KEEPING UP WITH MEGATRENDS

THE IMPLICATIONS OF CLIMATE CHANGE AND URBANIZATION FOR ENVIRONMENTAL EMERGENCY PREPAREDNESS AND RESPONSE

A report prepared for OCHA and UNEP upon request of the Advisory Group on Environmental Emergencies

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Mobilizing and coordinating the international response to environmental emergencies

OCHA

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EXECUTIVE SUMMARY

In the past decade, the world has experienced a number of devastating natural disasters[1], from earthquakes and tsunamis to floods, mudslides, hurricanes, and drought. Not only do natural disasters kill and injure hundreds of thousands of people a year, they also trigger environmental emergencies such as chemical accidents, fires, and oil spills, and generate large quantities of disaster waste. The nuclear accident at Japan's Fukushima Daiichi 1 in 2011 illustrates the vulnerability of many industrial facilities to large-scale, sudden-onset natural disasters. The period between 2002 and 2011 included over 4000 disasters linked to natural hazards, resulting in over one million deaths and greater than $1 billion in losses.[2]

If it seems like some of these events are occurring with greater intensity, it is because they are. While studies are ongoing, the trends of climate-related events have been linked to changes in the "frequency, intensity, spatial extent, duration and timing of extreme weather and climate events"[3], including tropical cyclones, heavy precipitation events, and flooding – in addition to sea level rise, extreme heat, drought, and subsidence. The growing trend in climate-linked disasters poses worrying questions about the ability to respond to these related environmental emergencies. The staggering impact of natural and industrial disasters, particularly in developing countries, illustrates another significant trend – the growth of megacities and their vulnerability to disasters and environmental emergencies. The concentration of huge numbers of people in urban centers magnifies vulnerability to disasters and accidents, especially in informal settlements with insufficient infrastructure and poor to nonexistent land use planning.

This study[4] examines the effects of these two megatrends – climate change and urbanization – on environmental emergencies. It considers how climate change and urbanization affect the scope and scale of emergencies, as well as what these trends mean for emergency preparedness and response. It is clear that these trends are posing multiple challenges for emergency responders by overwhelming national and local-level emergency preparedness and depleting the capacity to prepare, respond, and rebuild. **One emerging opportunity for addressing these challenges is greater utilization of the Environmental Emergencies Centre (EEC)[5], which offers a programmatic approach to strengthening regional and national capacity to prepare for and respond to environmental emergencies.** The Centre offers vast potential for training emergency planners, disaster managers, and national and local authorities in vulnerable, low- and middle-income countries. Specifically, the EEC's

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[1] There is often a disparity among the terminology used by practitioners regarding natural disasters and natural hazards and the terms are often used interchangeably. This reflexive use is both recognized and reflected in this study.

[2] UNISDR, "Towards a Post-2015 Framework for Disaster Risk Reduction," at 2.

[3] Intergovernmental Panel on Climate Change (IPCC). 2012. Summary for Policymakers. In *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation,* ed. C.B. Field, et al. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press at 5.

[4] This study was prepared at the request of the Advisory Group on Environmental Emergencies (AGEE). The AGEE is a global forum held every two years, bringing together international environmental experts and disaster managers to share information, expertise, and lessons learned for improved response to environmental emergencies worldwide, particularly in developing countries. The Joint UNEP/OCHA Environment Unit acts as the Secretariat to the AGEE.

[5] The Environmental Emergencies Centre is a flagship effort from OCHA and UNEP and acts as an online support tool for national and regional capacity development activities in response to industrial and technological accidents and the environmental impacts of natural disasters and complex emergencies.

scope could be expanded to focus on more programmatic or thematic assessments that concentrate, for example, on the vulnerability of coastal megacities to environmental emergencies.

A second opportunity is through the use of new and existing tools that can forecast and share information related to environmental emergency preparedness and response. With respect to forecasting and risk assessment, the study explores the possibility of expanding existing tools, and identifies areas where the use of new tools might be warranted. For example, UNEP has already extended the APELL (Awareness and Preparedness for Emergencies at Local Level) programme to incorporate a multi-hazard approach through the "Multi-Hazard Training Kit for Local Authorities – for Community Vulnerability Reduction, Prevention, and Preparedness", which is particularly relevant to emergency preparedness efforts in urban areas. For risk assessment specifically, tools such as the Community Risk Profile Tool, the Hazard Identification Tool, and the Flash Environmental Assessment Tool could also be employed to help communities and first responders identify environmental risks before and in the immediate aftermath of emergencies.

A third opportunity is through the increased efforts by OCHA and UNEP to improve integration of technological and industrial accident scenarios into national contingency planning. Widespread urban poverty means that more people are living in unsuitable areas, such as steep slopes prone to mudslides or near industrial facilities. Current contingency planning does not necessarily take into account the scenarios that accompany the widespread destruction of infrastructure occasioned by natural disasters, such as damage to electrical power grids, pollution in water distribution systems, oil and gas pipeline explosions or leaks, and accidents involving hazardous waste. In December 2011, Member States adopted UN General Assembly Resolution (A/66/L.33), which recognized the importance of "*applying a multi-hazard approach to preparedness . . . including giving regard to, inter alia, secondary environmental hazards stemming from industrial and technological accidents*." Strengthening coordination around megacities and environmental emergencies among organizations such as OCHA, UNEP, UNISDR, and UNDP could aid in the development and adaptation of operational guidance and capacity-building workshops for preparedness and response to these emergencies.

A final opportunity can be found through improved integration of the environment as a cross-cutting issue in humanitarian response and relief efforts. Environmental impacts in the aftermath of an emergency or crisis can often threaten the success of recovery activities when they are not taken into account by relief operations. Humanitarian relief is designed for rapid and intense response to suffering, but can leave behind pollution and waste, concentrated overuse of resources, and swift, untenable urbanization. Furthermore, as natural resources often serve as the source of economic and social reconstruction, addressing environmental concerns is crucial not only for sustainable (re)development, but for reducing future vulnerability as well. Workshops on mainstreaming environmental considerations into humanitarian action can be undertaken at the regional and country levels, including training events on humanitarian coordination and early recovery. Such a resource could also be made available through the Environmental Emergencies Centre, both as a virtual training platform and in the form of onsite courses.

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Box 1. UNEP, OCHA, and the JEU

The United Nations system for mobilizing and coordinating international emergency assistance to countries facing environmental emergencies has been provided since 1994. This is delivered through a partnership between the United Nations Environment Programme (UNEP) and the UN Office for the Coordination of Humanitarian Affairs (OCHA), through their Joint UNEP/OCHA Environment Unit (JEU). Assistance is provided at the request of affected countries, usually when the environmental emergency exceeds national capacity to respond. The JEU serves as the secretariat to the Advisory Group on Environmental Emergencies (AGEE).

The AGEE is an international forum that brings together international environmental experts and disaster managers to share information, expertise and lessons learned for improved response to environmental emergencies worldwide, particularly in developing countries. The AGEE meets once every two years to share experiences and new approaches in the field of response to environmental disasters, as well as to review the work of the JEU, and to provide advice and guidance on areas for development and future activities. At its ninth meeting (in 2011), the AGEE issued 26 recommendations focusing on preparedness, national capacity, and regional approaches, among other things.

The AGEE has recommended examination of the effects of two megatrends—urbanization and climate change—on international environmental emergency preparedness and response. This study draws on the following sources: (1) interviews conducted with experts in the fields of environmental emergency preparedness and response, humanitarian assistance, urbanization, and climate change; and (2) desk research on climate change, urbanization, and environmental emergencies.

I. INTRODUCTION

"Urbanization and climate change are co-evolving in such a way that populations, often in densely packed urban areas, will be placed at much higher risk from climate change."

(UN Habitat 2011)

Source: UN Photo 2010, Cholera response delayed due to flooding in slum area of Gonaives, Haiti

INTRODUCTION

The percentage of the world's population living in cities is rapidly increasing. Informal settlements are being built in more vulnerable locations, including near or among industrial sites. Infrastructure for transportation and sanitation is becoming increasingly stressed, making it more likely to fail in the event of an emergency. In addition, climate change is contributing to sea level rise and changing weather patterns. As a result, communities are faced with new and increasing vulnerability to environmental emergencies arising from increased intensity and, in some cases, frequency of storms and flooding, increased incidence of landslides and erosion, land instability from groundwater depletion, and more extreme heat events. Local, national, regional, and international institutions and frameworks to prepare for and respond to environmental emergencies will need to consider the implications of these new challenges.

This study examines the effects of these two megatrends on international environmental emergency preparedness[6] and response.[7] It includes an analysis of how urbanization and climate change may affect environmental emergencies, independently and together; and highlights possible opportunities for further dialogue, research, and action on improving the international framework for environmental emergency preparedness and response to better cope with the impacts of these two trends. The study does not discuss disaster risk reduction (including disaster prevention).[8] Nor does it discuss the need to strengthen the resilience of urban communities to environmental emergencies. While these are important concepts that bear on the ability to respond to environmental emergencies, the focus here is on those environmental emergencies that exceed national capacity to respond and for which international assistance is necessary.

Box 2.

Environmental emergencies are defined as "sudden-onset disasters or accidents resulting from natural, technological or human-induced factors, or a combination of these, that causes or threatens to cause severe environmental damage as well as loss of human lives and property." The term includes "secondary consequences from natural hazards such as earthquakes, storms, floods, tsunamis, wildland fires, landslides and/or man-made disasters such as industrial accidents, transport accidents, chemical spills, oil spills and a multitude of other types of emergencies."

(UNEP/GC.22/INF/5, 13 November 2002)

[6] *Preparedness* is defined as: "the knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions." 2009 UNISDR Terminology on Disaster Risk Reduction, at 21 (hereafter 2009 UNISDR Terminology).

