CHAPTER 2: African Cities in the Face of Climate Change and Urban Infrastructure Investment

Abstract

It has become obvious that the value of a single "green" building or eco-labelled product is marginal if it is not supported by sustainable urban infrastructure and a culture of sustainability. Developing countries need international assistance to support adaptation in the context of national planning for sustainable development, more capacity-building and transfer of technology and funds. Data collection was done through desktop analysis, secondary data analysis and report analysis. Systematic planning and capacity-building are also needed to reduce the risk of disasters and raise the resilience of communities to increased extreme events such as droughts, floods and tropical cyclones. Funding for adaptation in developing countries must be sufficient and sustained. Least Developed Countries (LDCs) and Small Island Developing States (SIDS), in particular, need special consideration due to their extreme vulnerability.

INTRODUCTION

Africa is under pressure from climate stresses and is highly vulnerable to the impacts of climate change (United Nations Framework Convention on Climate Change, 2007). The purpose of this chapter is to focus on approaches and strategies for enhancing urban infrastructure investment to address challenges posed by climate change in urban areas in Africa. Many areas in Africa are recognised as having climates that are among the most variable in the world on seasonal and decadal time scales. Without the ability to identify and serve these populations, humanitarian aid after disasters and longer-term development programmes may systematically but inadvertently exclude them when creating policies and programmes (Twig, 2019). This will leave out vulnerable groups that are unable to plan for and adapt to change and are exposed to loss of housing, property, life, employment and opportunity for economic and social development.

BACKGROUND AND OVERVIEW

Exposure to sudden or repeated environmental shocks and stressors negatively affects human health outcomes, including mental health (Patz *et al.,* 2005), access to resources such as food and water (McDonald *et al.,* 2011, Cisneros *et al.,* 2014, Porter *et al.,* 2014), livelihood and economic

opportunities (Mearns and Norton, 2010), migration and displacement and may also impede efforts to end harmful social practices such as child marriages and gender-based violence (Raleigh *et al.,* 2010; Svanemyr *et al.,* 2015). Conversely, humans may cause environmental degradation such as deforestation or soil erosion, through the use of environmentally damaging farming practices and poor urban planning. This cycle leads to reliance by vulnerable individuals and communities on environments that may not be able to sustain their needs. Climate change exacerbates many of these interactions (Population Council, 2018).

Harvest failure is a key risk for rural households in Sub-Saharan Africa (SSA) (Sinha and Lipton, 1999). Africa's geography and agro-ecology (prone to drought and intense rain) combine with inefficient agricultural technologies and inadequate agricultural support and result in environmental degradation, unmanaged pests and poor access to inputs, increasing vulnerability. Harvest failure not only affects crop dependent households, but also the wider rural economy (including households dependent on non-farm income sources) and national well-being and stability. It also can have long-term effects as people sell assets as a coping strategy. National budgets are also destabilised as trade (and national income) is reduced and relief has to be imported. The food crisis experienced in Southern Africa in 2001-03 is a case in point. Heavy rains in the late growing season in 2001 triggered a harvest failure of maize, the region's main staple (Wiggins, 2005:3). An immediate impact was felt by crop-dependent households. But harvest failure was not the only cause of this food crisis, for institutional weaknesses, political factors, donor policies and economic inequalities also contributed (Booth *et al.,* 2006: 58). Together they led to a significant increase in prices across the region (for example, a four-fold increase in Malawi), causing acute problems for the poor. It is estimated that in late 2002, the lives and livelihoods of as many as 16 million people in Lesotho, Malawi, Mozambique, Swaziland, Zambia and Zimbabwe were threatened (Wiggins, 2005:2; Maunder and Wiggins, 2007:4).

LITERATURE REVIEW AND THEORETICAL PERSPECTIVES

Anthropogenic climate change complicates this already complex picture. A changing climate will alter the frequency, intensity, duration, timing and location of slow- and sudden-onset climate-related hazards (IPCC, 2012, 2014a). The impacts of climate change are being felt through increasing drought and heavy rainfall, contributing to flooding, sea-level rise and

abnormally high temperatures (Blunden and Arndt, 2017). These shifts in climate are impacting the ecosystems upon which livelihoods and economies, cultures and societies depend for water, food, energy and waste removal, among other services (Cozzetto *et al.,* 2013). It is important to understand that not all climate-related hazards can be attributed to climate change. Climate attribution science is much stronger at understanding the influence of climate change on hazards (IPCC, 2012; Peterson *et al.,* 2012), but not every occurrence is caused by or unduly exacerbated by climate change.

