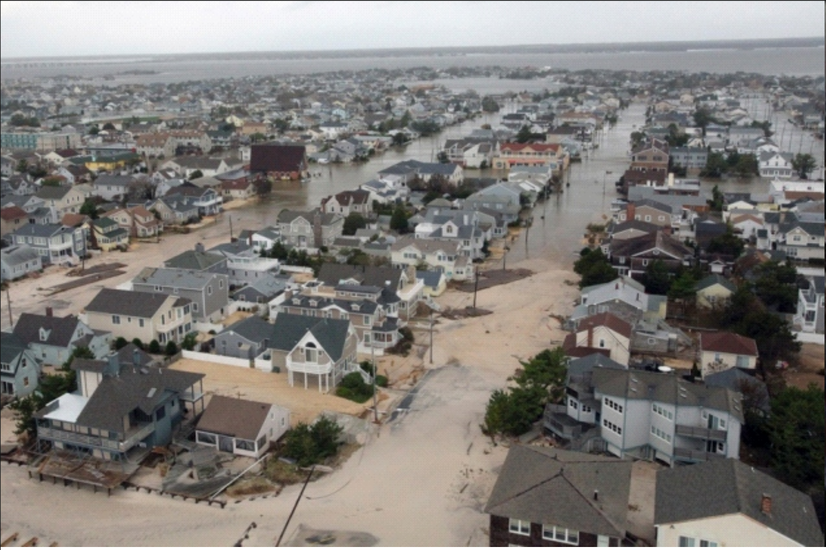
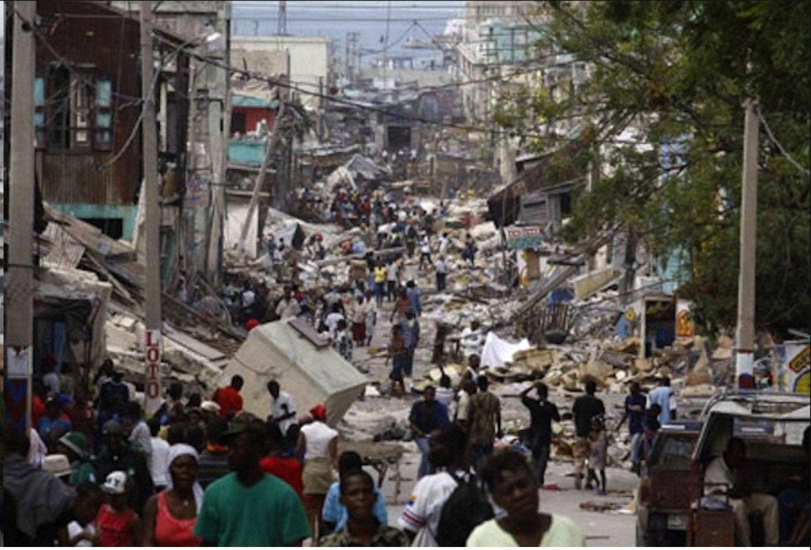

DISASTER RISKS RESEARCH AND ASSESSMENT

TO PROMOTE RISK REDUCTION AND MANAGEMENT

Summary for Policymakers

Disaster Risks Research and Assessment to Promote Risk Reduction and Management

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ICSU-ISSC AD-HOC GROUP ON DISASTER RISK ASSESSMENT

Summary for Policymakers

Disasters related to natural events continue to grow in number, intensity, and impact. In many regions, natural hazards are becoming direct threats to national security because their impacts are amplified by rapid growth and unsustainable development practices, both of which increase exposure and vulnerabilities of communities and capital assets. Reducing disaster risk then becomes a foundation for sustainable development.

Science-driven approaches to disaster risk reduction (DRR) and disaster risk management (DRM) can help communities and governments become more resilient and reduce the human and economic impacts of disasters. Science plays a significant role in all stages of disaster risk and its management often providing rapid scientific assessment of and usable knowledge to decision-makers (e.g., Ghafory-Ashtiani and Hosseini 2008; Machlis and McNutt 2010; Kumar et al. 2014). Scientists can do more to co-produce and deliver scientific knowledge on disasters and disaster risks for policy makers and society by providing robust, evidence-based frameworks and a variety of knowledge products (e.g., concepts, tools, technology, data, advices, training) for social policy engagement, development, and implementation.

