UNISDR
The United Nations Office for Disaster Risk Reduction

GAR
Global Assessment Report
on Disaster Risk Reduction

2015

BACKGROUND PAPER

Prepared for the 2015 Global Assessment Report on Disaster Risk Reduction

CLIMATE CHANGE AND DISASTER RISK REDUCTION

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17 November 2014 (amended March 30, 2015)

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1. Introduction

Efforts to reduce disaster risks and climate change risks have co-existed for a long time, and in the last two decades, they have increasingly been linked. In particular, the relationship between climate change adaptation and disaster risk reduction has received significant attention (Mercer, 2010; Schipper, 2009; Schipper and Pelling, 2006; Thomalla et al., 2006), leading to calls for greater policy connections between the two domains. Not only are there considerable similarities in the types of actions needed to reduce both kinds of risks, but the adaptation community can learn a great deal from the disaster risk reduction (DRR) community. Historically, there has been some frustration within the DRR community about the growing attention and funding being given to adaptation, without the recognition that disaster risk reduction performs several of the same functions (e.g. Helmer and Hilhorst, 2006). On the climate side, as international negotiations have stalled, the growing impact of climate-related disasters has become a major motivator for trying to break the inaction. The relationship between climate change and disaster risk – and between strategies to address them – is thus a very timely and policy-relevant issue.

Despite many overlaps, DRR and adaptation have evolved separately, with distinct differences. For example, DRR focuses on current and near-term risks (as well as remediation after disasters), while adaptation typically takes a longer view. Others have highlighted differences in how each discipline defines risks (e.g. Mercer, 2010; Schipper, 2009). Aiming to address some of these issues amid growing concern about climate-related disasters, the Intergovernmental Panel on Climate Change produced a Special Report*, Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* (IPCC, 2012). The report, widely known as SREX, notes that disaster risk arises from the combination of both climate change and variability, *and* faulty development practices. While it does not propose merging adaptation and disaster risk reduction, it suggests they should work in harmony.

The Hyogo Framework for Action (HFA), which laid out an agenda for 2005–2015 to increase the resilience of nations and communities to disasters (UNISDR, 2005), recognizes climate change and variability as drivers of disaster risk. The HFA aims to support research on climate-related hazards and weather and climate modelling and forecasting as part of its efforts to identify, assess and monitor disaster risks and enhance early warning. It also aims to reduce underlying risk factors relating to climate change and variability and to promote the integration of risk reduction associated with existing climate variability and future climate change into strategies for the reduction of disaster risk and adaptation to climate change (Priority for Action 4).

UNISDR's 2013 Global Assessment Report (UNISDR, 2013a) highlights the need for countries to embrace a more forward-looking and proactive approach to better anticipate future risks. A synthesis report on related consultations for a post-2015 DRR framework (HFA2) describes resilience as "a common outcome that integrates poverty reduction, disaster risk reduction, sustainable livelihoods and climate change adaptation, as integral to sustainable development" (UNISDR, 2013b, p.4). The report further states that "HFA2 should reflect an enhanced understanding of risk as informed by the evidence and findings from the Global Assessment Reports and the IPCC SREX Report" (p.5) and needs to integrate climate change issues more fully. Suggestions put forward during the consultations include the integration of adaptation into national DRR frameworks, the integration of DRR into adaptation strategies, the development of joint action plans, and national "resilience strategies" that integrate climate risk and development concerns (p.10).

The role of climate change itself – the range of potential futures depending on how much greenhouse gas concentrations are allowed to rise – is a less-explored dimension of the links between climate change and DRR. Yet this dimension is critical for understanding how climate-related disaster risks may evolve and how DRR (and adaptation) will have to evolve to address them – both important themes in the IPCC's *Fifth Assessment Report* (IPCC, 2013b; 2014e). The IPCC is highly confident that the overall risk of climate change can be reduced by limiting the rate and magnitude of greenhouse gas emissions (IPCC 2014b). Climate change mitigation policy is likely to play a crucial role not only in terms of curbing greenhouse gas emissions, but also, potentially, by introducing new risks or shaping policy issues related to risk. For example, producing biofuels to replace petroleum products may increase competition for limited land and water resources (Harvey and Pilgrim 2011; Ajanovic 2011).

This paper aims to advance the dialogue between the climate and DRR communities by investigating differences, overlaps and potential synergies between the two realms. The objective is to better understand the relationship between how efforts to reduce climate and disaster risks and the potential for integration. Insights from our analysis may be useful in developing new policy frameworks to manage risks from climate change and variability, in particular the successor to the HFA. We do not argue for merging adaptation and disaster risk reduction into a single domain of action. This is neither realistic, given many practical constraints, nor desirable, since they continue to serve distinct purposes (Schipper, 2009) and must therefore be allowed their own policy and practice spaces to operate. Instead, this paper aims to identify ways for climate and disaster risk reduction to work better together, and for future policy action to promote successful coordination. The paper is based on a literature review and additional information from input papers (Bachofen et al. 2014; Bamforth et al. 2014; Cheong 2014; Giupponi et al. 2014; da Costa and Pospieszna et al. 2014; van der Geest et al. 2014; Miyan 2014; Myeong 2014; Neira 2014; Pathak and Halani 2014; Rahimi 2014; Suarez et al. 2014; Tall et al. 2013; Verma 2014)

Underlying our analysis is a risk-based approach to the management of climate variability and change, which can help to bridge the divided between adaptation and disaster risk reduction. Jones and Preston (2011) find that a risk-based approach "stands as the most appropriate overarching framework for assessing climate change adaptation" (p.305). A risk management approach is useful for considering how climate change mitigation policies might affect the impact of disasters on people. Risk analysis is increasingly seen as crucial for the assessment and management of climate impacts at the global scale (IPCC, 2012; PROVIA, 2013). Risk management approaches may also inform discussions about the mandate and practices of the newly established Warsaw International Mechanism for Loss and Damage under the UN Framework Convention on Climate Change (UNFCCC).

Figure 1 illustrates the core concepts of the SREX report (IPCC, 2012) and its framing of the relationship between climate change adaptation and disaster risk reduction. Exposure and vulnerability to weather and climate events, combined with the impacts of the events themselves, are understood as the key factor in disaster risk. Thus, reducing this exposure and vulnerability is a core goal of both DRR and adaptation. Importantly, both adaptation and DRR have to be understood in the context of wider social and economic development. Development can exacerbate disaster risks, both in the long run – by increasing greenhouse gas emissions that drive climate change – and in the near term, by creating or worsening hazards (e.g. in coastal areas where natural storm-surge protection is removed in favour of beachfront property development). At the same time, development is a key factor in reducing vulnerability (e.g. by improving basic infrastructure, or increasing literacy so people can read evacuation instructions). Disaster impacts can also interfere with development pathways and outcomes.