[7] *Response* is defined as: "The provision of emergency services and public assistance during or immediately after a disaster in order to save lives reduces health impacts, ensure public safety and meet the basic subsistence needs of the people affected." 2009 UNISDR Terminology, at 24-25. It is predominantly focused on immediate and short-term needs, and may extend into the subsequent recovery stage. *Id.* at 25.

[8] *Disaster risk reduction* is defined as the process of reducing disaster risks "through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events." 2009 UNISDR Terminology, at 10-11. There has been some discussion about the need to focus more on disaster risk reduction and mitigation than on preparedness and response strategies, at least with respect to human settlements. See UN Human Settlements Programme, Humanitarian Affairs, and the Role of UN-HABITAT: Strategic Policy on Human Settlements in Crisis and Sustainable Relief and Reconstruction Framework (2008), at 23.

Part I of this study addresses the megatrend of climate change, including an examination of current trends and implications for environmental emergency preparedness and response. It includes a case study on climate change and flood preparedness. Part II addresses the megatrend of urbanization and includes a case study on earthquake response and the implications for environmental emergency response. Part III sets forth practical recommendations for improving the international framework for environmental emergency preparedness and response to cope with the impacts of climate change and urbanization on environmental emergencies. It includes a case study highlighting the intersection of climate change and urbanization with environmental emergencies and the implications for improved preparedness and response.

II. CLIMATE CHANGE

"Climate change leads to changes in the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events, and can result in unprecedented extreme weather and climate events."

(IPCC 2012)

Source: NOAA, Department of Commerce 2010. Flooding in France.

CLIMATE CHANGE is having unprecedented impacts on the occurrence of natural disasters and the associated risk of an environmental emergency. As the 2012 IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation ("SREX") Summary for Policymakers notes, climate change "leads to changes in the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events, and can result in unprecedented extreme weather and climate events."[9]

High urban densities increase vulnerability not only to environmental emergencies generally, as shown above, but to climate change-related disasters in particular.[10] Geography can also exacerbate vulnerability to climate change as a result of higher temperatures, changing precipitation patterns, and sea level rise.[11] The lack of precise data about future emissions levels and climate change impacts translates into a growing degree of uncertainty concerning the frequency and intensity of extreme weather events,[12] as historical trends and risks no longer apply. As such, communities living in areas exposed to storm surges, flooding, and landslides face greater exposure to climate risks,[13] even while it is unclear just how much greater those risks will be.

Certain groups within these populations are even more vulnerable to impacts from environmental emergencies linked to climate change. For example, children are more likely to be killed or injured during disasters, less able to adapt to heat exposure, and less resistant to waterborne diseases.[14] This is because children's physiological and metabolic systems are less adaptable to heat and other climate-related threats than those of adults.[15] Older adults are also more vulnerable to extreme heat events.[16] Climate change is also expected to intensify existing patterns of gender-based vulnerability.[17] With climate change already stretching the disaster relief system, future climate-related emergency events will generate increased and more costly demands for assistance,[18] especially because many developed countries are also vulnerable to climate-related disasters.

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[9] Intergovernmental Panel on Climate Change (IPCC). 2012. Summary for Policymakers. In *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation,* ed. C.B. Field, et al. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, at 4 (hereafter "IPCC SREX Summary for Policymakers").

[10] International Federation of Red Cross and Red Crescent Societies, *World Disasters Report 2010: Focus on Urban Risk (2010), at 119 (hereafter "IFRC, World Disasters Report 2010").*

[11] Field, S. "Urban Risks: Moving from Humanitarian Response to Disaster Prevention" (Wilton Park May 2011), at 4.

[12] IFRC, *World Disasters Report 2010,* at 133.

[13] *Id.*

[14] UNICEF, Children's Vulnerability to Climate Change and Disaster Impacts in East Asia and the Pacific (2011 UNICEF East Asia and Pacific Regional Office), at 1 (hereafter "Children's Vulnerability to Climate Change and Disaster Impacts"); IFRC, *World Disasters Report 2010,* at 121-22.

[15] Children's Vulnerability to Climate Change and Disaster Impacts, at 1.

[16] U.S. Environmental Protection Agency, *Reducing Urban Heat Islands: Compendium of Strategies,* at 16.

[17] IFRC, *World Disasters Report 2010,* at 121 and 122 (Table 6.2, Gender and Climate Vulnerability).

[18] OCHA Occasional Policy Briefing Series – No. 2, Climate Change and Humanitarian Action: Key Emerging Trends and Challenges (August 2009), at 2-3 (hereafter "OCHA, Climate Change and Humanitarian Action").

A. Effects of Climate Change on the Scope and Scale of Emergencies

The trends of climate-related events are likely to have significant effects on natural disasters and other environmental emergency events, primarily through sea level rise, tropical cyclones, heavy precipitation events, flooding, extreme heat events, drought, and subsidence.[19] Climate-related disasters affected an estimated 2.4 billion people between 1999 and 2009, with the cost of responding to such disasters increasing tenfold between 1992 and 2008.[20] It is projected that future damage from tropical cyclones in the Central America/Caribbean region for 2020-2025 will range from US$79-$102 billion.[21] While climate events are also linked more broadly to ecosystem degradation, the potential implications of degraded ecosystem services for vulnerability to environmental emergencies are not discussed in this study.[22]

The trends of climate-related events are also likely to affect the severity and frequency of extreme weather events.[23] Floods and storms already constitute the majority of sudden-onset disasters to which international assistance is provided, and an increase in their frequency and/or intensity will reduce the capacity of communities and others to prepare for these events, respond to them, and rebuild in their wake.[24] In 2010, an estimated 42 million people were displaced by sudden-onset natural disasters, primarily climate-related hazards in the form of floods and storms.[25] Specifically, both the magnitude and frequency of floods are projected to increase[26], including in areas that have not been prone to flooding in the past.[27] Although deaths from flood events have decreased overall due to flood control efforts and implementation of early warning systems, the number of people affected by floods has increased dramatically.[28] In 2007 alone, 105 million people in China, 18 million people in India, and nearly 9 million people in Bangladesh were affected by floods.[29] In 2008, over one million people were affected by flooding in Colombia, even though there were only 65 deaths.[30]

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[19] See generally UN-HABITAT, *Global Report on Human Settlements 2011: Cities and Climate Change* (hereafter UN-HABITAT, *Cities and Climate Change*); IFRC, *World Disasters Report 2010,* Table 6.1 at p. 117 (Climate Change Impacts on Urban Areas).

[20] *Id.*

[21] Curry, J., M. Jelinek, B. Foskey, A. Suzuki, & P. Webster, Potential Economic Impacts of Hurricanes in Mexico, Central America, and the Caribbean ca. 2020–2025, *LCR Sustainable Development Working Paper No. 32* (World Bank: Walter Vergara, ed. June 2009).

[22] For a discussion of the ecosystem-based approach to disaster risk reduction, see "The Role of Ecosystem Management in Climate Change Adaptation and Disaster Risk Reduction," UNEP Copenhagen Discussion Series Paper 2 (June 2009); Sudmeier-Rieux, K. and N. Ash, Environmental Guidance Note for Disaster Risk Reduction: Healthy Ecosystems for Human Security (IUCN Environmental Guidance Note for Disaster Risk Reduction 2009); and the Partnership for Environment and Disaster Risk Reduction (PERR) at www.pedrr.net/.

[23] IPCC SREX Summary for Policymakers, at 4; Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, eds., 2008: *Climate Change and Water.* Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, at 26 (hereafter "IPCC, *Climate Change and Water*"); OCHA, Climate Change and Humanitarian Action, at 2-3; Report on Wilton Park Conference WP 940, "Responding to Flooding – Improving the Preparation and Response" (January 2009), at 2 (hereafter "Wilton Park, Responding to Flooding").

[24] OCHA, Climate Change and Humanitarian Action, at 2-3.

[25] UNEP News Centre, "UNEP Chief Addresses UN Security Council Debate on Climate Change and Security" (July 20, 2011).

[26] Milly, P.C.D., R.T. Wetherald, K.A. Dunne, T.L. Delworth. 2002. Increasing risk of great floods in a changing climate. *Nature* 415 (6871): 514-517; See, for example, Cunderlik, J.M. and S.P. Simonovic, 2007. Inverse flood risk modeling under changing climatic conditions. *Hydrological Processes,* Vol 21(5): 563–577.

[27] Wilton Park, Responding to Flooding, at 2.

[28] *Id.*, at 3-4.

[29] *Id.*, at 4.

[30] *Id.*

The effects of these extreme weather events are likely to be magnified by sea level rise.[31] Sea level rise is a significant concern for coastal cities, which face rising water levels and storm surges.[32] Globally, sea levels have risen 1.7 ± 0.5 mm/yr over the course of the last century, with the average rate for 1993-2003 almost double that amount (3.1 ± 0.7 mm/yr).[33] Although the low-elevation coastal zone only covers two percent of the world's land area, it contains ten percent of the global population, with a greater percentage located in developing (as compared to developed) countries.[34] As such, sea level rise, which increases the risk of coastal floods,[35] is predicted to affect five times as many coastal residents in 2080 as in 1990.[36] It is also associated with slow-onset impacts such as coastal erosion,[37] which can render areas more vulnerable to sudden-onset storms and flooding.[38]

These trends can present challenges to emergency responders. Extreme weather events such as Hurricane Katrina and Cyclone Nargis have demonstrated how even a modest increase in storm intensity can overwhelm emergency preparedness at the local (and national) level.[39] Storms and floods that are both more intense and more frequent can also deplete capacity to prepare, respond, and rebuild.[40] Infrastructure already burdened by growing populations may also be vulnerable to damage by corrosive ocean water and other weather-related impacts.