Growing results related to integrated research on disaster risks should be systematically reviewed through periodic assessments at local, national, regional, and global levels. Following earlier proposals on periodic assessments of disaster risks (Burton 2001; UK Natural Hazards Working Group 2005; ENHANS 2011; UNISDR 2013; ICSU 2014),

> *we call for significant improvements of existing assessment processes by scientific advice on disaster risks to support and catalyze disaster policy development and management across governments. Comprehensive periodic assessments of disaster risks at local to global levels should be undertaken by a high-level, trans-disciplinary body of experts appointed by national governments together with international and inter-governmental scientific organizations dealing with disaster risks.*

Through a participatory process of working with civil society and relevant stakeholders, this international body will produce a clear and unambiguous scientific view on the current state of knowledge in disaster risk, the potential socio-economic impacts of natural hazards, and the ways to reduce (if not prevent) significant human and economic losses. The development of assessment process will facilitate the inclusion of cultural and cross-cultural perspectives. It will also produce the robust unambiguous evidence of economic, operational, and strategic benefits of using scientific knowledge and information, to address hazard prevention, mitigation, and response actions. Potential disasters triggered by natural hazard events will be evaluated in the light of the political, economical, social, and cultural barriers to suggest the ways for applications and implementations of remedies.

The United Nations Office for Disaster Risk Reduction (UNISDR) produces Global Assessment Reports on Disaster Risk Reduction (GARs) providing global overviews and more thematically-based assessments of disaster risk (e.g., UNISDR 2013), but not an explicit assessment of the state of scientific knowledge. We believe that the proposed body would strengthen existing UN structures by periodic assessment of disaster risks and could enhance the scientific input (e.g., peer-reviewed science) into the existing assessment process to elevate its impact (e.g., Tokyo Statement and Action Agenda 2015).

We presently lack a comprehensive assessment of disaster risk, so we can only briefly summarize here the current understanding of disaster risk research, practice, and experience. In doing so, we provide the initial evidentiary basis for anticipated future impacts of disasters from the perspective of integrated disaster research – the engagement of multiple disciplines and researchers, scales (local to global), methodological approaches, and stakeholders in the co-production of problem-focused, policy relevant research related to disaster risk. Assuming that a natural hazard event happened, exposure and vulnerability are the key determinants of disaster risk and the main drivers of disaster loss. The dynamic variability in exposure and vulnerability is well documented in the research literature (e.g., Wisner et al. 2004) as is the understanding of differences – geographically between and within regions but also among sectors and social groups (e.g., Birkmann 2014). However, despite this, few countries have developed multi-hazard impact data bases to support research and policy formation.

Hazards: Origins, Monitoring, and Experiences

Geological and hydro-meteorological hazards account for most disaster events. Much is known about the physical processes and forcing mechanisms of geohazards including the role of anthropogenic activities (Gupta 2011; Bobrowsky 2013; Alcántara-Ayala 2014). In some places, extreme events are occurring more frequently causing an increase in floods, landslides, debris flows, and storm surges. For example, in Jeddah, Saudi Arabia, precipitation averages a few cm a year, but in November 2009 heavy rains (in total, about 9 cm for four hours) produced severe flash flooding. Extra-large super cyclones such as Typhoon Haiyan in 2013 are increasing due to continuous energy supply from the warmer sea sub-surface temperature (Pun et al., 2013). Prolonged or decadal droughts are appearing more frequently as well, often related to El Niño cycles (van Dijk et al. 2013). Heat waves and cold waves are increasing in many regions (e.g. Europe, India, and China).

Extreme solar storms pose a threat to all forms of high technology (e.g. communication, information, power systems) and could have globally catastrophic effects (Baker et al. 2014). Although relatively rare when compared to other hazards, near-Earth asteroids and comets have potentially catastrophic impacts (Valsecchi and Milani Comparetti 2007). Communicable disease outbreaks (cholera and measles) including hemorrhagic fevers (such as Marburg and Ebola) are recurrent biological disaster risks, especially in Africa. The trans-boundary character of Africa's epidemic risk profile along with greater climate variability, advancing urban population growth, increased mobility, increased social vulnerability, and greater regional and global connectivity severely degrades the region's DRM capacity, which requires strengthening (Holloway et al. 2013; Tall et al. 2013).

An accurate prediction of earthquakes (space, time, and the magnitude) is not yet possible; however it is possible to estimate the potential vulnerability of locales to earthquake hazards (Ismail-Zadeh 2014). Earthquake scenarios have been found to be effective tools for preparedness, response, and mitigation. Also earthquake early warning alert systems have shown success, especially in Japan with its rapid detection of earthquakes (Allen 2011) and timely warnings of severe shaking (Okada et al. 2004). The prediction of volcanic eruptions is advanced due to continuous instrumentation and observations around the world's volcanoes (Sparks 2003), but still is not sufficiently precise. Although tsunami warning systems are well advanced and operational in many regions of the world, there is still a long way to accurate warning in terms of locations, run-up heights, false alarms, etc. Also tsunami modeling still needs improvement.

Landslide monitoring has been promoted through regional and global cooperative initiatives (Sassa 2009). Systems for detection and monitoring are already in place for near-Earth asteroids and comets with improved capabilities underway (Farnocchia et al. 2012).