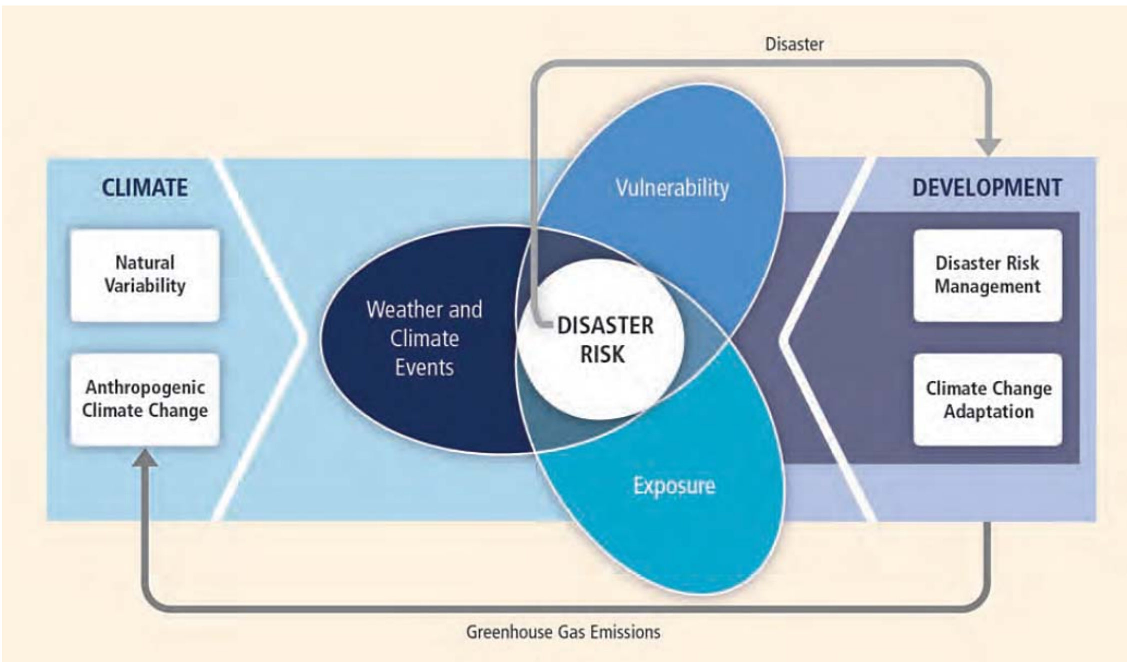


Figure 1: A framework for understanding disaster risk, adaptation and development. Source: IPCC (2012, p.4).

In the section that follows we briefly describe the relationship between disasters, climate change and development. In Section 3 we examine the role of climate change as a driver of disaster risks. Section 4 looks at climate change mitigation as a way to reduce disaster risks. In Section 5 we explore the relationship between DRR and adaptation, and in Section 6 we discuss possible entry points for bringing them closer together. Section 7 presents conclusions and recommendations for how a successor to the HFA can address adaptation and DRR in an integrative manner.

2. Disasters, climate change and development

Discussions on the post-2015 agenda for DRR (HFA+) are happening at the same time as the time-frame for the Millennium Development Goals (MDGs) is coming to an end and the new Sustainable Development Goals (SDGs) are being formulated. A new comprehensive UNFCCC agreement on international climate change action is also meant to be approved in 2015. Hence, the year 2015 presents a unique opportunity to better integrate these three new international frameworks to guide policy and action on disasters, climate change and development more effectively and coherently.

Several observers have highlighted the need to link DRR more strongly with climate change mitigation and adaptation and sustainable development (Schipper and Pelling, 2006; Tanner, 2014), and that need is increasingly acknowledged. In that context, the effectiveness of current approaches to DRR has been questioned, for several reasons:

1. Despite the growing scientific knowledge on the causes of vulnerability to natural hazards, disaster risk continues to increase dramatically in many parts of the world, arising from a combination of natural hazards, climate change, environmental degradation, rapid and poorly planned urban development in vulnerable locations, and insecure livelihoods.

2. New risks that increase the exposure of people and assets to disasters are arising from existing and emerging economic and social processes, and growing faster than existing risks are being reduced (IPCC, 2012; Lavell and Maskrey, 2014).

3. Climate change is expected to continue to drive disaster risk, with significant increases in the frequency, intensity, spatial extent and duration of extreme events (Cardona et al., 2012).

4. There is a growing recognition that vulnerability and exposure to disaster risk and climate change impacts are driven to a great extent by social, cultural, economic, and political factors, including multi-dimensional inequalities, discrimination and marginalization (IPCC, 2014b). However, the underlying causes of social vulnerability and drivers of risk are not well understood and/or addressed by policy-makers and practitioners (Zou and Thomalla, 2010; Veland et al., 2013; Wang et al., 2012). Assessments of the performance of the HFA found the least amount of progress was made in addressing the underlying risk factors and causes of risk creation (UNISDR, 2011; UNISDR, 2013a). The HFA has had very limited impact on improving governance at the national and sub-national levels to reduce social vulnerability and to empower particularly vulnerable social groups.

5. Important linkages between natural resource management, development, DRR, and climate change mitigation and adaptation exist but are frequently not understood or considered. The importance of the environment and ecosystem-based approaches to DRR is receiving increasing attention (Peduzzi et al., 2010), but investment has been limited to-date.

6. Some scholars (e.g. Lavell and Maskrey, 2014) question the DRR paradigm because efforts continue to focus primarily on emergency management and preparedness, and corrective or compensatory risk management, not on the underlying drivers of risk.

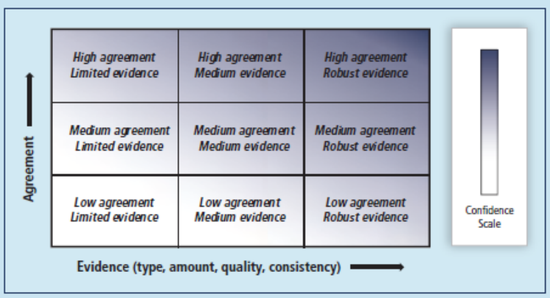
7. The new emphasis on disaster resilience offers some new ways of thinking but is interpreted in a range of different ways, is poorly understood by many policy-makers and practitioners, and has important limitations, particularly without a good understanding of vulnerabilities and risks.

Although development is generally considered a key element to reducing vulnerability to disasters and climate change, not all development will do this; in fact, some development will increase vulnerability. This is because "development" is a broad term that encompasses everything from literacy and health care, to progress, growth, expansion, materialism and westernization. In many cases, these latter aspects are significant drivers of vulnerability (Wisner, 2001). For example, road construction can exacerbate flood risks. When hotels and buildings are erected along coastal zones, they can create new dynamics that may increase the impacts of storm surges or lead to flooding, as well as exposing occupants to greater risk. When dams are built, the change in water volume and flow can affect floods and drought risks downstream. These problems are not inherent to development, but result from a failure to consider current and future disaster risks in the planning process; as a result, investments in hazardous areas may be wasted and/or create new hazards.

A rethink is thus urgently needed to better integrate disasters, climate change and development issues in theory and practice and enable transformational change in how we do "development". Current discussions on the post-2015 agenda for DRR (HFA+) have identified the need for a new framework to prevent the creation of new risks (including those arising from climate change), reduce existing risks, and strengthen resilience (United Nations General Assembly, 2014, Coughlan de Perez et al. 2014).

3. Climate change as a driver of disaster risk

This section is based on recent work by the International Panel on Climate Change, particularly the *Fifth Assessment Report* contributions of Working Groups I and II (IPCC, 2013a; 2014a), SREX (IPCC, 2012), and the Synthesis Report (IPCC, 2014b). These reports constitute the most comprehensive and scientifically established assessments of climate change as a driver of disaster risk presently available. They examine the relationship between climate change and extreme climate- and weather-related events, their causes, their social and economic impacts, their geographic distribution, and strategies to manage the associated risks, and provide extensive guidance relevant to policy-makers. Unless otherwise noted, any statement about observations and projections of climate change and extreme events given here follow the IPCC *Guidance Note on Consistent Treatment of Uncertainties* (Mastrandrea et al., 2010), as shown in Figure 2. As illustrated, the level of certainty in statements about observations and projections of climate and weather extremes and their impact is a function of the confidence in the validity of a finding, which depends on the amount, quality and consistency of data and degree of agreement; likelihood is expressed in terms of probability.



A depiction of evidence and agreement statements and their relationship to confidence. Confidence increases toward the top-right corner as suggested by the increasing strength of shading. Generally, evidence is most robust when there are multiple, consistent independent lines of high-quality evidence.