Sea level rise near harbors that are sites for chemical plants and other industrial facilities poses additional risks. For example, floods and storms could lead to industrial spills as secondary environmental emergencies. This is a concern in more remote areas as well. For example, as the Arctic region opens up to resource extraction (e.g., petroleum drilling) and a concomitant increase in shipping activity, it may become vulnerable to impacts linked to sea level rise and extreme weather events.

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[31] Nicholls, R.J. and A. Cazenave, 2010, Sea-Level Rise and Its Impact on Coastal Zones, *Science*, Vol. 328, pages 1517 – 1520; OCHA, Climate Change and Humanitarian Action, at 3.

[32] Church, J.A. and N.J. White, 2006. A 20th century acceleration in global sea-level rise, *Geophysical Research Letters*, Vol. 33; UN-HABITAT, *Cities and Climate Change*, at 66.

[33] IPCC, *Climate Change and Water*, at 20. However, there was a reduction in global Mean Sea Level rise rate from 2005 – 2008 of approximately 2 mm/year. Ablain, M., A. Cazenave, G. Valladeau, and S. Guinehut. 2009. A new assessment of the error budget of global mean sea level rate estimated by satellite altimetry over 1993–2008. *Ocean Science* 5, 193-201.

[34] McGranahan, G., D. Balk and B. Anderson, 2007. The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones. *Environment and Urbanization* 19:17; OCHA, Climate Change and Humanitarian Action, at 3.

[35] WMO/GWP Associated Programme on Flood Management, Flood Management in a Changing Climate: A Tool for Integrated Flood Management (August 2009), at 10. See, for example, Pickering, M.D., N.C. Wells, K.J. Horsburghb, and J.A.M. Green, 2012, The impact of future sea-level rise on the European Shelf tides, *Continental Shelf Research*, Volume 35(1), Pages 1–15; Ruocco, A.C., R.J. Nicholls, I.D. Haigh and M.P. Wadey, Reconstructing coastal flood occurrence combining sea level and media sources: a case study of the Solent, UK since 1935. *Natural Hazards*, Volume 59(3) - 1773-1796.

[36] UN-HABITAT, *Cities and Climate Change*, at 66.

[37] *Id.*, at 71; See also Leatherman, S. P., K. Zhang, and B. C. Douglas (2000), Sea level rise shown to drive coastal erosion, Eos Trans. AGU, 81(6), 55.

[38] U.S. Environmental Protection Agency, Coastal Zones and Sea Level Rise, http://epa.gov/climatechange/effects/coastal/index.html.

[39] OCHA, Climate Change and Humanitarian Action, at 2.

[40] *Id.*, at 3.

Subsidence poses another concern.[41] Climate change is likely to further increase the frequency and intensity of drought-induced soil subsidence,[42] as groundwater usage is likely to intensify during hot and dry periods.[43] The draining of aquifers can cause large sinkholes to form in urban areas or under industrial facilities, thereby increasing the risk of emergencies, including industrial accidents. Subsidence can also significantly contribute to flooding, as seen in Thailand,[44] where severe flooding in the fall of 2011 is considered to be the country's worst in fifty years.[45]

Climate change will also cause more frequent, intense, and longer-lasting extreme heat events.[46] In addition to restricting water availability for some areas (such as communities dependent on glacial melt water) and generating increased energy, heat events are more likely to harm vulnerable groups, including the poor, elderly, the young, and those with health conditions.[47] More directly, heat events can lead to natural disasters such as forest fires. In 2010, record-breaking temperatures and drought created the conditions for widespread forest fires across central Russia.[48] The fires killed more than 60 people, left over 2,000 people homeless, and caused billions of dollars' worth of damage. A February 2012 study found that the frequency of heat waves has increased by a factor of three, linking the 2010 events in Russia to both natural climate fluctuations and human-induced warming.[49]

Extreme heat can also affect the ability to respond to an environmental emergency. There is some evidence that high temperatures can prevent planes from taking off,[50] which could cause difficulties for relief planes in areas without sufficiently long runways. High temperatures can also affect the stability of relief materials or chemicals used to fight industrial accidents, as well as human susceptibility to toxicity.[51] In addition, high temperatures can have secondary effects bearing on vulnerability to environmental emergencies. For example, ocean warming combined with more intense El Niño events has led to a dramatic increase in coral bleaching, which could undermine protection of coastlines from waves, storm surges, and coastal erosion.[52] Increased sea surface temperatures have also been linked to extensive increases in hurricane activity.[53]

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[41] See, for example, Ericson, J.P., C.J. Vorosmarty, S,L. Dingman, L.G. Ward and M. Meybeck, 2006, Effective sea-level rise and deltas: causes of change and human dimension implications, *Global and Planetary Change* Vol 50, pages 63–82.

[42] Swiss Re, The Hidden Risks of Climate Change: An Increase in Property Damage from Soil Subsidence in Europe (2011), at 7 (hereafter "Swiss Re, The Hidden Risks of Climate Change").

[43] UN-HABITAT, *Cities and Climate Change*, at 71.

[44] The World Bank, *Climate Risks and Adaptation in Asian Coastal Megacities: A Synthesis Report*, at 23-31 (World Bank 2010).

[45] Environment News Service, "Natural Disasters Make 2011 a Record Year for Insurance Loss," January 4, 2012.

[46] UN-HABITAT, *Cities and Climate Change*, at 69. See, for example, Gaffen, D.J, and Ross, R. Increased summertime heat stress in the U.S. *Nature* 1998;396:529 –30.

[47] *Id.*, at 70. See also Luber, G. and M. McGeehi 2008. Climate Change and Extreme Heat Events. American Journal of Preventative Medicine 35(5) – 429-435.

[48] Goldammer, J.G. 2010. Preliminary Assessment of the Fire Situation in Western Russia. Analysis of 15 August 2010, presented at the State Duma, Moscow, 23 September 2010. International Forest Fire News No. 40, 2-23.

[49] University of Oxford, "Russia Heat Wave 'Had Both Manmade and Natural Causes,'" Feb. 21, 2012; Lauren Morello, ClimateWire, "New Study Finds Epic Russian Heat Wave Most Likely Caused by Climate Change (Feb. 23, 2012).

[50] Pilotfriend, Effect of temperature and altitude on airplane performance, http://www.pilotfriend.com/training/flight_training/aft_perf.htm.

[51] For general links between temperatures and human toxicity, see C.J. Portier, et al. 2010. A Human Health Perspective on Climate Change: A Report Outlining the Research Needs on the Human Health Effects of Climate Change. Research Triangle Park, NC: Environmental Health Perspectives/National Institute of Environmental Health Sciences.

[52] R. Buddemeier, J. A. Kleypas, and R. B. Aronson, Potential Contributions of Climate Change to Stresses on Coral Reef Ecosystems (February 2004), at 15, 31.

[53] ScienceDaily, "Increased Hurricane Activity Linked to Sea Surface Warming" (Jan. 30, 2008).

Climate change will also affect droughts and their impact on human populations. The frequency, duration, and geographic extent of extreme droughts are all expected to increase.[54] The impacts of such drought events include stress on water supplies and greater risk of food and water shortages, malnutrition, and water- and foodborne diseases.[55] These effects, while not directly linked to environmental emergencies, can all exacerbate the effects of an emergency whose occurrence coincides with a drought event – particularly since abrupt changes in drought frequency and duration are possible.[56]

The impacts of climate change on environmental emergencies will also be felt on a geographic scale. The combined effects of sea level rise, temperature increases, and the other phenomena noted above suggest that emergencies may be more likely to occur in places, such as the Arctic, where they did not pose a risk in the past. The historical location and specific types and sources of emergencies may change, as hurricanes and tropical storms move northward.[57] In addition, more extreme weather events may occur at different places at the same time, further stretching international response efforts.

While most impacts of climate change on environmental emergencies relate to adaptation (e.g., extreme weather events and other disasters), climate mitigation efforts may also pose a risk. For example, an increased emphasis on producing biofuels or carbon capture and storage facilities means that more industrial plants will likely be constructed, including in urban areas. Those constructing such plants should consider the potential effects of climate change and urbanization trends on facility safety, so as to reduce their vulnerability to accidents and secondary effects of extreme weather events.[58]

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[54] Burke, E.J., S.J. and N. Christidis. 2006. Brown, Modeling the recent evolution of global drought and projections for the 21st century with the Hadley Centre climate model. *Journal of Hydrometeorology,* 7(5): 1113-1125.; Burke, E.J. and S.J. Brown. 2008. Evaluating uncertainties in the projection of future drought. *Journal of Hydrometeorology* 9(2): 292-299; IPCC, Climate Change and Water, at 42;

[55] *Id.*, at 41, Table 3.2.

[56] U.S. Global Change Research Program, Global Climate Change Impacts in the United States, at 26 (www.globalchange.gov/images/cir/pdf/Global.pdf).

[57] Esteban, M., C. Webersik, and T. Shibayama (2010) *Methodology for the Estimation of the Increase in Time Loss due to Future Increase in Tropical Cyclone Intensity in Japan*, Climatic Change, vol. 102, no. 3-4, Springer.

[58] For information about the potential dangers posed by carbon capture and storage facilities, see Fogarty, J. and M. McCally, "Health and Safety Risks of Carbon Capture and Storage," JAMA, January 6, 2010—Vol 303, No. 1, at 67-8.

B. Implications of Climate Change for Environmental Emergency Preparedness and Response

The interactions between climate change and disasters raise several concerns about how to respond to environmental emergencies that arise in the context of climate change. One notable question is how to prepare for such emergencies given the increased probability of, but uncertain timing regarding, future extreme weather events. This is particularly true given the geographic implications of a greater number of events taking place in more areas around the world and the strain these events are likely to place on existing resources. As this study discusses in Part IV, efforts to strengthen preparedness should be undertaken at the regional level.