Our knowledge of extreme weather forecasting and real-time public warnings have significantly improved due to the existing high level of scientific and technological capability coupled to effective communication and response capabilities, which substantially reduces losses in most countries. For effective operations of early warning systems, there is a need for the technical information to be properly communicated to all who need it and for recipients to be prepared for, and able to take appropriate responses (Basher 2006). For example, the increased accuracy of forecasting cyclonic storm tracks and timing in the Atlantic, Pacific, and Indian Ocean basins has led to more timely evacuations from coastal areas, thus saving lives. Similarly, the Famine Early Warning System monitors weather patterns, rainfall estimates, water availability, and agro-climatological data to anticipate drought and food insecurity risks, especially in Africa. Research on the weather-climate nexus has also advanced our understanding of the global oceanic forcing of drought and flood conditions across continents. Public health surveillance systems and disease outbreak detection have been revolutionized with the use of the Internet and social media such as Twitter, providing real or near-real time health surveillance (Brownstein et al. 2009; Chunara et al. 2013). Despite the great success in understanding of the physical processes behind natural hazards, there are still many challenges related to hazards science, and particularly, in the reduction of uncertainties in forecasting of hazard events, local resolution of models, and prediction lead time, among others.

Human Consequences

Despite advances in hazard monitoring, losses continue to escalate and the impacts are becoming more burdensome as national and global economic growth has slowed, constraining nations in their abilities to shoulder the losses without external assistance. Increasingly, it does not take an extreme event to cause extreme impacts and damages, especially with geographically large trans-boundary events such as heat waves (the Russian heat wave in 2010; Europe in 2003), flooding (Europe 2013; West Africa 2010; Thailand's Chao Phraya 2011), or tropical cyclones. Similarly, the cascading impacts of locally-generated disasters assuming global significance because of disruptions of supply chains (e.g. the Great East Japan earthquake or the Bangkok flooding) or airline traffic (the 2010 Eyjafjallajökull volcanic eruption) highlight the interconnectedness of global society, even when considering that all disasters have local origins.

Understanding the dynamic interaction of hazard exposure and vulnerability is critical. Improvements in the science of vulnerability assessments have been made, but there is no consistent (or preferred) methodology for conducting them, making comparisons difficult between places, or from local to global scales. Latin America and the Caribbean have been leaders in the development of holistic, multi-sectoral approaches to DRM (Carreño et al. 2007), but even these have not been fully deployed throughout the region, and their application to complex, cascading risks such as drought remain limited. Hazard and disaster risk data are lacking in many regions, and this is especially true for measurements of vulnerability and exposure. Good quality demographic data is particularly difficult to obtain in many regions. While there are a few national and/or sub-national disaster loss and damage databases, they are not comparable at present. The role of the IRDR DATA project in reconciling hazard peril definitions across databases is a positive step in utilizing science in support of DRM policy and practice (IRDR 2014). Community-based and other social learning approaches for monitoring and assessing resilience are equally important.

Recovery after disasters is emerging as a major theme in integrated research on disaster risks. Improvements in the conceptualization of recovery – psychological, social, business, infrastructure – and the role of resilience (enhancing and building community capacity pre-and post-event) is examined in a number of places, e.g. New Zealand and Australia (Miller and Rivera 2011; Paton and McClure 2013). Understanding how people interpret risks and choose actions based on their interpretations is vital to any strategy for disaster reduction (Eiser et al. 2013). Affected communities have both resilient and vulnerable groups, and it is the interaction of these two that provides the relative balance of strengths and vulnerabilities which govern the timing and nature of social recovery. Business continuity planning provides the foundation for business and livelihood survival in disaster-affected regions. Quality and types of infrastructure and access to essential services (food, water, sanitation, shelter, and power) often differentiate the length of the recovery period which can be further set back by the occurrence of other events before full recovery.

Managing Future Disaster Risk

Many nations face challenges in assessing, understanding, and responding to the time-dependent nature of disaster risk, and this is where integrated disaster risk research plays a critical role. Changes in the intensity of occurrences of events coupled with changes in vulnerability and exposure will alter the impacts of natural hazards on society in mostly negative ways. Projections of future geological hazards are possible, on the one hand, but extremely difficult (e.g., Keilis-Borok et al. 2001). On the other hand, it is possible to develop projections of future hydro-meteorological events based on climate modeling but these are also of varying reliability depending on models employed and spatial and temporal scales used in the forecast. The macro and micro-scale social processes producing vulnerability (unsustainable development, increasing urbanization, social inequalities, and wealth/livelihood disparities) are accelerating and in many world regions amplify the impacts of natural hazards. Managing current disaster risk is the key for addressing future risk (Lavell and Maskrey 2013) and building disaster resilience. To what extent can analysis and control of hazards reduce disasters?