The following terms indicate the assessed likelihood:

Term*	Likelihood of the Outcome
Virtually certain	99–100% probability
Very likely	90–100% probability
Likely	66–100% probability
About as likely as not	33–66% probability
Unlikely	0–33% probability
Very unlikely	0–10% probability
Exceptionally unlikely	0–1% probability

* Additional terms that were used in limited circumstances in the Fourth Assessment Report (*extremely likely:* 95–100% probability, *more likely than not:* >50–100% probability, and *extremely unlikely:* 0–5% probability) may also be used when appropriate.

Figure 2: Treatment of uncertainty in weather and climate observations and projections. Reproduced from IPCC (2012, p.21).

3.1 Climate and weather extremes

Observations

The *Fifth Assessment Report* finds that warming of the climate system is "unequivocal", and many changes observed since the 1950s "are unprecedented over decades to millennia" (IPCC, 2014b). The global combined land and ocean surface temperature rose by about 0.85°C between 1880 and 2012, and 1983–2012 was very likely the warmest 30-year period in the Northern Hemisphere in 800 years. Global sea level has risen, ice and snow cover has declined, and changes in the global water cycle have been observed. Human influence on the climate system "is clear" and it is "extremely likely" to have been the dominant cause of observed warming since the mid-20th century, the IPCC notes. The IPCC also finds that recent climate changes have had "widespread impacts" on human and natural systems on all continents and across the oceans, indicating these systems' sensitivity to a changing climate.

The IPCC is less confident about some of the evidence on extreme events, however. It finds that it is very likely that globally, the number of cold days and nights has declined and the number of warm days and nights has increased, and it is likely heat waves have become more frequent in large parts of Europe, Asia and Australia (IPCC, 2014b). However, the IPCC expresses only low confidence in observed global trends in droughts, due to a lack of direct observations, geographic inconsistencies, and issues with how drought is defined.

With regard to heavy precipitation events, the IPCC finds it likely that there are more regions where they have increased than where they have decreased, and that both the frequency and intensity of heavy precipitation events has increased in North America and Europe (IPCC, 2014b). Confidence in heavy precipitation trends elsewhere, however, is "at most medium". SREX notes that there are strong regional and seasonal variations in heavy precipitation events, and there is limited statistical evidence to account for changes in long-term trends (IPCC, 2012). There is a low to medium certainty about changes in heavy precipitation in Central and South America, with positive trends in many areas but negative trends in some areas. For Africa, SREX expresses only low to medium confidence in changes in heavy precipitation due to lacking or inconsistent scientific literature.

The IPCC expresses only low confidence that climate change has changed the magnitude or frequency of floods globally (IPCC, 2014b), due to limited evidence and because human activities, such as land use change and infrastructure, also affect flood risks. However, there is medium to high confidence that climate change has changed hydrological components such as precipitation and snowmelt which may impact flood trends (IPCC, 2012). Flood costs have been rising since the 1970s, but this is partly due to increased exposure of people and assets, the IPCC notes (IPCC, 2014b).

The IPCC finds it likely that extreme sea levels (such as during storm surges) have increased since 1970 (IPCC, 2014b), mostly due to a rise in global mean sea level (0.19 metres in 1901–2010). However, the IPCC expresses low confidence that long-term changes in tropical cyclone activity are robust, or in the attribution of global changes to any particular cause. But the IPCC finds it "virtually certain" that intense tropical cyclone activity has increased in the North Atlantic since 1970.

Projections

The IPCC warns that continued emission of greenhouse gases "will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems" (IPCC, 2014b). The risks associated with future climate change are expected increase with rising temperatures.

Figure 3 shows projected changes in global mean temperature relative to the period 1850–1900 for two emission pathways (see Section 4) and the level of additional risk due to climate change. For example, the risks from extreme weather events such as heat waves, extreme precipitation and coastal flooding are expected to be high with even 1°C of additional warming, and they become higher as temperatures rise. The IPCC stresses that the risk of large-scale singular events that cause abrupt and irreversible change – affecting large ecosystems such as coral reefs – becomes high if temperatures rise by more than 3°C. It is also important to note that because of the long time-scale at which climate change occurs, the increase in global average temperature until the year 2040 varies very little between the different emission pathways.

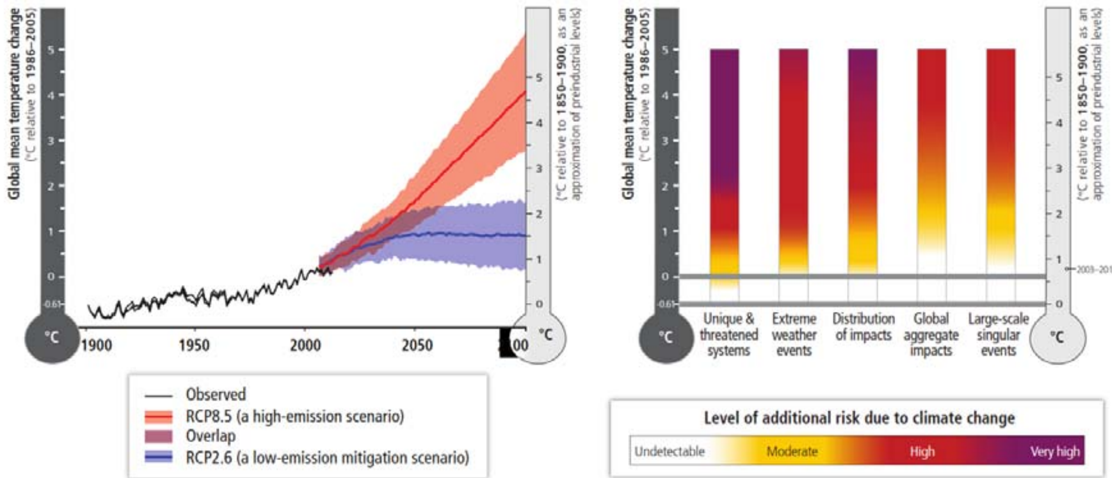


Figure 3: Emission scenarios, projected changes in global mean temperatures and associated risks. Source: IPCC (2013b, p.21).

The IPCC finds it likely that hot days and nights will become warmer and more frequent in the first half of this century, and "virtually certain" that they will be by the late part of the century (IPCC, 2013b). It also finds it very likely that the frequency and duration of warm spells and heat waves will increase in most land areas of the world in the later part of the century.

Extreme precipitation events are likely to become more intense and more frequent over many land areas in the first half of this century, the IPCC finds, and they are very likely to increase over most mid-latitude land masses and over wet tropical regions by the end of the century (IPCC, 2013b). Depending on the emission pathway used in projections, the IPCC finds that a 1-in-20-years annual maximum 24-hour precipitation rate could become a 1-in-15-years or 1-in-5-years event in many regions by the end of the 21st century. There is also medium confidence that heavy precipitation will increase in some regions even as total precipitation decreases (IPCC, 2012). Changes in precipitation in general will not be uniform across the globe, with decreases in some areas and increases in others (IPCC, 2013b).

The IPCC expresses medium confidence that the intensity and/or duration of droughts is likely to increase on a regional to global scale in the second half of the century (IPCC, 2013b). These changes are likely to affect, in particular, regions that are already dry, such as southern Africa, Central America, Mexico and North America, northeast Brazil, the Mediterranean region and Southern Europe (IPCC, 2012).

There is generally a low confidence in projections of future changes in fluvial floods, although changes in precipitation and temperature suggest changes (IPCC, 2012). It is very likely, however, that climate change will cause spring peak floods in snowmelt- and glacier-fed rivers to occur earlier. There is also medium confidence that changes in heavy precipitation can contribute to an increase in local flooding.