Climate change highlights the critical need for more accurate forecasting, early warning, and data sharing. One issue is the lack of updated data on climate-related disaster risks (including where climate-related disasters are most likely to strike) and how to translate these risks into an improved response. The 2011 IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation provides more recent data on the increased risks posed by climate change, based both on climate extremes and on the exposure and vulnerability of human and natural systems.[59] Using this data, OCHA and UNEP could develop a more programmatic approach focusing on coastal cities and emergency preparedness.

On a related note, more accurate vulnerability assessments are needed to identify areas facing an increased risk of environmental emergencies linked to climate change (the level and completeness of vulnerability assessments can help indicate the level of disaster preparedness for a given region).[60] For example, existing vulnerability assessments conducted by industry in the context of Natechs[61] do not include natural hazard triggers.[62] Similarly, risk assessments can be used to determine the nature and extent of risk to populations, property, services, livelihoods, and the environment by evaluating existing conditions of vulnerability and exposure to potential hazards.[63] The identification of hot spots through the use of hazard mapping could also be useful, although hot spots should not draw attention away from other priority areas. Greater use of satellites could help with mapping hazardous areas, such as those prone to flooding, although risk assessments based on such mapping should be interpreted together with community-level vulnerabilities.[64] These maps should be regularly updated, with new information incorporated into past assumptions of risk for events like floods, which should then be provided to those countries sharing river basins.

In addition, more information is needed about the links between an increase in the frequency and severity of natural disasters and the secondary impacts that would constitute environmental emergencies (such as the considerable inland oil spill at the Murphy Oil Refinery following Hurricane Katrina in Louisiana).[65] Similarly, there appears to be a lack of education and awareness at many levels about the particular risks that climate change poses with respect to environmental emergencies.

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[59] IPCC SREX Summary for Policymakers, at 4.

[60] Cruz, A.M, L.J. Steinberg, A.L.V. Arellano, J.-P. Nordvik, & F. Pisano, *State of the Art in Natech Risk Management* (European Communities 2004), at 16 (hereafter "Cruz, *Natech Risk Management*").

[61] Natechs is the abbreviation for natural hazard-triggered technological accidents.

[62] *Id.*, at 51.

[63] ISDR, Terminology on Disaster Risk Reduction, http://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf

[64] Responding to Flooding, at 8.

[65] Picou, J.S., "Katrina as a Natech Disaster: Toxic Contamination and Long-Term Risks for Residents of New Orleans" (June 30, 2009). For a general discussion of Natech issues, including the need for further research, see Cruz, *Natech Risk Management*.

Box 3. Case Study: Climate Change and Flood Preparedness in Pakistan

The severe floods that hit Pakistan in the late summer of 2010 and early fall of 2011 demonstrate the compounding effect that climate change can have on environmental emergency response. The 2011 monsoons fell on a country still recovering from the record-setting monsoon season of 2010, which caused the Indus River to breach its banks and bury one-fifth of Pakistan under water. An analysis of weather patterns over the past sixty years shows that this type of flooding is more likely to occur in the future. This means that disaster response will have to quickly contribute to recovery and preparedness so that Pakistan is ready by the time the next floods arrive.

Floods present a particularly complex problem in Pakistan, where approximately one-third of household income is derived from the agricultural sector. Prolonged and severe flooding of agricultural land has led many people to find other sources of income, putting further pressure on cities.

Pakistan is already taking steps to address these problems, but given the repetitive threat that flooding poses, it is important that relief efforts are tightly coupled with recovery efforts, and that recovery efforts focus on building resilience to future floods. Pakistan's National Disaster Management Authority is planning to construct storage facilities in high-risk areas that contain flood relief equipment and emergency food and medical supplies. Since accessing flood victims is one of the primary challenges of flood relief, distributing these storage facilities will allow stranded communities to engage in limited "self-help" until relief crews are able to reach them.

Since flooding can be linked to trends in climate change, international response groups should incorporate this long-term outlook into their actions. It is important to focus not only on rebuilding infrastructure, but also on promoting integrated flood risk management that includes preparedness planning, early warning, flood proofing (rather than prevention), and watershed management. For example, Pakistan is laced with an old, poorly-maintained irrigation system that has not been modernized and does not effectively serve the country during the dry months, when water is scarce. Instead of focusing recovery efforts on restoring the status quo, it would be less costly in the long run to take the opportunity to modernize the irrigation system and improve storm water management as well as dry season water availability throughout the year.

For more information, see Independent Evaluation Group, The World Bank, "Response to Pakistan's Floods: Evaluative Lessons and Opportunity" (2010), http://siteresources.worldbank.org/EXTDIRGEN/Resources/ieg_pakistan_note.pdf; Vulnerability, Risk Reduction, and Adaptation to Climate Change – Pakistan (Climate Risk and Adaptation Country Profile: Global Facility for Disaster Reduction and Recovery Climate Investment Funds, and the World Bank, April 2011), http://sdwebx.worldbank.org/climateportalb/doc/GFDRRCountryProfiles/wb_gfdrr_climate_change_country_profile_for_PAK.pdf.

III. URBANIZATION

"Rapid urbanization and the growth of megacities, especially in developing countries, have led to the emergence of highly vulnerable urban communities, particularly through informal settlements and inadequate land management."

(IPCC 2012)

Source: UN Photo 2010. Rapid urbanization in Dhaka, Bangladesh.

URBANIZATION has become one of the defining trends of the twenty-first century. The combination of rapid population growth and transformation of the global economy means that almost all growth in the near future will take place in urban centers of developing countries.[66] Cities can provide increased economic opportunities, better educational choices, and an improved quality of life; life expectancy is higher for urban residents.[67] At the same time, urban residents who cannot afford to live in areas with adequate infrastructure, housing, and sanitation face increased risks from environmental emergencies.

Urbanization is also creating risks for large numbers of people. As the IPCC has noted, "[r]apid urbanization and the growth of megacities, especially in developing countries, have led to the emergence of highly vulnerable urban communities, particularly through informal settlements and inadequate land management."[68] Furthermore, the detrimental impacts of urbanization on the scope and scale of environmental emergencies will only be magnified by climate change.[69] The 2010 *World Disasters Report* notes that "[l]ow-income urban residents are particularly vulnerable to climate change for a variety of reasons, including: 1) greater exposure to hazards (e.g., through living in makeshift housing on unsafe sites); 2) lack of hazard-reducing infrastructure (e.g., roads allowing emergency vehicle access); 3) less adaptive capacity (e.g., inability to move to less dangerous sites or access savings or insurance); 4) less state provision of assistance; 5) less legal and financial protection."[70] The concentration of large numbers of residents in urban areas, together with the risks of extreme weather events linked to climate change, thus poses significant challenges for disaster response.

A. Urbanization Trends

People move to cities for a multitude of reasons: proximity to economic opportunity, access to health care, access to electricity and other utilities, and even refuge from conflict or famine. Urbanization is often perceived to be one of the hallmarks of a developed country, marking a shift away from agriculture and subsistence living to a more vibrant and industrial economy.[71] However, nearly three-quarters of the urban population and most of the largest cities in the world are now located in low- and middle-income countries, with a seven-fold increase in the urban populations of low- and middle-income countries since the 1950s.[72] This trend can present problems when governments lack resources to guide the structure and growth of cities and to adapt institutions to a more urbanized society.[73]

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[66] Cohen, B., "Urbanization in developing countries: Current trends, future projections, and key challenges for sustainability," Technology in Society 28 (2006), at 63-80.

[67] IFRC, *World Disasters Report 2010,* at 8.

[68] IPCC SREX Summary for Policymakers, at 8.

[69] UN-HABITAT, *Cities and Climate Change*, at 1.

[70] IFRC, *World Disasters Report 2010*, at 21.

[71] IFRC, *World Disasters Report 2010*, at 17.

[72] Satterthwaite, D. et al, *Adapting to Climate Change in Urban Areas: The Possibilities and Constraints in Low and Middle-Income Nations* (IIED Working Paper), at vii & 6.

[73] IFRC, *World Disasters Report 2010*, at 18.

More than half of the world's population lives in cities and, by 2030, the urban population is expected to exceed 5 billion.[74] In Asia alone, urban populations were projected in 2009 to gain 3.5 million people every month for the next two years.[75] In Latin America and the Caribbean, urban populations are expected to grow 85 percent by 2030, in a region that is already one of the most urbanized in the world.[76]

Along with this shift toward a more urban population, demographic shifts such as an increase in the percentage of older residents relative to younger people, and an increase in the populations of developing countries relative to developed ones will reshape the challenges of and responses to environmental emergencies.[77] This will likely affect the availability of resources for relief efforts and will also alter the types of needs responders will face.

B. Effects of Urbanization on the Scope and Scale of Environmental Emergencies

The explosive growth in urban areas has increased vulnerabilities to environmental emergencies, including fires, explosions, and the dispersal of toxic substances.[78] Since 1990, the population of urban slum dwellers has grown,[79] and an estimated one-third of the world's population currently resides in slums.[80] Port-au-Prince, Haiti, for example, was designed for 250,000 people, but rapidly grew to contain more than two million people.[81] The emergence of slums within growing cities means these neighborhoods are being built in some of the least desirable and most environmentally vulnerable areas, such as steep hillsides and other unstable ground, over high-volume pipelines, and in floodplains.

In addition, most of the new megacities are located on the coast, further increasing their vulnerability.[82] The number of people living in a 100-year flood plain is predicted to grow from 40 million to 150 million over the next century.[83] The extensive growth of megacities in Asia will be a significant factor behind the projected development in coastal flood risk worldwide.[84] In West Africa, where much of the population already resides in growing coastal cities, the 500-kilometer stretch of coast between Accra, Ghana, and the Niger Delta will be almost completely urbanized by 2020.[85] The combination of urban growth, industrialization, and extensive oil, gas, and

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[74] United Nations Population Fund, Linking Population, Poverty and Development, http://www.unfpa.org/pds/urbanization.htm.