Human mobility is an age-old phenomenon driven by numerous factors. People move in search of better economic and employment opportunities due to changing policies at home or abroad, to escape conflict and social persecution, or in combination with natural hazards and environmental degradation affecting their livelihoods (Shen, 2013; Lilleor and Van den Broeck, 2011; Piguet, 2010; Ibáñez and Vélez, 2008). A principal cause can rarely be disentangled. Instead, the complex interplay between social, political, economic, cultural and environmental factors that determines an individual's, family's or community's vulnerability and their capacity to uproot or stay that results in population movement. A case study from Vietnam suggests that sudden-onset of events like floods or typhoons increase the likelihood of people migrating internally (either temporarily or permanently), whereas people may seek to adapt to slow-onset events *in situ* (Koubi *et al.,* 2016). By contrast, in Indonesia and Bangladesh, people are temporarily relocating in response to extreme weather events like flooding, but migrating on a longer-term basis when confronted with creeping environmental stress and repeated slow-onset events like prolonged heat and drought during key agricultural seasons (Mueller *et al.,* 2014).

Africa will face increasing water scarcity and stress with a subsequent potential increase of water conflicts as almost all of the 50 river basins in Africa are transboundary (Ashton, 2002; De Wit and Jacek, 2006). Agricultural production relies mainly on rainfall for irrigation and will be severely compromised in many African countries, particularly for subsistence farmers and in SSA. Under climate change, much agricultural land will be lost, with shorter growing seasons and lower yields. National communications report that climate change will cause a general decline in most of the subsistence crops, for instance, sorghum in Sudan, Ethiopia, Eritrea and Zambia; maize in Ghana; millet in Sudan and groundnuts in the

Gambia. Of the total additional people at risk of hunger due to climate change, although a large proportion, Africa may well account for the majority by the 2080s (Fischer *et al.,* 2002).

Climate change is an added stress to threatened habitats, ecosystems and species in Africa and is likely to trigger species migration and lead to habitat reduction. Up to 50% of Africa's total biodiversity is at risk due to reduced habitat and other human-induced pressures (Boko *et al.,* 2007). The latter include land-use conversion due to agricultural expansion and subsequent destruction of habitat, pollution, poaching, civil war, high rates of land-use change, population growth and the introduction of exotic species. For example, the habitat of the great apes, including the western lowland Gorilla identified as critically endangered on the World Conservation Union's (IUCN) red list of threatened species – is likely to decline between 2002 and 2032.

RESEARCH METHODOLOGY

Combining qualitative and quantitative methods can strengthen the credibility (that is, the internal and external validity) and usefulness of findings. While quantitative data can show what is happening, qualitative data can help to explain why something is happening and add a subjective perspective. For this study, desktop review, secondary data analysis and report analysis were used. These include reports, government documents and magazines.

RESULTS AND DISCUSSION

In Uganda, evidence suggests that cash transfers offer high economic returns, especially when coupled with training programmes (Blattman *et al.,* 2014). 'Grand Bargain', agreed at the 2016 World Humanitarian Summit, emphasizes that cash transfers can help empower conflict-affected people and bolster local markets. Cash-for-work components may also be used to (re)construct the necessary infrastructure for people to pursue agricultural livelihood strategies (Twigg, 2019). Indeed, infrastructure in fragile environments has increasingly emerged as a priority among donors, to promote access to markets and establish the preconditions for long-term economic growth (Ali *et al.,* 2015). One impact assessment from the Democratic Republic of Congo (DRC) suggests that improved roads help to increase freedom of movement through better security, reduce transport costs and increase farm-gate prices (Levine and Chastre, 2004). However, the longer-term effects of

cash transfers are not clear. Bypassing the state and its social protection function is not a sustainable policy as it ultimately undermines state legitimacy (Schultze-Kraft *et al.,* 2014).