It is considered very likely that coastal system and low-lying areas will increasingly experience adverse impacts such as submergence, coastal flooding, and coastal erosion as a result of sea-level rise in the coming century (IPCC, 2014b). The IPCC also expects with a high level of confidence that exposure to risk associated with sea level rise will increase, as a result of population growth, urbanization and economic development. In this context, the IPCC also highlights that many risks of climate change are concentrated in urban areas, which are threatened by coastal surges, flooding, and heavy precipitation, and may also suffer from water scarcity and heat stress.

In addition, IPCC finds it very likely that precipitation extremes related to monsoons will increase in South America, Africa, Asia and Australia. It also finds it likely that the areas covered monsoon systems will become larger, and monsoon seasons will become longer in many regions (IPCC, 2013b). It is also deemed likely that the global frequency tropical cyclones will either decrease or remain essentially unchanged, concurrent with a likely increase in both global mean tropical cyclone maximum wind speed and precipitation rates. Current scientific knowledge does not suggest considerable changes in extra-tropical cyclones.

3.2 Social and economic impacts

In line with the existing literature on disaster risk reduction, the IPCC defines impacts of natural disasters as a product of a community's or society's vulnerability and exposure to a certain climate and weather extreme (IPCC, 2012). Economic impact of natural disasters are framed in terms of "*costs* and *losses* of economic losses and or stocks, as well as consequential indirect effects on economic flows, such as on GDP" (IPCC, 2012, p.264). Observations and projections of the costs associated with climate- and weather-related disasters have a number of limitations. The IPCC also highlights that most estimates of past and future losses from disasters account only for economic losses, omitting many non-monetary losses in human lives, cultural heritage and ecosystem services (IPCC, 2012). Informal or undocumented losses, as well as losses from indirect impacts are also usually not included in both observations of past and projections of future losses from climate and weather related extremes. An additional problem is uncertainty surrounding the attribution of impact from past and future disasters to changes in the global climate.

Observations

SREX states with high confidence that economic losses from climate- and weather-related extreme events have increased since the second half of the 20th century, noting large regional and inter-annual variability. While total economic losses from natural disasters are highest in developed countries, fatality rates and economic losses in terms of GDP are higher in developing countries. SREX also highlights that 95% of fatalities caused by natural disasters occurred in the developing world, and that deaths have been reduced considerably since the middle of the 20th century.

Research has estimated the average annual damages from climatological, hydrological and meteorological disasters in 2002–2011 at US$103 billion, US$24 billion and US$52 billion, respectively (Guha-Sapir et al., 2013). This research has also shown that 47.9% of damages occurred in Asia, 38.6% in the Americas, 9% in Europe, 3.7% in Oceania and less than 0.8% in Africa. According to SREX, there is high agreement about the geographic distribution of losses from natural disasters among different databases. It also notes that comparatively lower losses from natural disasters in Africa can be at least partly be explained by reporting bias.

SREX also summarizes that there is medium evidence and high agreement that long-term trends in normalized economic losses cannot be attributed to anthropogenic climate change. Instead, there is high confidence that exposure of people and economic assets account for long-term increases in economic losses form climate- and weather related disasters, but a role of climate change has not been excluded. There is also a high confidence that settlement patterns, urbanization, and change in socioeconomic conditions have all contributed to the observed trends in impacts from climate- and weather-related disasters.

Notably, the *Fifth Assessment Report* finds, with very high confidence, that the impacts of climate-related extreme events such as heat waves, droughts, floods, cyclones, and wildfires "reveal significant vulnerability and exposure of some ecosystems and many human systems to current climate variability" (IPCC, 2014e, p.6). In countries at all levels of development, the IPCC notes, these impacts, which include deaths and illness, disruption of food production and water supply, and damage to infrastructure and settlements, among others, "are consistent with a significant lack of preparedness for current climate variability in some sectors".

Projections

The *Fifth Assessment Report* lists a number of key risks which are identified with high confidence, and that can be linked to climate-related extreme events (IPCC, 2014c):

1. Risk of death, injury, ill-health, or disrupted livelihoods in low-lying coastal zones and small island developing states and other small islands, due to storm surges, coastal flooding, and sea level rise.

2. Risk of severe ill-health and disrupted livelihoods for large urban populations due to inland flooding in some regions.

3. Systemic risks due to extreme weather events leading to breakdown of infrastructure networks and critical services.

4. Risk of mortality and morbidity during periods of extreme heat, particularly for vulnerable urban populations and those working outdoors.

5. Risk of food insecurity and the breakdown of food systems linked to warming, drought, flooding, and precipitation variability and extremes, particularly for poorer populations in urban and rural settings.

6. Risk of loss of rural livelihoods and income due to insufficient access to drinking and irrigation water and reduced agricultural productivity, in semi-arid regions.

7. Risk of loss of marine and coastal ecosystems, biodiversity, and the ecosystem goods, functions, and services they provide in the tropics and the Arctic.

The IPCC finds high agreement among scientists that aggregated economic damages accelerate with increasing temperature (IPCC, 2014c), but it also stresses that there have only been a few attempts to quantify these damages for high-emission scenarios, with additional warming of 3°C or more. SREX predicts with medium confidence that increases in economic damages from climate- and weather- related disasters will be driven primarily by changes in socio-economic factors (IPCC, 2012). In the case of tropical cyclones, increases in economic losses are dependent with a high level of scientific confidence on the level of exposure and changes in the intensity and frequency of these phenomena. There is also medium confidence that damages from tropical cyclones and floods will increase in the 21st century, depending on location, climate scenario used and method used to assess future impacts. There is also high confidence that climate change has the potential to significantly affect water management systems, although it is not necessarily the most important factor affecting future water supply.

Scientific literature about future social and economic impact of climate and weather disasters, particularly in developing and least developed countries, is limited in both scope and quantity. Nonetheless, SREX stresses that there is a general consensus that compared with developed countries, developing countries are more economically vulnerable to climate- and weather-related disasters because they a) depend more on natural capital and climate-sensitive activities (e.g. agriculture and fishing); b) generally have lower disaster preparedness and response capacity; c) lack in adaptive measures and climate-proof investments; and d) face higher risks from maladaptation due to weak governance and risk reduction and management (IPCC, 2012). These factors are further exacerbated by urbanization, population growth and land use change.

4. Reducing disaster risk: mitigation of climate change

Emissions of greenhouse gases have been increasing since the dawn of the Industrial Revolution, and the current atmospheric concentration of CO_2, which exceeds 400 ppm, is unprecedented in at least the last 800,000 years (IPCC, 2013b). As noted above, there is broad scientific consensus that rising CO_2 concentrations are already changing the climate, and a sharp decrease in greenhouse gas emissions is needed to avoid far greater and more dangerous changes.

4.1 Potential

The IPCC's *Fifth Assessment Report* (IPCC, 2013b) offered detailed climate projections under four Representative Concentration Pathways (RCPs) reflecting different degrees of effort to mitigate climate change: a business-as-usual pathway (RCP8.5), two intermediate emissions pathways (RCP6.0 and RCP4.5), and a pathway with very ambitious mitigation efforts (RCP2.6). The IPCC expresses high confidence that risks associated with climate change are reduced substantially in the low-emission scenario (RCP2.6) compared with the high-emission scenario (RCP8.5) (IPCC, 2014c).

Under the highest-emission pathway, RCP8.5, global surface temperatures are expected to rise by 3.7°C (likely range 2.6°C to 4.8°C) relative to the reference period of 1986–2005 (IPCC, 2013b). The three other RCPs assume policy intervention and help to estimate the potential of mitigation measures to reduce climate-related risks and the costs for adaptation. All three scenarios also assume that greenhouse gas emissions stabilize at the end of this century.