[75] United Nations, Department of Economic and Social Affairs, World Urbanization Prospects, the 2009 Revision, http://esa.un.org/unpd/wup/index.htm.

[76] *Id.*

[77] Sullivan, C., "As Earth Nears 7B, Experts See Biggest Impact on Cities," (Climate Wire Oct. 19, 2011).

[78] Grünewald, F., B. Renaudin, C. Raillon, H. Maury, J. Gadrey, and K. Hettrich, *Mapping of Future Unintentional Risks: Examples of Risk and Community Vulnerability* (Groupe URD 2010), at 34 (hereafter "Grünewald, *Mapping of Future Unintentional Risks")*.

[79] UN-HABITAT/UNESCAP, *Are We Building Competitive and Livable Cities? Guidelines for Developing Eco-efficient and Socially Inclusive Infrastructure* (2011), at 14.

[80] UN-HABITAT, *Cities and Climate Change*, at 69.

[81] IFRC. *World Disasters Report* 2010, at 23.

[82] Population Reference Bureau, Human Population: Urbanization, http://www.prb.org/Educators/TeachersGuides/HumanPopulation/Urbanization.aspx.

[83] UN-HABITAT, *Cities and Climate Change*, at 70-71.

[84] Id., at 71.

[85] Brooke, R., "What if Japan Happened in Africa?", The Mark, April 4, 2011.

mineral exploitation in a region already experiencing coastal storms and surges creates a major vulnerability to future weather-related disasters.[86]

Rapid urban growth, often without the benefit of land use planning and building standards, can amplify vulnerability to disasters and poses considerable challenges for those responding to such events.[87] For example, expansive informal settlements with no functional building codes and road maps create a greater likelihood that houses will collapse and that rescue workers will have difficulty reaching residents in distress.[88] Slum developments may present other factors that increase vulnerability, such as dangerous electric lines, dispersed sewage, a lack of stormwater drainage, and no solid waste control.[89] Furthermore, as cities expand, people are moving closer to dangerous industrial facilities (previously sited at a safe distance), increasing their vulnerability to harm in the event of an industrial accident.[90]

Overcrowding in urban areas can generate traffic problems, complicating the ability of relief teams to rely on ground transport to navigate a disaster zone. The lack of a sufficient street network in crowded areas can also hinder relief efforts. For example, in Haiti following the 2010 earthquake, relief convoys were slowed by the lack of access roads – often, there were only unmarked "corridors" – between streets.[91] (For more details on lessons learned from the earthquake response in Haiti, please see Box 4.)

One of the greatest risks facing vulnerable urban communities is flooding. Floods are one of the most costly and damaging disasters, and they are expected to increase in frequency and severity, particularly in Asia, Africa, and Latin America.[92] As the urban footprint spreads, the area of impermeable ground grows – thereby increasing the volume of stormwater runoff. Rapid, unplanned growth means that storm water management systems often develop much more slowly than population growth, leaving many areas without any drainage systems whatsoever. Even where drainage systems do exist, they often become clogged by trash and debris as a result of inadequate municipal solid waste management, resulting in backups throughout the city.

Because inadequate drainage can turn a historically average rain event into a flood event, emergency responders in urban areas must be prepared to deal with sudden floods. In Bangkok, a combination of overbuilding in catchment areas, urban sprawl, and the filling-in of canals was predicted to contribute to (and has in fact resulted in) extensive damage from flooding.[93] Similarly, in Kampala, Uganda, over half of the population lives in informal settlements where construction, roads, and the accumulation of trash have combined to reduce natural drainage capability, making people (particularly children) vulnerable to flooding from even small amounts of rain.[94]

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[86] *Id.*

[87] Inter-Agency Standing Committee, IASC Strategy, Meeting Humanitarian Challenges in Urban Areas (2010), at 4-5 (hereafter "IASC Strategy").

[88] UN OCHA, "Humanitarian Issues: Tackling Environmental Emergencies in Slums" (Feb. 14, 2012). http://www.unocha.org/top-stories/all-stories/humanitarian-issues-tackling-environmental-emergencies-slums.

[89] IFRC, *World Disasters Report 2010*, at 21, Table 1.2.

[90] Grünewald, *Mapping of Future Unintentional Risks*, at 34.

[91] IFRC, *World Disasters Report 2010*, at 23.

[92] UN-HABITAT, *Cities and Climate Change*, at 68.

[93] Mydans, S., "As Thailand Floods Spread, Experts Blame Officials, Not Rains," *New York Times* (October 13, 2011).

[94] UN-HABITAT, *Cities and Climate Change*, at 87 (Box 4.10).

With more people living in cities, and many cities located on coasts or in river basins, response efforts may need to be amplified for the same magnitude storm event. For instance, five inches of rainfall in the Yangtze River Basin may have caused only minor flooding in uninhabited areas twenty years ago, but in areas of significant population growth, the effects of increased runoff and inadequate stormwater drainage now combine to greatly intensify the effects on urban residents. Not only do urban floods destroy buildings and roads and cause deaths and injuries, they can contaminate clean water supplies and treatment centers, facilitate the spread of waterborne disease, and circulate trash and pollutants.[95]

Urbanization is also creating vulnerabilities with respect to subsidence – which, as noted in Part I of this paper, is also affected by climate change. In essence, many cities are sinking. Settlements built on deltas are compressing loose soil and slowly sinking as they grow. Cities that sit atop aquifers may also begin to sink or encounter sinkholes, as aquifers are drawn down by a growing population more quickly than they can be recharged. Subsidence threatens settlements and infrastructure, such as roads, that could collapse and become unusable. It also threatens to damage industrial facilities or waste storage facilities that could leak hazardous materials into the environment as a result. In some regions of Europe, damages from subsidence have exceeded those of most other natural hazards and are as great as those caused by floods.[96] Subsidence has been observed in cities around the world, from Tokyo and Dhaka to Shanghai, Manila, and Jakarta, among others.[97] In Bangkok, where extensive flooding occurred in 2011, urban development has been linked to widespread ground subsidence, and resulting problems with flooding and structural damage, for nearly thirty years.[98]

Another threat linked to urbanization is landslides. The process of soil weathering and erosion, caused in part by the clearing of vegetation to construct buildings and roads, can weaken soil stability and increase the likelihood of landslides.[99] In addition, shoddy construction and deficient infrastructure can exacerbate slope degradation, which also increases the risk of landslides[100] – as seen in Port-au-Prince, Haiti, after the 2010 earthquake. These destructive events are likely to increase with the expansion of urban development onto marginal lands, such as steep slopes.[101]

Extreme heat events, which are linked to climate change, can also exert greater impacts on urban populations. Stagnant conditions can trap pollutants in urban areas, subjecting residents to unhealthy air at the same time that they are confronting high temperatures.[102] The urban heat-island effect (in which asphalt and concrete retain heat during the day and release it at night) can raise temperatures even higher, although the severity of this effect depends on a city's physical layout, population size and density, amount of green space, and other factors.[103]

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[95] *Id.*, at 68.

[96] Swiss Re, The Hidden Risks of Climate Change, at 1.

[97] UN-HABITAT, *Cities and Climate Change*, at 71.

[98] Gupta, A., Ecology and Development in the Third World, at 72 (Case study J on urban development, subsidence, and flooding in Bangkok) (Taylor & Francis 1998).

[99] UN-HABITAT, *Cities and Climate Change*, at 68.

[100] *Id.*

[101] *Id.*

[102] The Disaster Center, www.disastercenter.com/guide/heat.html.

[103] UN-HABITAT, *Cities and Climate Change*, at 69-70.

To sum up, urbanization trends generate multiple risks that can trigger or exacerbate environmental emergencies. In some cases, these trends can combine with climate change to cause even more harm to the environment and human health. These trends can increase the vulnerabilities of urban areas to environmental emergencies, as well as the costs imposed by such emergencies. Urbanization also poses obstacles for delivering assistance in response to an environmental emergency. The growing vulnerability of urban areas to emergencies, combined with the higher costs associated with responding to such emergencies, is likely to draw heavily on available financial and other resources. Finally, urbanization poses unique challenges with respect to the coordination of emergency responders, as discussed further below.

C. Implications of Urbanization for Environmental Emergency Preparedness and Response

In congested cities, the impacts of environmental emergencies are likely to be greatly magnified, as shown above. These impacts pose significant challenges for international responders to environmental emergencies. The Inter-Agency Standing Committee (IASC) Strategy on Meeting Humanitarian Challenges in Urban Areas has acknowledged that the skills needed to facilitate relief, recovery, and reconstruction in urban areas differ from those required in rural areas:

> Humanitarian actors need knowledge of urban and spatial planning, shelter/housing rehabilitation and water and sanitation adapted for operations in complex, dense and under-serviced urban environments. In addition, knowledge of urban vulnerability and community resilience analyses, beneficiary targeting approaches, land use and tenure patterns, strategic planning for urban relief strategy development and engagement of national and municipal authorities are all increasingly essential skills for urban crises responses.[104]

A first challenge is how to transport emergency responders and equipment to the location of an environmental emergency. The lack of sufficient roads in congested urban areas, particularly in slums and other informal settlements, can hinder or completely block first responders who will also need to identify the major secondary environmental impacts and risks. Events such as floods can further hinder response efforts by short-circuiting transformers, thereby disrupting energy transmission and distribution.[105]

Access to slums by emergency responders poses a particular challenge with respect to security. The absence of government institutions further enables the development of organized crime as a substitute authority. This can make it difficult for emergency responders to safely reach vulnerable areas. Further destruction and looting can also take place as displaced populations return to their homes.[106]

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[104] IASC Strategy, at 3.

[105] UN-HABITAT, *Cities and Climate Change*, at 68.