Financial inclusion, a key resilience capacity, allows for broad-based participation of poor and marginalised groups in these financial intermediation processes (Olga, 2017). Financial inclusion can be defined as access to useful and affordable financial products and services that meet the needs of low-income and vulnerable groups, delivered responsibly and sustainably. Cross-country evidence shows the positive impact of financial inclusion on increasing household resilience to external shocks (Mark, 2017). Digital payments enhance the impacts of risk-sharing (formal and informal insurance) by lowering transaction costs and expanding the social network able to contribute, including across borders. They also increase efficiency and targeting for cash transfer programmes. These efficiency improvements enhance the impacts of financial inclusion on household resilience. For example, following a drought in Kenya, mobile money (M-PESA) users experienced no reduction in consumption compared to a 6-10% reduction in consumption among non-users (Suri *et al.,* 2014). Among women in Niger targeted for cash transfers after a drought, digital payments increased their diet diversity, the amount of food consumed and women's empowerment (Jenny, 2016). In the Philippines, international remittances responded to income shocks related to rainfall, replacing 60% of lost household domestic income.

Another tool for enhancing urban infrastructure investment to address challenges posed by climate change in urban areas in Africa is Geographical Information Systems (GIS). Planners have always been involved in developing communities everyone would want to call home. Originally, this meant designing and maintaining cities and counties through land-use regulation and infrastructure support. Agencies have had to balance the needs of residential neighbourhoods, agricultural areas and business concerns. Now, in addition to that complex challenge, local governments must factor into these decisions, the requirements of a growing list of regional, state and federal agencies and special interest groups. Rapidly changing economic conditions have further complicated the process by threatening the funding needed to carry out these functions. To date, local governments have been right-sized and downsized and have had budgets drastically cut while trying to maintain

service levels. Information technology, especially GIS, has proven crucial in helping local governments cope in this environment.

People have moved throughout history and for many reasons. Some are displaced – forced to move due to conflict and persecution, natural hazards like flooding, or cascading disasters such as drought-influenced famine – and others choose to migrate temporarily or permanently in pursuit of better economic conditions, for family reasons or, at times, when seasonal conditions, like failing rains, make it difficult or impossible to earn a livelihood (Ibáñez and Vélez, 2008; Piguet, 2010; Lilleor and Van den Broeck, 2011; Shen, 2013). In other cases, governments have pursued policies and programmes promoting movement and population relocation from highly hazard-exposed areas, or have forcibly displaced communities through land-grabbing and threats of violence.

Measures addressing climate change adaptation and mitigation, while also adopting an ecosystem-based approach, can be manifold and serve as a useful illustration of how the different sectors can contribute to promoting ecosystem-based approaches. Table provides an overview of ecosystem-based adaptation (EbA) and ecosystem-based mitigation (EbM) measures that can be assigned to the different sectors. As all measures listed contribute to tackling climate change; the climate is not considered as a separate sector.

Table 1: *Measures linked with EbA and EbM, categorised by sector* (Doswald and Osti, 2011)

Sector	Relevant measures linked with EbA) and EbM
Agriculture	• Land-use zoning • Habitat protection for water regulation • Protection of key species (e.g. pollinators) • Conversion/reversion of arable land to grassland or forest • Maintaining genetic diversity • Consistency between crops produced and the local natural environment • Rain-fed water harvesting techniques • Sustainable management techniques for crops and soil • Application of no/low-tillage cultivation, crop rotation, agro-forestry • Soil moisture conservation practices (e.g. incorporating green manure into the soil or providing some degree of surface cover for the soil by mulches or by tillage practices that leave plant residues on the soil surface in water-scarce ecosystems)