In Africa, disaster risk conditions may be exacerbated by the interactions between climate variability including temperature and rainfall, and the persistent conditions of vulnerability which combine to heighten disaster risk. Food and food security, aggravated health vulnerabilities caused by lack of sanitation, and access to safe water coupled with disease epidemics create a complex risk profile for the continent (Boyd et al. 2013; Niang et al. 2014). Asia's economic prosperity and rising inequality (UN-Habitat 2013) is increasing its vulnerability due to inadequate access to housing and services (water, energy, transport, sanitation) especially in the megacities in the region. In poorer parts of the region, droughts, flooding, food insecurity, and internal political conflicts are displacing people from their homes and livelihood bases, compromising the economic gains. Current investments in DRR are not on par with the increasing physical and social vulnerability of the region (World Bank 2012).

Extreme events are likely to have their greatest effect on infrastructure and some climate-dependent sectors such as agriculture and water resources. One of the main drivers for likely increased losses is exposure (other drivers include power relations and politics meaning that vulnerability is not reduced) – more assets at risk, especially those in coastal and riverine environments, and wild land-urban areas (e.g., Australia, Portugal, Spain). From an adaptation standpoint, many social and economic systems employ buffers to respond to slow onset hazards (e.g. storage, water transfers, purchase of grain) but lack response capabilities as drought intensifies and buffers are depleted (Pulwarty and Verdin 2013). Seismic risks remain in the Americas, in southern Europe, in many earthquake-prone regions of Asia and the Pacific, and in New Zealand. The implementation of modern seismic building codes will significantly reduce earthquake losses. In North America, it is the built infrastructure that is most susceptible to future damage from natural hazard events, although the cascading effects of such events can cause significant societal disruptions in transportation, commerce, power and water supplies, and other critical technologies. For example, an extreme space weather event can severely disrupt the bulk power system on a continental scale. The effects of disruptions are disproportionate as they concern people with higher and lesser means; this is true in poor countries as well as in poorer places of richer countries. Intensification of land resources due to population growth, increasing development of human settlements in high risk areas, and urbanization in Latin America highlight the need to link territorial planning to DRM in the region. For Latin America and Africa, the impact of extreme events is more reflective of societal vulnerability that amplifies the potential aftermath and longer term recovery. Within the region, it is the accumulation of smaller and medium scale events (reflecting the exposure and vulnerability) that contribute to loss profile and increasing importance of managing disaster risk. Recognition of the growing risk natural hazards pose to societies has led to a concomitant emphasis in mitigation (reduction) and warning systems and community preparedness (readiness) programs being included in DRR strategies. Facilitating sustained preparedness is essential to reducing risk from event that occur with little or no warning (e.g. earthquakes, locally-generated tsunami) and to ensuring people can act on warnings in timely and appropriate ways. Facilitating preparedness involves not only making sound scientific and practical information and resources available to people but also developing the psychological and social capital and capacity required to interpret and use information and resources in ways that accommodate diverse and unique local needs and expectations. Managing future risk will increasingly require community engagement strategies that increase the capacity of civil agencies and communities to have shared responsibility in DRM.

The Role of Science

Disaster events will continue to grow, if vulnerability is not reduced, and the economic impact will far exceed the cost of mitigation and preparedness by orders of magnitude. Large sums are expended on international emergency assistance after disasters that effectively transfer the risk (and responsibility) from the affected local area to the global community. Such international aid becomes a *de facto* risk transfer mechanism. More timely interventions and sustained multi-year efforts to support DRM including research, management and resilience building can enhance sustainable development efforts (Ismail-Zadeh and Takeuchi 2007; Venton 2012). Greater efforts are needed to communicate science-based disaster risk assessments, socio-economic impacts, evaluations of mechanisms for risk reduction, and prescriptive options for translating scientific findings to practice.

Periodic scientific assessments of disaster risks can contribute to the significant enhancement of knowledge on specific risks at global, regional, national, and local levels. Our proposal is that a baseline assessment should be undertaken by a high-level, trans-disciplinary body of experts appointed by national governments together with international and inter-governmental scientific organizations dealing with disaster risks and also include, where relevant and appropriate, inputs and engagement with various sectors and civil society (ICSU 2014). Although this mechanism could provide the baseline for evaluating the effectiveness of future risk reduction measures, including those proposed under the post-Hyogo Framework for Action and Sustainable Development Goals, the emphasis will be given to local and national efforts in disaster risk assessment, social learning, and civil engagement that involves detailed local information (e.g. on hazards, land cover, infrastructure, human activities, etc.)

Linking DRM to broader sustainable development goals can be achieved through proactive and community based resilience efforts (Cutter 2014). However, this is only possible with the knowledge transfer generated through integrated research on and periodic assessments of disaster risks that are effectively communicated to society and governments.

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