[106] UN Human Settlements Programme, Humanitarian Affairs, and the Role of UN-HABITAT: Strategic Policy on Human Settlements in Crisis and Sustainable Relief and Reconstruction Framework (2008), at 24 (hereafter "UN, Strategic Policy on Human Settlements in Crisis").

A second challenge is how to evacuate vulnerable populations from the areas surrounding an emergency event. In some cases, evacuation may not be possible. For example, evacuating a flooded city may not be appropriate or feasible, and if it is, responders must figure out how to evacuate the population and where to send people.[107] Evacuation can be hazardous or even deadly if not orchestrated properly. In Houston, Texas, thirty-one people died while evacuating from Hurricane Rita under hot and crowded highway conditions.[108] At least some of those deaths were linked to heat exhaustion.[109]

A third challenge is the lack of contingency plans for responding to environmental emergencies in urban areas, particularly for industrial facilities. Without such plans, responders are less likely to know what dangers may be posed by leaking hazardous chemicals or spills, and how to address them. Even where such plans exist, they will not be useful if they are not sufficiently accessible, both in terms of actual location and with respect to the language in which they are written.

In thinking about emergency response, the question also arises as to whether mitigation of any kind is even feasible. In some cases, it simply may not be possible to mitigate or respond directly to the emergency - for example, when flooding takes place in an area where the drainage channels are already completely full. Thus, it is important to recognize that where there are major emergencies, the options for mitigation, compared to simply letting the emergency run its course (while undertaking whatever humanitarian relief is possible, such as evacuation), may be very limited.

D. Coordinating Response to Environmental Emergencies at the Local, National, Regional, and International Levels

In addition to the settlement trends discussed above, urbanization has magnified the challenge of how to coordinate disaster response across different geographic levels (local, national, and international). As international response to environmental emergencies raises coordination challenges that are too numerous to address here, this section will examine challenges that relate specifically to environmental emergencies in urban areas.

Urban areas can present particular coordination challenges, although they also provide opportunities given their available capacities and the localized nature of impacts. Capacity to respond at the local and national levels varies significantly. Because urban areas have greater overall capacity and staff, there may be incentives for international responders to work directly with municipal institutions. At the same time, protocol requires the coordination of international assistance with national governments, even though national capacity is lacking in many countries.

A first question is therefore how international organizations should coordinate their response efforts for environmental emergencies with national governments (who usually are responsible for foreign relations) and local authorities (who usually have more familiarity with a particular context). This may be further complicated by the

[107] Wilton Park, Responding to Flooding, at 11.

[108] O'Hare, P., "Heat Forces Closure of FEMA Office for the Day," *Houston Chronicle* (September 28, 2005).

[109] Knabb, R. D., D. P. Brown, and J. R. Rhome, National Hurricane Center, Tropical Cyclone Report: Hurricane Rita (March 2006), at 8.

fact that in some areas, municipal governments may be as well (or possibly better) prepared as national governments to lead the response to environmental emergencies. This raises the question of how the international community should coordinate with municipal actors without neglecting national governments. For their part, local or national authorities do not always know when and how to call on the international community for assistance. Thus, problems may exist at many different levels when governments and organizations respond to environmental emergencies.

The IASC Strategy on Meeting Humanitarian Challenges in Urban Areas sets forth ideas on how international groups can partner with national governments.[110] For example, a clear and effective strategy for multi-stakeholder partners should be developed in high-risk areas before crisis occurs, or at the beginning of an emergency. The strategy should provide for the host government to lead, or at least coordinate, the emergency response effort. This can maximize available institutional capacity, foster local ownership, reduce dependency on assistance, and avoid creating parallel response structures.

While international responders may be formally paired with a country's Ministry of Foreign Affairs, in reality they end up working with local authorities. Yet again, often, there is insufficient information available to the international response community about who is in charge of disaster response at the municipal level – not to mention, as may be applicable, the state, province, district, and national level. That is, with whom at each level does the international community coordinate? How does the communication process work? Although there is necessarily some overlap in responsibilities, it is not clear in what areas, or to what extent, this should be the case.

On a related note, municipal governments often are not well integrated into national and international response frameworks. In some cases, local authorities do not know whom to call for help responding to an emergency or even whether or how to contact authorities at the international level. Even contacting the national government does not always lead them to the right persons or groups. Because municipal governments can play a significant role in responding to emergencies in megacities, their participation in response efforts should not be marginalized.

The lack of information sharing is another significant gap. Currently, there is no existing standardized mechanism for sharing information between different levels of responders to an environmental emergency. For example, following the 2010 earthquake in Haiti, UNEP struggled to convey information to the humanitarian community about how to handle solid waste disposal issues in Internally Displaced Person (IDP) camps (see discussion in Box 4). Moreover, information about the need for services, and what services can be provided (including by international organizations and agencies), is not readily available to local, national, regional, and international organizations and agencies.

Similarly, there is no clearinghouse at the national level for any existing local, national, or regional environmental emergency response plans. This further reinforces the lack of awareness by different levels of government of what each other is doing, or will do, in response to an emergency. UNEP and OCHA have called for the development of a clearinghouse for environmental emergency response – a

[110] IASC Strategy, at 4-5.

"centralized mechanism for receiving and fielding requests for international assistance and information about environmental emergencies".[111] They have also recommended the development of standard operating procedures, or a joint management plan, that would outline agreed roles and responsibilities across a number of environmental emergency response scenarios. This document could be used to help improve the coordination of international organizations responding to environmental emergencies as well as to assist with response efforts by regional organizations.[112]

There is also a need to upgrade the skills of first responders to address urban-based challenges. For example, emergencies in Haiti, Kenya, and Pakistan highlighted gaps in technical knowledge (including on urban food, water and sanitation, and shelter issues), the slow deployment of staff with appropriate technical skills, and the need for urban advisors to coordinate the greater number of actors in urban areas.[113] A stronger emphasis on capacity development during disaster mitigation can increase the ability of local government (and civil society actors) to respond effectively to disasters.[114]

The ability to quickly access financial resources to respond to a disaster can also be a challenge. The international community, working with national institutions, could help set up some structures to address this need. For example, the Caribbean Catastrophe Risk Insurance Facility (CCRIF) was established to reduce the economic impact of natural catastrophes by providing affordable insurance policies to Caribbean governments, so as to ensure immediate liquidity in the aftermath of a disaster. It is currently comprised of sixteen member governments. In 2010, CCRIF paid US $7.75 million to the Haitian Government to aid in its response to the January earthquake.

[111] UNEP Information Note, "Implementing the UNEP Governing Council Decision on Strengthening International Cooperation on the Environmental Aspects of Emergency Response and Preparedness," 9th Meeting of the Advisory Group on Environmental Emergencies (May 18-20, 2011), at 6.

[112] *Id.*, at 6.

[113] IASC Strategy, at 5.

[114] UN, Strategic Policy on Human Settlements in Crisis, at 18.

Box 4. Case Study: Earthquake Response in Haiti

Even before the 7.0 earthquake that struck in January 2010, Haiti faced severe environmental degradation, including deforestation and soil erosion, as well as water, sanitation, and waste-disposal issues, particularly in its large cities. The country's capital Port-au-Prince has followed a trend of rapid urbanization over the last several decades. Designed for a population of 250,000 people, the city rapidly grew to contain more than two million residents. Many of the environmental problems that emerged in the immediate aftermath of the earthquake had been developing for some time, though their impact was greatly heightened by the combination of underdevelopment and poor urban planning that characterized the city. The international response to the earthquake highlights some lessons about dealing with the environmental impacts of disaster response, including problems with coordination, the impacts of refugee camps, and how to bridge the gap between immediate response and long-term redevelopment.

The response to the earthquake, whose epicenter lay just 10 miles southwest of Port-au-Prince, was complicated by the fact that Haiti's central government and on-the-ground relief organizations were also victims. An estimated 40% of Haiti's government officials died during the quake and 13 out of 15 major government buildings collapsed. Aid agencies were housed in poorly-constructed multi-story buildings that also collapsed, causing great loss of life and resources. With no real capacity on the part of the central government, response teams lacked a critical point of coordination and oversight.

UNEP's attempts to focus on the environmental impacts of the earthquake response illustrate the challenges faced in addressing environmental issues during a major disaster. One big challenge involved the need to inform the humanitarian community about environmental issues that arose. For example, the establishment of camps for Internally Displaced Persons (IDPs) raised the question of how to deal with large-scale solid waste disposal issues. UNEP hosted technical experts and provided expertise to different humanitarian organizations about these and other issues, but there was no mechanism to ensure that the groups would listen and act on the information. Some groups did, while others disregarded it.

Even when individual organizations had decided to address environmental issues, problems arose, particularly regarding coordination. One general problem was that the scale of the coordination challenges (thousands of aid workers and hundreds of organizations) overwhelmed the amount of resources available. As the global focal point for environmental issues, UNEP established a number of working groups in order to coordinate efforts, but with mixed results. Some groups, such as those working on biogas to address waste disposal and improved stoves to address deforestation, were able to focus on their missions. Others, such as the environmental health working group, had trouble maintaining efforts and failed to garner much interest.

In addition to mitigating the environmental impacts of the disaster response, other challenges involved how to incorporate environmental protections into rebuilding and reconstruction, including such approaches as urban catchment restoration, land use planning, ecological sanitation, and waste management. UNEP and other international actors could address these challenges as one way to bridge the gap between short-term humanitarian assistance, recovery, and long-term development needs.

More broadly, the Haiti earthquake response illustrates some other lessons for responding to environmental emergencies. First, UNEP country programs must integrate emergency preparedness and contingency planning into their own operations. Second, UNEP should help humanitarian organizations mainstream environmental issues into their relief operations. It is too late to start doing this once a major emergency has taken place. This is critical because underlying environmental problems, which can exacerbate humanitarian and socio-economic impacts, will only grow worse as a result of natural disasters.