Built environment	• Construction of more energy-efficient buildings • Installation of hard defence structures (e.g. sea walls to buffer against coastal flooding) • Reduction of impermeable surfaces • Installation of green roofs and vertical gardens • Use of ecosystem-consistent materials (e.g. barriers for water retention in wetlands constructed with wood and peat from the site instead of concrete)
Urban and regional planning	• Land-use zoning • Increase use of green infrastructure and spaces (e.g. green roofs, urban tree planting, parks/recreational areas, green belts) • Increase blue infrastructure and spaces (lakes and ponds) • Increase soil infiltration in parks, parking lots and green curbs
Energy	• Implementation of renewable energy policies to reduce greenhouse gas (GHG) emissions • Encourage energy-efficient behaviour to reduce public energy demand for fossil fuels • Enhance the use of energy sources restoring biodiversity (e.g. coppicing/wood fuel) • Implement sustainable criteria for biofuels and bio-energy
Fishery	• Sustainable management of fisheries and avoidance of overfishing • Integrated river basin management
Forestry	• Forest conservation, restoration, reforestation • Protection of watershed forests • Sustainable forest management (sequestration of carbon) • Evaluation of the protective characteristics of forests
Health	• Support creation of green spaces in cities to reduce the urban heat island effect • Plant urban trees to improve air quality • Support and marketing of organic food products
Tourism	• Enhance eco-tourism and sustainable nature tourism • Increased green area for recreation
Transport	• Maintain ecological connectivity in constructing grey infrastructure (via e.g. green bridges or tunnels)
Water	• River and floodplain re-naturation/restoration • Restore canals to more natural meandering rivers • Dyke relocation • Habitat restoration, creation or protection • Watershed management • Dune restoration; sand nourishment (coastal zones) • Rain-fed water harvesting techniques • Habitat protection for water regulation
Coastal defence	• Maintenance and restoration of mangrove forests (EU Outermost Regions and Overseas Countries and

	Territories include several small island states in the three oceans – Indian, Pacific and Caribbean) • Implementation and use of Integrated Coastal Zone Management (ICZM) principles and tools (e.g. managing impacts of climate change and safeguarding resilience of coasts/coastal systems; preparing for, preventing and managing natural hazards and technological (human-made) hazards; and integrating coherent strategies covering the risk-dimension (prevention to response) into planning and investment
Biodiversity	• Land-use zoning • Protection of key species (e.g. pollinators) • Conversion/reversion of arable land to grassland or forest • Maintaining genetic diversity • Consistency between crops produced and the local natural environment • Sustainable management techniques for crops and soil • Application of no/low-tillage cultivation, crop rotation, agro-forestry • Removal of alien/invasive species
General	• Installation of hard defence structures (e.g. sea walls to buffer against coastal flooding) • Reduction of impermeable surfaces • Use of ecosystem-consistent materials

Glick *et al.* (2011) found that interest in and acceptance of adaptation has increased in both the conservation community and more broadly over the last 10 years. They found a five-fold increase in climate change adaptation literature from 2007 to 2020 and from this, they infer that the conservation and research communities have realised that mitigation alone is no longer sufficient to address the challenges of climate change. However, they did find that literature focused on human systems were most prevalent, with those orientated towards biodiversity and ecosystem conservation being least represented. They also found that from 2007 to 2010,the term 'ecosystem-based adaptation' has gained currency (Colls *et al.,* 2009; Vignola *et al.,* 2009; Watts *et al.,* 2011), although it is still very poorly represented in published literature. While scientists can offer specific information to guide conservation actions, the choice of restoration or management goals is ultimately process-driven as much by societal values, economic constraints and political feasibility as scientific knowledge (Lackey, 2004; Tear *et al.,* 2005; Stein, 2009; Lindenmayer and Hunter, 2010; Glick *et al.,* 2011).

Developing countries are the most vulnerable to climate change impacts because they have few resources to adapt; socially, technologically and financially. Climate change is anticipated to have far-reaching effects on the sustainable development of developing countries including their ability to attain the United Nations Millennium Development Goals by 2015 (UN, 2007). Many developing countries' governments have given adaptation action a high, even urgent, priority. Developing countries need international assistance to support adaptation in the context of national planning for sustainable development, more capacity-building and transfer of technology and funds (United Nations Framework Convention on Climate Change, 2007). Systematic planning and capacity-building are also needed to reduce the risk of disasters and raise the resilience of communities to increase extreme events such as droughts, floods and tropical cyclones. Funding for adaptation in developing countries must be sufficient and sustained. LDCs and SIDS in particular need special consideration due to their extreme vulnerability.

Global warming is causing the melting of glaciers in the Himalayas and in the short term, this means increased risk of flooding, erosion, mudslides and GLOF in Nepal, Bangladesh, Pakistan and North India during the wet season (UNFCC, 2007). Since the melting of snow coincides with the summer monsoon season, any intensification of the monsoon and/or increase in melting is likely to contribute to flood disasters in Himalayan catchments. In the longer term, global warming could lead to a rise in the snowline and the disappearance of many glaciers, causing serious impacts on the populations relying on the seven main rivers in Asia fed by melt water from the Himalayas. Throughout Asia, one billion people could face water shortage, leading to drought and land degradation by the 2050s (Christensen *et al.,* 2007; Cruz *et al.,* 2007).