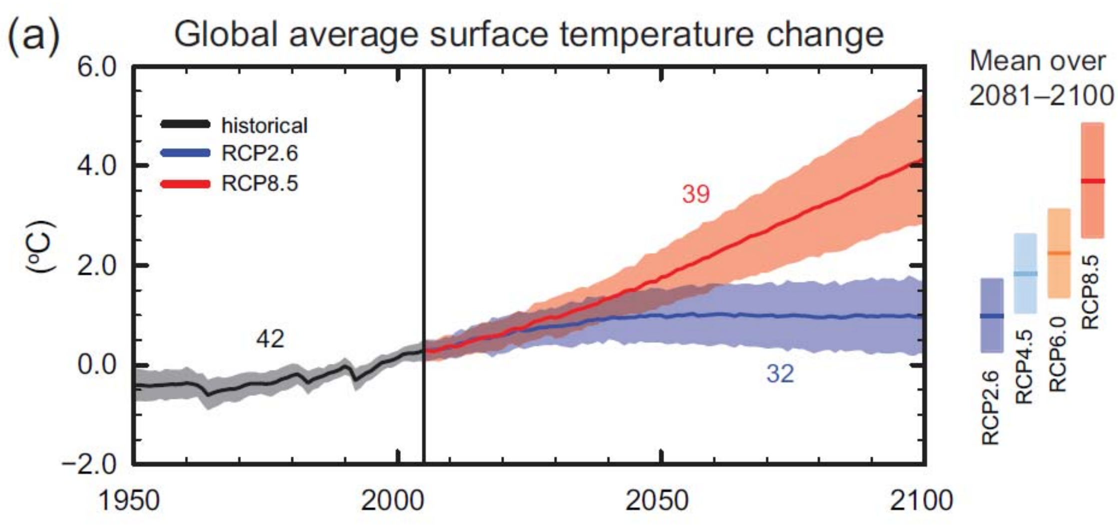


Figure 4: Global average surface temperature increase relative to 1986–2005. Source: IPCC (2013b, p.21).

Under RCP6.0, which assumes that mitigation is delayed and global greenhouse gas emissions peak only around 2060, global temperatures are projected to increase by 2.2°C relative to 1986–2005 (likely range between 1.4°C and 3.1°C) by 2100 (Masui et al., 2011). For RCP4.5, warming is projected to be 1.8°C by 2100 (likely range between 1.1°C and 2.6°C), as a result of the effective global mitigation action. The only scenario under which the IPCC finds it "very likely" that the 2°C target can be met, however, is RCP2.6, which envisions a 70% reduction in cumulative greenhouse gas emissions between 2010 and 2100 and assumes full participation by all countries as soon as possible (van Vuuren et al., 2011).

4.2 Ongoing mitigation efforts

The UNFCCC is the most important venue for international cooperation on climate change, but action on this front has been slow. As noted above, under the 2010 Cancún Agreements,[1] governments agreed to a target of keeping the global temperature increase below 2°C compared with pre-industrial levels, and more than 90 countries made conditional and unconditional pledges to reduce emissions. Yet several studies, most notably by the United Nations Environment Programme (UNEP, 2013; 2012), have found that the Cancún pledges fell short considerably of the levels of mitigation needed to meet the 2°C target.

In its most recent analysis UNEP found that for a more than two-thirds chance of meeting the 2°C target, global emissions should be no higher than 44 Gt CO_2e by 2020, and drop by about 3% per year from then until 2050. Yet emissions in 2010 were already about 50.1 Gt CO_2e, UNEP noted, and with every year that action is delayed, the cost and effort required to meet the 2°C target increase.

If emissions continue on a "business as usual" trajectory, UNEP found, emissions by 2020 would reach 59 Gt CO_2e. If countries implement their conditional Cancún pledges, with stringent accounting rules, emissions would be 52 Gt CO_2e; if they only implement their unconditional pledges and use more lenient accounting rules, emissions would reach 56 Gt CO_2e – representing a 12 Gt CO_2e gap between the 2°C target in the Cancún Agreements, and the pledged actions meant to achieve it.

As noted in the introduction, governments are now negotiating a new climate agreement to be approved at the UN Climate Change Conference in Paris in 2015, and go into effect in 2020. As part of this process, countries are preparing "intended nationally determined contributions", outlining how they intend to help reduce global climate risk (e.g. through emission reduction commitments, carbon-intensity targets for their economies, sector-specific mitigation actions, etc.). The ambition of those contributions will determine, to a great extent, whether warming can be kept under 2°C – or at any level that avoids the most dangerous impacts. However, as stressed by UNEP and also in the IPCC's *Fifth Assessment Report*, the longer that ambitious action is postponed, the more difficult it will be to avoid dangerous climate change (UNEP, 2013; IPCC, 2013b; 2014d).

It is important to note that emissions trends in recent years, and efforts to mitigate climate change, differ considerably among countries. For example, the second and third largest emitter countries in 1990, Russia and Germany, reduced their emissions by 50.8% and 23.8%, respectively. Greenhouse gas emissions in the United States, the world's largest emitter in 1990 (now second to China), increased in the same time period by 7.6%. In Japan, the fourth largest emitter in 1990, emissions have also increased by 2.9%.[2]

[1] See http://unfccc.int/meetings/cancun_nov_2010/items/6005.php.
[2] Greenhouse gas emissions including LULUCF per UNFCCC data: http://unfccc.int/ghg_data/ghg_data_unfccc/time_series_annex_i/items/3842.php.

Overall, while greenhouse gas emissions from industrialized countries have grown only modestly or even decreased since 1990, emissions in developing countries have increased, often rapidly (though again, there are major differences between countries). In 2012, additional emissions in China and India accounted for two thirds and one quarter, respectively, of the net global CO_2 emission increase. In terms of per capita emissions, however, China and particular India are still behind industrialized countries, but the gap is narrowing, in particular in the case of China (Olivier et al., 2013).

5. The relationship between disaster risk reduction and adaptation

Disaster risk reduction and adaptation are two ways of reducing the risk posed by natural hazards. The former has been defined as "systematic efforts to reduce disaster risks through analyzing and managing the causal factors of disasters including the reduction of vulnerability, and improved preparedness for adverse events" (UNISDR, 2009a). Adaptation, meanwhile, is defined as "adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts" (IPCC, 2012).

Both DRR and adaptation are concerned with reducing vulnerability, monitoring hazards, and raising societal capacities to reduce and manage risks. DRR provides a broader perspective that takes into consideration a range of potential hazards (including geophysical, biological, and chemical hazards) and their interactions and cumulative effects (ADPC, 2013). The overlap between DRR and adaptation is in managing disaster risk related to climate variability and climate extremes, and preparing for risks related to climate change (ADPC, 2013). However, in the literature, DRR and adaptation are conceived in fundamentally different ways: while DRR is a set of practices that can be put into action, adaptation is more of an overarching notion – a change in perspective that guides actions. Thus, in practice, DRR can be a component of adaptation, to the extent that adaptation requires addressing climate-related disaster risks.

Both DRR and Adaptation have an "**ideal**" way of operating – i.e. what is written in the literature or in policy documents – and an "**actual**" way of operating.

- For **disaster risk reduction**, the ideal way is to systematically prepare people for extreme events – whether the result of extreme vulnerability or extreme natural hazards – so that impacts are minimal. Actual disaster risk reduction, however, tends to focused on addressing the impacts of individual events, which can be substantial.
- For **adaptation**, the ideal way involves a long-term process of adjusting to changes (including more severe natural hazards), and iterative learning. Actual adaptation efforts to date, however, have tended to involve individual and relatively short-term projects that mostly look at expected or experienced impacts and for which we don't have much evidence of outcomes (because it is relatively new).