For more information on these issues, see UNEP, *UNEP in Haiti: 2010 Year in Review* (2011), http://postconflict.unep.ch/publications/UNEP_Haiti_2010.pdf.

IV. THE WAY FORWARD

"Adapting urban areas to climate change is not a new 'standalone' task, or responsibility that can be allocated to one single stakeholder. It requires change in the ways that almost all sectors of the government, business, and households behave and invest."

(UN-Habitat 2011)

Source: Peter Prokosch 2011. The environmental challenges of rapid urbanization in Ilakaka, Madagascar since the discovery of alluvial sapphire deposits.

THE WAY FORWARD

Although the megatrends of climate change and urbanization pose many challenges for international environmental emergency response, these challenges are not insurmountable. While megacities are more vulnerable to disasters because of their greater size and population, they also possess greater resources for preparing and responding to environmental emergencies.[115] On the climate change side, scientists are continuing to develop tools for forecasting extreme weather events and other manifestations of climate change. The question for UNEP and OCHA is how to harness these tools and resources to strengthen preparedness and response to environmental emergencies.

At the outset, it should be noted that there do not appear to be any revolutionary new approaches for dealing with the impacts of climate change and urbanization on environmental emergencies. This may be because these megatrends do not present entirely new issues; instead, they multiply or exacerbate the impacts of emergencies that the international community is already confronting. As such, the key step may be to focus more closely on preparedness, particularly at the regional level, as well as on strengthening national capacity to respond to environmental emergencies. In addition, OCHA and UNEP could consider how to develop a more programmatic approach focusing on megacities and environmental emergencies, in partnership with UN-HABITAT, UNISDR, and UNDP. More specifically, such an approach could focus on coastal cities and preparedness and include specific operational guidance on how to prepare for, and respond to, environmental emergencies.

Strengthening regional capacity could help alleviate the strain that will be placed on the international community to help with environmental emergency responses. The ***Environmental Emergencies Centre*** (EEC), which will offer online and in-person training for emergency planners, disaster managers, and national and local authorities in vulnerable low- and middle-income countries, could help facilitate a more programmatic approach to strengthening regional and national capacity to prepare for and respond to environmental emergencies. In this regard, the EEC's project document should be expanded beyond a limited number of individual country assessments in order to focus on more programmatic or thematic assessments that look at, for example, the vulnerability of coastal megacities to environmental emergencies. Such use of the EEC could improve the priority setting process and expand the EEC's reach and applicability.

In considering options for preparedness, response, and capacity building, it is important to ***enhance, utilize, and develop new and existing tools*** to forecast and share information on environmental emergencies. Strengthening regional capacity and resilience to prepare and respond to recurring environmental emergencies is critical. With climate events linked to more frequent and/or intense extreme weather events around the world, and urbanization patterns causing greater numbers of people to need help during an emergency, the resources available at the international level will in all likelihood be insufficient going forward.

Risk assessment and hazard identification are critical components of both preparedness and the initial response phase. The Awareness and Preparedness for

[115] UN-HABITAT, *Cities and Climate Change*, at 85-6.

Emergencies at Local Level (APELL) programme, developed after the Bhopal tragedy, provides information to communities to help them understand local risks and assists local and national authorities to compile a contingency plan in the event of a disaster. Although APELL was originally developed for technological and industrial accidents, UNEP is considering how it could be used to address emergency preparedness and response to risks of all kinds – in light of recent natural disasters that have caused extensive damage to health, property, and the environment – as well as efforts to promote climate change adaptation.[116] Because the main components of the APELL process apply to emergency preparedness regardless of the specific hazards present, the scope of the APELL Programme was extended to incorporate a multi-hazard approach, with project demonstrations and capacity-building pilot initiatives in India, Thailand, Sri Lanka, and Morocco.

With respect to climate change specifically, greater use could also be made of existing tools, and new tools could be developed, to help forecast and share information about where natural disasters are likely to occur, as well as provide early warning to help communities prepare to respond to environmental emergencies. Steps can also be taken to gather important information about environmental risks in particular areas before emergencies occur. For example, hazard risk and vulnerability mapping should be used to identify areas with an increased vulnerability to environmental emergencies on the basis of such factors as high population growth, poor governance, hazardous infrastructure, and low adaptive capacity.[117]

The Global Disaster Alert and Coordination System (GDACS) automatically compiles and analyzes information from diverse online sources to determine the likelihood of humanitarian intervention. Because many environmental emergencies are too small for GDACS to highlight, a similar database specifically targeted at such events would be useful. (Although APELL conducts country assessments for its Flexible Framework activities, these are not linked to response efforts.) Better use of geographic information systems and information from publications such as a risk index measuring vulnerability to natural disasters in 173 countries compiled by the German Environmental Agency and United Nations University could contribute to such a database for environmental emergencies.[118] OCHA's existing Global Focus Model, which relies on the Maplecroft database to score countries' risks by analyzing hazards, vulnerability, and capacity, could be used for this purpose.

Information and communications technology can also be deployed more fully to strengthen preparedness and response to environmental emergencies, particularly in urban areas. For example, community-based early warning systems could be carried out using cellular networks, including in areas previously identified as being prone to particular climate-related hazards such as flooding.[119] In areas with sufficient wireless access, social media (such as Twitter and Facebook) could be used to share real-time information about environmental emergencies – such as chemical spills – as they unfold, as well as about response measures. For example, social media, including an

[116] For example, UNEP's report on *Disaster Risk Management for Coastal Tourism Destinations Responding to Climate Change – A Practical Guide for Decision Makers* (2008) adapts the APELL approach to increase the capacity of coastal tourism communities to better prepare for and respond to natural disaster emergencies.

[117] Brooke, R, "What if Japan Happened in Africa?" The Mark, April 4, 2011.

[118] United Nations University, Institute for Environment and Human Security, World Risk Report (2011), http://www.ehs.unu.edu/file/get/9018.

[119] Wilton Park, Responding to Flooding, at 8.

online Google tool called "Person Finder," were used following the 2011 earthquake in New Zealand to assist search-and-rescue missions.[120]

Strengthening efforts by OCHA and UNEP to ***improve the integration of technological and industrial accidents into national contingency planning*** is also essential. Rapid urbanization is placing greater numbers of people at risk, while the likelihood of these types of accidents is increasing as well. Applying a multi-hazard approach to emergency preparedness, as outlined in UN General Assembly Resolution A/66/L.33, answers the requests by Member States and the greater international community for increased operational guidance and capacity building around preparedness and response to environmental emergencies.

It is particularly important to involve communities in such efforts, as APELL was designed to do. The APELL "Multi-Hazard Training Kit for Local Authorities – for Community Vulnerability Reduction, Prevention, and Preparedness" assists local authorities in preventing and improving preparedness for emergencies from multiple hazards that may be present in their communities.[121] The kit seeks to assist local authorities to increase public awareness of hazards, foster communication between community stakeholders (including government officials, industry representatives, and the public), and develop cooperative emergency plans for local areas.[122] Because the APELL approach is always implemented at the city or town level, it is particularly suited for urban preparedness efforts.

The fact remains that risk assessments can be very resource-intensive. Before disasters occur, UNEP's Community Risk Profile Tool can be used to help communities decide where risk assessments are needed. It can also be used to support awareness raising and capacity building.[123] Communication of risks to local populations is also an important component of disaster risk management,[124] and this tool can be employed by local authorities as well as insurers, aid agencies, and industries interested in learning more about risks in a particular area.

It is also important to assess risks and hazards in the immediate aftermath of a disaster, particularly in urban areas where a higher concentration of industrial facilities can pose a threat. The Hazard Identification Tool (HIT) and Flash Environmental Assessment Tool (FEAT) can be used to improve the assessment process after disasters occur.[125] Both tools allow first responders to identify and prioritize secondary environmental risks such as large infrastructure, nuclear facilities, hazardous waste storage sites and other facilities, and hazardous chemicals following a large-scale, sudden-onset natural disaster.

Integrating the use of these tools in environmental emergency preparedness

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[120] Tonya Garcia, "New Zealand Earthquake Spurs Social Media Response," PRNewser, February 22, 2011, *available at*: http://www.mediabistro.com/prnewser/new-zealand-earthquake-spurs-social-media-response_b15694.

[121] UNEP and INERIS, APELL Multi-Hazard Training Kit for Local Authorities – For Community Vulnerability Reduction, Prevention, and Preparedness (2010).

[122] *Id.*, at 6.

[123] UNEP and INERIS, *Assessing the Vulnerability of Local Communities to Disasters: An Interactive Guide and Methodology* (2008).

[124] IPCC SREX Summary for Policymakers, at 14.

[125] Joint UNEP/OCHA Environment Unit, *Environmental Emergencies: Learning from multilateral response to disasters* (UN 2009), Ch. 1.

and response actions may require some programmatic changes. The Inter-Agency Standing Committee's Strategy on Meeting Humanitarian Challenges in Urban Areas calls for the development of new humanitarian approaches and tools for urban areas, including standard operating procedures, rapid assessments, and other urban-specific operational strategies and tools for key humanitarian sectors.[126] OCHA and UNEP could take the lead on developing and adapting these approaches for responding to urban environmental emergencies. More generally, OCHA and UNEP could also undertake targeted communication and outreach efforts to disseminate information about the links between climate change and environmental emergencies in urban areas, particularly in vulnerable developing countries.

With respect to disaster relief, recovery, and reconstruction in urban areas more broadly, environment ***should become better operationalized as a cross-cutting issue into humanitarian response and relief activities***. Incorporating environmental training into humanitarian recovery efforts at the regional and country levels can help reduce future vulnerability to disasters and other emergency events. For example, UN-HABITAT's Strategic Policy on Human Settlements in Crisis introduces a sustainable relief and reconstruction framework that seeks to integrate disaster management efforts with a long-term reconstruction and economic recovery process.[127] The Environmental Emergencies Centre can also provide both virtual and in-person training platforms for topics ranging from "Environment as a Humanitarian Cross-Cutting Issue" to "Industrial and Technological Accidents", "Disaster Waste Management", and "Beyond Response", a training module that instructs emergency planners and disaster managers on using the HIT and FEAT tools before and after disasters occur.