RECOMMENDATIONS AND OPTIONS

Investment must be scaled up and innovative methodological approaches improved. New technologies and innovation can potentially help developing countries tackle a wide range of health, social and economic issues. Multi-stakeholder collaborations (public, private and community) can deliver resilience at scale, especially where it is possible to combine research, innovation and adaptive management of land and resources. As indicated in SDG2, international donors and local governments should 'increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension

services and technology development' to build the resilience of agriculture-based livelihoods.

Addressing deforestation requires an integrated approach to address the energy alternatives to fuel wood and promoting intensification of agriculture for improved productivity to reduce the clearing of forests for farming activities. Policies and legislation that promote community participation in forest and natural resources management must be put in place and implemented with a decentralised system of management that creates incentives and provides adequate capacities for community involvement. Zambia must reduce the deforestation rate to ensure a green economy and sustainable development.

Australia delivers climate finance from entities such as Fidelity and Climate Change Investment Fund and Official Development Assistance in Australia's Green Book, through bilateral programmes, contributions to multilateral funds, and working with countries to support access to and development of climate-friendly technologies, technical support and capacity-building and partnerships with business and other actors (Graham and Serdaru, 2020). Australia will continue to support countries to develop and implement ambitious national mitigation contributions and national adaptation plans, to access funds and attract investment from a range of sources (Boss and Thwaites, 2021).

This submission outlines Australia's efforts to provide and mobilise support for climate change action in developing countries, through:

i. Australia's climate finance pledge to 2020;
ii. Integrating climate change assistance into Australia's development programme;
iii. Contributions to multilateral funds;
iv. Mobilising private finance;
v. Building capacity and enhancing access to climate finance;
vi. Improving tracking and transparency; and
vii. Transformational change in support of Paris Agreement objectives.

Cities have different methods of accessing financing, be it by collecting taxes and fees for service, getting a share of tax income from their national governments, or by being able to issue municipal bonds or get low-interest loans on international money markets. That is where their attitude to

traditional versus high technology or commercial versus non-market solutions becomes significant: are cities able to come up with innovative solutions that do not depend on the most expensive technology and maintenance requirements? The development of the Bus Rapid Transit (BRT) model in Curitiba, instead of a traditional subway system requiring heavy investments, is a prime example.

The EU has a strong commitment to climate change adaptation and mitigation. Firstly and importantly, there is need to reduce GHG emissions (that is, take mitigation action) and take adaptation action to deal with the unavoidable impacts (Mohammed *et al.,* 2020).It recognises that 'strategies focused on managing and conserving water, land and biological resources to maintain and restore healthy, effectively functioning and climate change-resilient ecosystems are one way to deal with the (climate) impact and that is working with nature's capacity to absorb or control impact in urban and rural areas can be a more efficient way of adapting than simply focusing on physical infrastructure. Thus, it provides leverage for the development and implementation of ecosystem-based approaches to climate change adaptation and mitigation, but it contains little specific mention of ecosystem-based actions or evidence of ecosystem-based adaptation and mitigation actions. There is, however, an action point that encourages strategies that increase the resilience to climate change of health, property and the productive functions of land, *inter alia* by improving the management of water resources and ecosystems.

Capacity is still needed to enable developing countries to develop adaptation programmes and strategies. The Nairobi work programme is building capacity to understand and assess impacts, vulnerability and adaptation and to make informed decisions on practical adaptation actions and measures. The NAPAs have proved an important way to prioritise adaptation actions for least developed countries. Initiating a process for extending the positive experience of NAPAs for developing countries that are not least developed countries and that wish to develop national adaptation programmes or strategies, could vitally help adaptation option prioritisation. This would take into account lessons learned from the NAPA preparation process and its successful experience at policy integration and relevant outcomes from the Nairobi work programme. Using local coping strategies can assist community-based

adaptation and can be facilitated by knowledge exchange within different communities facing similar problems, such as via the UNFCCC local coping strategies database. Finding synergies between the Rio Conventions could also help share information and knowledge on assessment processes.

