. Kendra and Wachtendorf, note 21, p. 1.



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