The need to develop a sufficient international framework for responding to environmental emergencies is well understood. However, specific frameworks or protocols could also be developed to address the particular challenges raised by responses to environmental emergencies in urban areas, or responses to emergencies that occur in conjunction with extreme weather events triggered by climate change. Potential opportunities for the international community to focus attention on improving the international framework for responding to environmental emergencies – including those associated with urbanization and climate change – should be part of a broader strategy to build awareness, develop tools, and put these tools in place so that urbanization and climate change present opportunities for improving international preparedness and response, rather than challenges.

[126] IASC Strategy, at 6-8.

[127] UN, Strategic Policy on Human Settlements in Crisis, at 17-19.

Box 5. Case Study: Integrating Environmental Emergency Response into Humanitarian Efforts in Ethiopia

Ethiopia has many years of experience in emergency response mainly related to natural disasters, with drought and floods constituting the major hazards, followed by disease outbreaks, inter-communal conflict, and the influx of refugees from neighbouring states. Nonetheless, not much emphasis has been placed on identifying and addressing environmental emergencies such as chemical accidents and the release of hazardous wastes, which is not integrated into the current mechanism for identifying and addressing emergencies in the country *(OCHA Ethiopia, UNDP Ethiopia – Climate Change and Environment Unit (CCV))*.

The humanitarian response in Ethiopia has been largely focused on food insecurity in rural areas. These hazards are identified through the regular Early Warning System (EWS) and multi-sectoral seasonal assessments, which are primarily focused on rural areas (with the exception of flash floods and disease outbreaks captured through ad-hoc assessments).

The risk posed by environmental hazards, however, can be widely seen in major urban areas due to pollution risks from water and chemical areas, including suburban areas surrounding Addis Ababa, where factories dump pollutants into nearby rivers. With the growing urbanization of the country, such practices are becoming a concern in more and more areas. Although Ethiopia has environmental pollution prevention legislation and environmental standards, the lack of strong enforcement and absence of an integrated approach in developing a response framework remains a challenge *(UNDP Ethiopia CCV)*.

There is no mechanism currently in place for integrating environmental emergency response into the wider humanitarian response in Ethiopia. The risks of environmental emergencies (toxic waste, chemical spill, oil spills) are not regularly assessed through the existing humanitarian multi-sectoral assessment that forms the basis for identifying emergency requirements in the country. Actors including government ministries like the Environmental Protection Agency and partners such as UNEP need to be brought into the humanitarian coordination framework to ensure adequate integration.

Integrating environmental emergencies into the cluster approach used by humanitarian agencies can help ensure accountability and predictability in response efforts. This may be accomplished either by identifying a cluster lead agency for environmental emergency response at the country level, or by mainstreaming environmental emergency response into the country's respective sectors. It is also critical to raise awareness about the serious implications of environmental emergencies for human health and environmental protection. Such an awareness-raising effort should include comprehensive risk assessment and capacity building activities, as well as the development of a clear response strategy.

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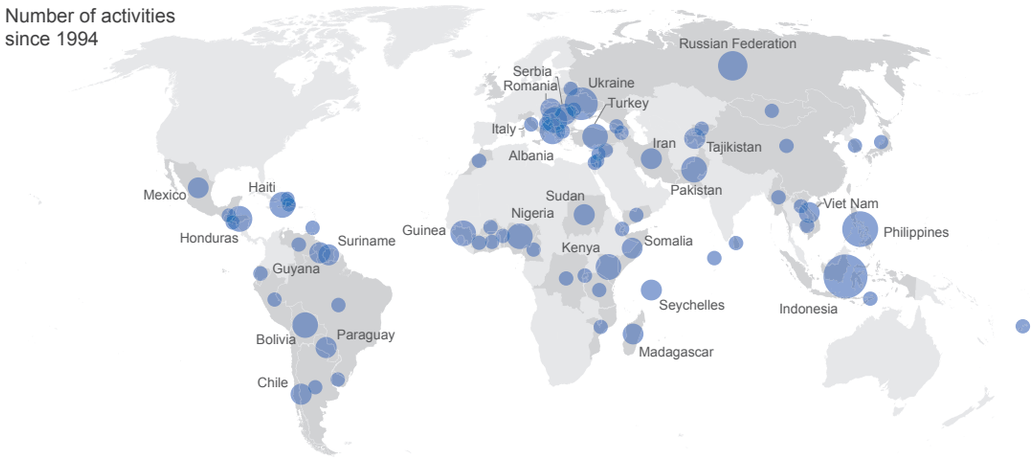
Appendix B: Environmental Emergency Section Activities (1994-2011)

Enviromental Emergencies Section Activities (as of 31 Dec 2011)

OCHA

The Joint UNEP/OCHA Environment Unit (JEU) is a collaborative arrangement between the United Nations Environment Programme and the UN Office for the Coordination of Humanitarian Affairs. It serves as the integrated United Nations emergency response mechanism to activate and provide international assistance to countries facing environmental emergencies.



								Total Activities
Albania				2		1		3
Argentina							1	1
Armenia				1				1
Belarus	1							1
Benin						1		1
Bolivia	1					2		3
Brazil					1			1
Burkina Faso						1		1
Cambodia	1							1
Cameroon				1				1
Chile			1	1				2
China				1		1		2
Côte d'Ivoire				1				1
DR of the Congo				1				1
Djibouti				1				1
Dominician Republic		1						1
Ecuador						1		1
El Salvador						1		1
Georgia				1				1
Ghana						1		1
Grenada						1		1
Guatemala		1						1
Guinea	1			1		1		3
Gulf of Mexico	1			1				2
Guyana				1		1		2
Haiti		1	1			1		3
Honduras	1	1				1		3
Hungary				2				2
Indonesia	2		3		3		1	9
Iran (Islamic Republic of)	1				1			2
Israel					1			1
Japan				1				1
Kenya	1			2				3
Kyrgyzstan				1				1
Lao PDR	1							1
Lebanon				1				1
Madagascar		1		1				2

								Total Activities
Maldives					1			1
Mexico			1					1
Moldova					1			1
Mongolia					1			1
Montenegro					1			1
Morocco					1			1
Mozambique						1		1
Myanmar		1						1
Nigeria				3				3
occupied Palestinian territory	1							1
Pakistan				1	1	1		3
Paraguay					1	1		2
Peru						1		1
Philippines				1	4	1		6
Republic of Korea					1			1
Romania					2			2
Russian Federation	1				1	2		4
Rwanda					1			1
Samoa				1				1
Serbia		1			1	1		3
Seychelles				1			1	2
Somalia	2							2
Sri Lanka				1				1
Sudan		1					1	2
Suriname					1		1	2
Syria					1			1
Tajikistan	2							2
Tanzania					1			1
FYR of Macedonia						1		1
Timor-Leste					1			1
Turkey	1			1	1			3
Turks and Caicos Islands							1	1
Ukraine	3				2			5
Uruguay							1	1
Venezuela							1	1
Viet Nam						1	1	2
Yemen	1							1

1 2 3 4 # of activities

129 activities since 1994

74 countries covered

Number of activities per year

2011	5
2010	11
2009	12
2008	10
2007	14
2006	11
2005	9
2003	10
2004	5
2002	4
2001	1
2000	9
1999	4
1998	8
1997	8
1996	3
1995	3
1994	2

The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Creation date: 14 Feb 2012 **Sources:** UNEP, UNCS **Feedback:** ochaavmu@un.org www.unocha.org www.reliefweb.int

Appendix C: Additional Platforms for Environmental Emergency Preparedness and Response

On monitoring/early warning of environmental emergencies:

1. UNEP's Early Warning Systems (EWS) Report: http://na.unep.net/geas/docs/Early_Warning_System_Report.pdf
2. Early Warning Portal of Global Risk Identification Programme (GRIP) : http://www.gripweb.org/gripweb/?q=early-warning-systems-catalogue
3. UNEP's Global Environmental Alert Service (GEAS): http://na.unep.net/geas/
4. UNEP live: http://www.uneplive.org/uneplive/catalog/main/home.page

On risk assessment:

1. Global Risk Identification Programme (GRIP): www.gripweb.org
2. Country pages on GRIP Web: http://www.gripweb.org/gripweb/?q=countries-risk-information

Sudden-onset disasters resulting from natural, technological, or human-induced factors (or a combination of these) that cause severe environmental damage as well as loss of human lives are known as environmental emergencies. Recently, the world has experienced a large number of devastating natural disasters and environmental emergencies, including tsunamis, floods, earthquakes, and the secondary impacts of chemical accidents, fires, and oil spills that compounds injury and devastation. The increase in frequency and intensity of recent disasters—mainly due to climate change—poses significant challenges in providing assistance to those affected by these events.

Rapid urbanization and increased urban poverty, particularly in developing countries, increases vulnerability to disasters as many more people live in informal settlements that lack sufficient infrastructure. Disasters and emergencies in urban areas pose many challenges for emergency responders and can overwhelm national and local capacity.

This publication explores the megatrends of urbanization and climate change, highlighting the major factors that contribute to increased vulnerability to natural disasters and environmental emergencies, and the implications for improving preparedness and response to these events. It has been carried out by the Environmental Law Institute, upon request of the international Advisory Group on Environmental Emergencies. The study contains practical recommendations for the UN Environment Programme and the UN Office for the Coordination of Humanitarian Affairs to assist vulnerable communities and countries in building resilience to future disasters and emergencies.