While there are many similarities between DRR and adaptation, mainly in their focus on natural hazards, there are also important differences. DRR focuses on reducing near-term risks (through preparedness and prevention), as well as on managing the consequences (response, relief, recovery). Adaptation is about helping people live with changes, including extreme events. Thus, the emphasis of DRR and adaptation is fundamentally different, even though the activities that they involve may look exactly the same.

5.1 Challenges to bringing together DRR and adaptation

Given how often people talk of "linking", "merging" or "integrating" DRR and adaptation, it is useful to discuss what is meant by those terms. Implicit in that language is the notion that adaptation and DRR are so closely connected that there is no need for distinction, such that policies, projects and plans can simply use one term to encompass the entire suite of actions and ideas. That is clearly not the case; along with the fundamental differences discussed above, there are several other issues that create challenges in bringing together adaptation and DRR. Below we examine the most significant.

Different purposes and perspectives

Crucial differences between DRR and adaptation have widely limited or hampered their integration in practice. These can be categorized with respect to different spatial and temporal scales, the knowledge base, and norm systems (O'Brien et al., 2008; Birkmann and Teichman, 2010). DRR is often seen as a cross-cutting topic within adaptation (for example, see the discussion of the German Adaptation Strategy to Climate Change 2008 in Birkmann and Teichman, 2010) or considered as an area of action within adaptation. Another obvious difference is that DRR focuses on a much broader range of disaster risks than adaptation, including non-climate hazards such as earthquakes.

There are some practical constraints too, such as the fact that DRR is about addressing the potential that a disaster will take place, whereas adaptation is about adjusting to new changes, such as increased risk. In other words, DRR is the suite of actions, policy, attitudes and understandings necessary to reduce the possibility that a hazard will be translated into a disaster, and the impacts caused by a disaster when it does occur. Adaptation is about making shifts to incorporate changes, including new risks, into life, to avoid or to minimize the damage that slow-onset changes in climate as well as extreme weather events can cause. There is therefore an implicit notion that adaptation is a bigger idea than DRR. We may talk of a risk reduction mind-set that penetrates everything we do, but adaptation requires that *and* accepting that change is happening, not just "risk".

Fragmented knowledge, institutions and policy

Research on the links between climate change, climate action and DRR is mostly case-based and fragmented, giving little guidance to practitioners and policy-makers. Despite the need to strengthen collaboration and to facilitate learning and information exchange between them, DRR and adaptation have largely remained distinct and independent research and policy communities with different approaches, institutions, conferences, assessment mechanisms, strategies and funding sources (Sperling and Szekely, 2005; Thomalla et al., 2006; Venton and LaTrobe, 2008; Birkmann et al., 2009; Schipper, 2009; Mitchell et al., 2010). Schipper (2009) argues that discrepancies in the intellectual development of the two fields and in the channels for implementation of risk reduction measures have resulted in policy inconsistency, redundant investment and competing approaches to addressing the same problems. Despite the commonalities between adaptation, mitigation and DRR, practices and policies at all levels are often disconnected.

Disparate policy arenas and poor governance

There is a huge challenge in reconciling the existing global policy arenas, including not only those that relate to adaptation and DRR, but also to mitigation of greenhouse gas emissions, development assistance, sustainable development, and economic development. At national level, these might be less challenging simply because the actors are fewer and the stakes lower, with more room for negotiation and opportunities for synergy, but governance is a crucial factor for making this happen. Both DRR and adaptation must be closely linked to poverty reduction and sustainable development, because climate change and disaster impacts threaten progress on poverty reduction and the achievement of the Millennium Development Goals and in the future the Sustainable Development Goals. (Schipper and Pelling, 2006; Box et al., 2013; Ulsrud et al., 2008; Leary et al., 2008; O'Brien et al., 2008).

Poor stakeholder coordination

A key challenge is the many different types of actors involved. This is a challenge not only for a clearer understanding of how adaptation and DRR are connected, but also because some of the actors are actually part of the problem. For example, power dynamics between different actors may lead one group to deliberately undo what another group has done, thereby not only wasting resources but also exposing people to greater vulnerability and more confusion. That was the case in El Salvador during the 1990s and early 2000s, where the institution that housed the risk reduction, seismic monitoring and meteorological institutes was separate from the civil protection authority, and both felt they had the mandate to address disaster risk (Schipper, 2006).

Another challenge is getting actors on the same "side" to understand each other. Debates continue on what exactly adaptation means, across and within domains of practice, science and policy (i.e. among practitioners, between practitioners and academics, among academics, etc.). It can be argued that the difference is not specifically between adaptation and DRR experts, but between those who focus on the physical impacts and those who focus on the development and vulnerability dimensions. While DRR is more established, many practitioners and governments continue to focus on post-event action only, giving preparedness and disaster prevention little care. In their work in Indonesia, Djalante and Thomalla (2012) describe coordination challenges in terms of defining the responsibilities and institutional arrangements for implementing DRR and adaptation, either individually or addressing both issues in an integrated way.

5.2 Ongoing efforts on DRR and adaptation

International

Considerable efforts to integrate climate change adaptation and disaster risk reduction activities have occurred at the international level, particularly in terms of international conventions and frameworks. While the UNFCCC focuses on longer-term climatic change, later negotiations of the framework, namely the Bali Action Plan in 2007, have called for enhanced action on adaptation that considers disaster reduction strategies, particularly in developing countries that are more vulnerable to the impacts of climate change (UNFCCC, 2007). Mitchell et al. (2010) highlight this document as an important landmark in expanding the way for further integration opportunities. Likewise, the Adaptation Committee has expressed its aim to provide climate-change related disaster risk reduction technical support and guidance (Adaptation Committee, 2013). Furthermore, there is widespread agreement that the IPCC-commissioned SREX was a significant step in the integration effort (Birkmann et al., 2009) and illustrated that disaster risk reduction can be seen as an important component of adaptation (UNISDR, 2013a).

In a similar vein, climate change has been mentioned in international disaster reduction agreements, including the HFA. The HFA Priority for Action 4 includes the impacts of hazards related to climate variability and climate change as underlying disaster risks and explicitly calls for the integration of DRR strategies with climate change adaptation to reduce underlying risk factors (UNISDR, 2005). UNISDR cites climate change as arguably the most significant underlying risk factor in disasters and urges a closer relationship between disaster risk reduction, adaption and mitigation measures in the HFA2 (UNISDR, 2013b). UNISDR has made considerable efforts in guiding disaster risk reduction and adaption integration policies and disseminating best practices in integration and HFA implementation (Mitchell et al., 2010). UNISDR's International Cooperation to Reduce Disaster Risk Programme seeks to increase complementarity and coherence between international agendas and aims to further engage with the Conference of the Parties (COP) to contribute to UNFCCC activities (UNISDR, 2014).

In addition to international agreements, international partnerships that aim to highlight the synergies between the two agendas have continued to emerge. An example of such a partnership is the "Building capacities for increased public investment in integrated climate change adaptation and disaster risk reduction" global initiative, led by UNISDR, which covers 30 small island developing states (SIDS) with the objective of accounting for disaster loss and estimating future risk with a focus on weather and climate-change related hazards (UNDESA, 2014).

Regional

Actions to enhance the relationship between disaster risk reduction and climate change adaptation have also taken place at the regional level. A number of SIDS, which are particularly vulnerable to climate-related disasters, have made significant regional efforts in this area. For example, the "Partnership to develop the Strategy for Climate and Disaster Resilience Development" (SRDP) was created when actors from the disaster and climate change communities in the Pacific, along with regional intergovernmental mechanisms, decided to coordinate their activities to develop an integrated Pacific regional strategy for disaster risk management and climate change by 2015 (UNDESA, 2014).

As in other regions, attention has been drawn to linking climate change adaptation and disaster risk reduction in Europe. While approaches to adaptation and disaster risk reduction differ among EU member states, there have been regional efforts, particularly led by the European Union, to further associate the two (UNISDR et al., 2011). For example, the EU's 2009 White Paper on adapting to climate change states that disaster risk reduction is "an essential part of successful adaptation" (Commission of the European Communities, 2009). Additionally, at the European Ministerial meeting on disaster risk reduction (in preparation for the development of the HFA2) held in July 2014, European Ministers urged the recognition of the "complementarity of disaster risk reduction and Climate Change Mitigation and Adaptation as policy goals and approaches to prevent and address risk, vulnerability, and the impacts of hazard events and climate change on people and society" (European Commission, 2014, p.2).

National

Efforts at the national level are perhaps most visibly articulated through national policies and frameworks. Many of these national efforts have been influenced or encouraged by more large-scale international frameworks, such as the HFA. The HFA states that a critical task for state actors is to promote the integration of disaster risk reduction with climate variability and climate change into disaster risk reduction strategies and adaptation (UNISDR, 2005).

The government of Vietnam has made efforts to increase collaboration between disaster risk reduction and adaptation agencies through the promotion of joint initiatives while still maintaining separate ministries for each (MARD, 2010; UNISDR, 2009b). Bangladesh has also made significant strides in this area, and the government has announced that disaster risk reduction and climate change adaptation have been in integrated in more than over 30 policies and plans (Government of Bangladesh, 2013; see also Roberts, 2014).

However, while some countries have made substantial progress in integrating disaster risk reduction and adaptation, many other countries have vocalized their commitments to integration, yet their national HFA progress reports show that relatively limited concrete action has taken place in regards to the development of formalized strategies and activities (Mitchell et al., 2010). During UNISDR's country consultations to inform the development of the HFA2, many countries called for the integration of disaster risk reduction into adaptation strategies and vice versa, as well as for an increase in joint action plans (UNISDR, 2013b). Furthermore, nearly all consultations expressed the need to more fully integrate climate change issues into the HFA2 (UNISDR, 2013b). While the conceptual thinking behind linking the two agendas is present both in the HFA and among national governments, it appears that significant challenges remain for the actual implementation of such thinking, as revealed by the limited examples of integration found in HFA progress reports.

Local

Disasters often have the greatest consequences at the local level and this is where the impacts of disasters are first felt. Cutter et al. (2012) point out that it is these localized impacts of disaster that then may ripple into the national, and often international, realms. As a result, there have been substantive efforts at the local level across countries to integrate disaster risk reduction and climate change adaptation activities. Local initiatives, which may be independent from national or international efforts, often warrant some flexibility and can be specifically designed to fit local conditions. For example, the local government in the Indian city of Pune implemented a city-specific climate change plan that also addresses disaster risks to deal with recurrent flooding (UNISDR, 2009b). Currently emerging local responses to climate change and disaster risk include the integration of climate risk information into disaster planning and community-based adaptation, which includes a strong local participation component (Cutter et al., 2012).

Despite the large number of local level actions, consultations from the Fourth Session of the Global Platform for Disaster Risk Reduction revealed the need to more deeply build on the activities of local governments and communities who are often strongly familiar with climate change and disaster risk in the local environment and may have well-designed tools and strategies to address these issues (UNISDR, 2013a). Cutter et al. (2012) argue that the main challenge for local efforts is "to find a good balance of measures that simultaneously address fundamental issues related to the enhancement of local collective actions, and the creation of subsidiary structures at national and international scales that complement such local actions". Therefore, collaboration between actors at different levels is crucial in realizing the potential of actions at the local level, as well as beyond.

6. Entry points for bringing together DRR and adaptation

In this section, we present ideas for how DRR and climate change can be brought together, in terms of both their objectives and practices, to more effectively reduce the risks from climate change and variability. First, we argue that both DRR and climate change need to jointly and explicitly promote transformative change in order to the tackle underlying causes of vulnerability. Second, we discuss the potential for mutual learning.

Despite the challenges of addressing disaster risk reduction and adaptation simultaneously in policy, projects and planning, there are strong arguments for promoting frequent interaction between DRR and adaptation experts. Both issues are framed in similar ways, presenting numerous opportunities for a robust relationship. The overlaps range from simple things, such as the fact that both DRR and adaptation planning tend to focus on specific sectors (e.g. water, agriculture, health, transport, energy, urban development, etc.) and/or a specific scale (international, national, local) or geographic area (village, town, city, coastal area, etc.), to more complex issues, such as that both are currently the subject of high-level international political negotiations.

One of the most important reasons for linking DRR and adaptation is that some current DRR practices can undermine opportunities for reducing vulnerability to natural hazards in the longer term (see Section 2). For example, international NGOs and humanitarian agencies frequently provide only "temporary", poor-quality shelter after a disaster, leaving governments or other actors to help build new, more resilient housing, with no guarantee that this will occur. In El Salvador, for example, Wisner (2001) found that those who lost their homes in Hurricane Mitch in 1998 were still living in temporary huts when two massive earthquakes struck in early 2001, leaving the people even more vulnerable since the huts were not designed to withstand severe earthquakes. With longer-term thinking, such shelter would not be accepted for more than a very short time. Thus, bringing adaptation to the table offers DRR an opportunity to improve.

The DRR community has been dealing with climate-related disaster risks since well before climate change was a widely discussed topic. This history includes a well-established toolbox for assessing and responding to risks, and hundreds of thousands of trained volunteers and professionals whose only business is to help reduce disaster risk. Improvements to local emergency services and the international humanitarian aid system are much needed to tackle the immediate impacts of current and future disasters. But the "business as usual" approach to DRR and disaster aid that focuses largely on disaster response and recovery is no longer desirable (Linnerooth-Bayer, 2005; Lavell and Maskrey, 2014). DRR practitioners need to pay greater attention and resource to disaster prevention and preparedness. This needs to be couched in thinking about reducing vulnerability and risk in a more holistic way, rather than on an event-by-event basis.

6.1 Transformative change

The expected outcome of the HFA is a reduction in disaster losses through better disaster risk reduction. This goal is consistent with the goal of adaptation: to reduce the impact of climatic shifts on people's lives. Yet while all five of the HFA priority action areas could be extended to adaptation, only the fourth ("reduce the underlying risk factors") actually gets at what causes risk. This is also where adaptation is mentioned. Discussions about adaptation, although sometimes overly focused on projects and their outcomes, and not enough on the complex *process* of adjusting to climate change, tend to more explicitly emphasize the importance of reducing vulnerability. This is demonstrated by the intense discussions on the differences and similarities between adaptation and development (see, e.g., Schipper, 2007; McGray et al., 2007). While vulnerability is a central feature of international disaster risk reduction efforts, and has been so since the adoption of the Yokohama Strategy in 1994, the next iteration of the HFA should put greater emphasis on priority area 4, if there is truly a desire to "integrate" disaster risk reduction efforts with those of adaptation to climate change.

For a truly effective, integrated approach to adaptation and disaster risk reduction, however, we will need a radical transformation in how we think about these issues. This requires:

1. A change in thinking about how adaptation is done, starting with an acknowledgement that decision-makers and practitioners see adaptation as a set of incremental steps, not as the continuous, long-term process that researchers envision. This incremental understanding of adaptation fits the nature of existing development assistance projects and programmes, but it will not produce the transformational change in attitudes, economies, behaviours and politics needed to reduce vulnerability to hazards.

2. A willingness to actively engage actors whose agendas influence vulnerability: those responsible for shaping priorities for national and international economic development, those bartering for peace in war zones, those dealing with health issues worldwide, etc.

3. Multi-hazard risk reduction units, such as the ones in El Salvador, that house units studying hazard and vulnerability together, so that they can collaborate and better understand each other's perspectives and challenges.

4. Guidance for disaster response and recovery on how to incorporate climate change in planning and programming.

5. A human rights-based approach, since many of the causes of vulnerability to climate change impacts and other hazards are rooted in poverty, inequality and injustice with respect to basic human rights and a lack of access to resources.

Both DRR and adaptation must be closely linked to poverty reduction and sustainable development, because climate change and disaster impacts threaten progress on poverty reduction and the achievement of development goals (Schipper and Pelling, 2006; Thomalla et al., 2006; Ulsrud et al., 2008; Leary et al., 2008; O'Brien et al., 2008). A more effective way of bringing adaptation into disaster risk reduction is to take vulnerability reduction as the starting point, rather than risk reduction. Vulnerability reduction is about changing the underlying conditions that make people susceptible to harm, and thus requires a more fundamental examination of the development pathways that both create and reduce risk (Lavell and Maskrey, 2014). Social welfare, quality of life, infrastructure and livelihoods need to be part of disaster risk reduction to facilitate adaptation to climate change (IPCC, 2012). Thus, rather than thinking about how to address risk, the focus should be on addressing the greatest drivers of risk.

6.2 Learning about disaster risk and climate change

The question is then how DRR and the climate change community can exchange knowledge and learn from each other in order to inform more effective policies to manage future climate risks. There is ample evidence that suggest that disasters can spur learning among policy-makers and lead to new policies and change in approaches to risk management (Brody, 2003; Albright, 2011; Birkland, 2006). However, the scope of disaster-induced learning and policy change depends critically on the severity of the disaster, beliefs about the causes and consequences of disasters, the availability of policy-relevant resources, the openness of decision-making processes, and the social and economic structures and underpin them (Johnson et al., 2005; Brody et al., 2009; Vulturius, 2013).

Special attention thus needs to be paid to the ways in which new knowledge about disaster risk and climate change is developed and how it moves into the policy realm. How can new knowledge and experience with disaster risk best be harnessed for policy-making? Given that hazards such as floods occur regularly in many places, and that climate change may alter the frequency and magnitude of some of these hazards (see Section 3), learning and decision-making about suitable risk management options is likely to happen in multiple iterations. Iterative risk management has been endorsed by the IPCC (2014e) as an effective approach to adaptation decision-making because it is most suitable for dealing with large uncertainties, long time frames, and the influence of both climate and non-climate related changes in disaster risk. It also offers decision-makers formalized methods to analyse vulnerability, risk and uncertainty and to assess possible policy responses (for an in-depth discussion, see PROVIA, 2013).

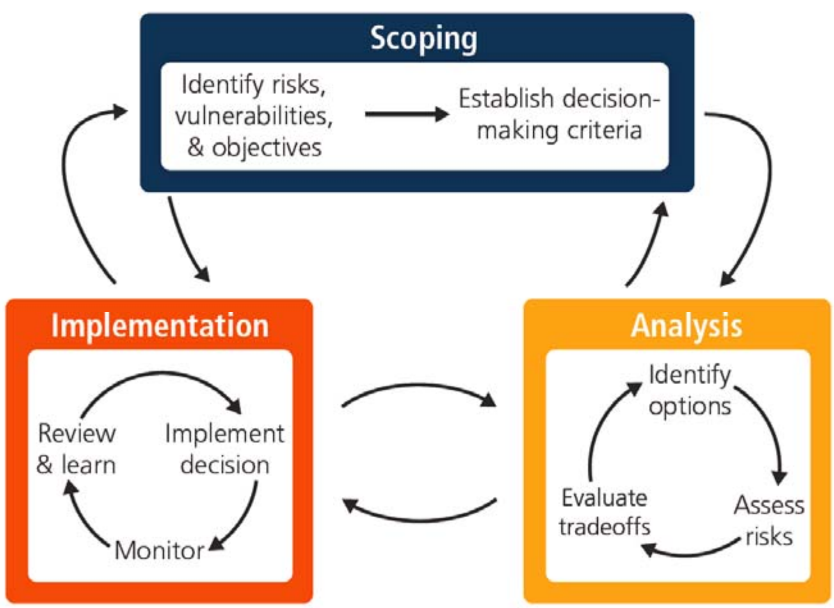


Figure 5: Climate change adaptation as an iterative risk management process. Source: IPCC (2014e, Figure SPM.3).

The concept of iterative risk management can also be linked to single-, double-, and triple-loop learning, another way to describe different levels of transformative change (Pahl-Wostl, 2009). Single-loop learning may result in adjustments to existing policies; double-loop learning implies changes in assumptions and beliefs that guide policy-making, and triple-loop learning refers to a much more profound transformation of policy paradigms and underlying governance structures (Armitage et al., 2008; Pahl-Wostl, 2009). It has also been suggested that institutions that are able to learn and change in response to disasters possess a greater capacity to cope with current risks and adapt to emerging risks (Tompkins and Adger, 2004; Smit and Wandel, 2006). Learning how to deal with the uncertainty of scientific knowledge about the impacts of climate change and differing preferences for adaptive measures among different policy stakeholders is of particular importance in this context of DRR and adaptation.

These insights suggest that governance mechanisms that are meant to deal with climate variability and change need to become more flexible and conducive to learning in order to be able to adapt to new experiences and knowledge. At the moment, however, the way in which a risk management approach for adaptation is framed largely neglects its potential to lead to comprehensive changes in beliefs and institutions. Risk management is often understood to be subsumed in established planning and decision-making structures (Travis and Bates, 2014; see Figure 4). Empirical evidence suggests, however, that decision-making for DRR and adaptation can also result from competition between different groups of policy stakeholders who hold diverging views about the causes of disaster risks and suitable actions to reduce them (Albright, 2011). The literature suggests that stakeholder platforms can offer a forum for learning among different policy actors and inform decision-making for policy change (Leeuwis and Pyburn, 2002; Bouwen and Taillieu, 2004; Armitage et al., 2008). Furthermore, joint learning by different stakeholders about disaster risks and risk reducing measures has the potential to lead to collective action (Pahl-Wostl, 2009; Ostrom, 2005).

7. Conclusions and recommendations

Climate change will cause more hazards, and they will be more severe. Coupled with persistent poverty and governance failures around the world, this means disaster risk is likely to increase. Thus, effective DRR measures will be needed as part of a broader effort to reduce climate risk. Both sides should recognize the different strengths that the other brings to the table, and collaborate to achieve common goals, and both should take a risk-based approach to ensure effective responses. A successor to the HFA should put greater emphasis on priority area 4, if there is truly a desire to connect disaster risk reduction efforts with those of adaptation to climate change.

Both DRR and adaptation also need to become better at taking into account the wider development context. Development can play a crucial role in reducing vulnerability, but often it instead compounds and exacerbates it, and it even creates new hazards. It would be useful to more explicitly recognize this problem – that current development pathways, including the associated greenhouse gas emissions, are increasing the risks posed by natural hazards.

Conversely, disaster impacts can interfere with development pathways and make major development investments go to waste. Many of these problems arise from ineffectual policies and governance structures at the national and sub-national levels. There is growing support within both the adaptation and DRR communities for addressing this problem; a successor to the HFA can help by promoting a more integrated approach to development, adaptation and disaster risk. This may require new approaches to governance and to finance.

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