Of the five adaptation principles, maintain and increase ecological resilience, accommodate change and develop knowledge and plan strategically, were evident in both the White Paper and Impact Assessment, while the other two (integrating across all sectors and take practical action now) were only explicitly evident in the Impact Assessment. Examples of acknowledgement of specific actions are given in Box 1.

Box 1: Examples of adaptation actions from the White Paper (WP) and Impact Assessment (IA)

Maintain and increase ecological resilience

- Conserve range and ecological variability of species - measures to maintain diversity in and increase connectivity between nature conservation sites are necessary (IA)
- Maintain existing ecological networks - the impact of climate change must also be factored into the management of Natura 2000 to ensure the diversity of and connectivity between natural areas and to allow for species migration and survival when climate conditions change (WP).

Accommodate change

- Make space for the natural development of rivers - enabling plants and animals to survive and helping wetland-dependent communities to adapt to climate change, while at the same time providing, through wetlands and salt marshes, for natural barriers that allow managing increasing water flow, floods and storms over large areas (IA).
- Develop the capacity of institutions to cope with change – WP mentions guidelines, governance and coordination, an EU action option (p.36) also capacity building (p.40).

Develop knowledge and plan strategically

- Undertake vulnerability assessments of biodiversity: Work is on-going at DG Environment to assess the feasibility and provide options for the design of (set of) vulnerability indicator(s) (WP and IA).
- Identify potential (cross-sectoral) win-win solutions - use the functions and services provided by ecosystems to achieve more cost-effective and sometimes more feasible adaptation solutions (IA).
- Monitor actual impacts of climate change - The proposed system for monitoring and reporting on climate change impacts will help in gathering further knowledge, irrespective of the impacts of climate change (WP and IA).

Integrate across all sectors

- Integrate adaptation and mitigation measures - need to exploit the synergies

between mitigation and adaptation efforts (IA).

- Build and strengthen partnerships -many regions would benefit from assistance for capacity-building and best practice sharing (IA).
- Raise awareness of benefits of the natural environment to society - communication/awareness raising/capacity-building - an EU action option (IA).

Take practical action now

- Conserve existing biodiversity - The maintenance of biodiversity and ecosystems is essential for both ensuring their resilience to climate change impact and allowing the provision of ecosystem-based services (IA).

Source: EU White Paper, Impact Assessment, (2009)

Local coping strategies are an important element of planning for adaptation. Climate change is leading communities to experience climatic extremes more frequently and new climate conditions and extremes. Traditional knowledge can help to provide efficient, appropriate and time-tested ways of advising and enabling adaptation to climate change in communities that are feeling the effects of climate changes. Several examples of local coping strategies are mentioned in the background papers to the workshops.

In Africa, rural farmers have been practising a range of agricultural techniques as coping strategies and tactics to enable sustainable food production and deal with extreme events. These include intercropping and crop diversification; use of home gardens, diversification of herds and incomes, such as the introduction of warming sheep in place of goats in the Bara province in Western Sudan, pruning and fertilizing to double tree densities and prevent soil erosion in semi-arid areas, for example, Senegal, Burkina Faso, Madagascar and Zimbabwe; manipulation of land-use, leading to land-use conversion, for example, a shift from livestock farming to game farming in Southern Africa; water conservation techniques to cope with arid conditions such as the Zaï technique in Burkina Faso. Farmers dig pits in the soil to collect organic material carried by the wind during the dry season. At the start of the rainy season, farmers add organic matter from animals, attracting termite activity resulting in termite tunnels that can collect rain deep enough that it does not evaporate and thus increasing soil fertility. In many locations, tribal and individual movements and migration are also identified as adaptation options.

In Asia, farmers have traditionally observed several practices to adapt to climate variability, for example, intercropping, mixed cropping,

agroforestry, animal husbandry and developing new seed varieties to cope with local climate. Various water use and conservation strategies include terracing, surface water and groundwater irrigation; and diversification in agriculture to deal with drought. Structural and non-structural measures are used to deal with flood and coastal inundation. For example, in the Philippines, after Typhoon Sisang in 1987, which destroyed over 200,000 homes, the Department of Social Welfare and Development decided to instigate a programme of providing typhoon-resistant housing designed to withstand wind speeds of 180 km/h for those living in the most typhoon prone areas. In Bangladesh, the Cyclone Preparedness Programme has been set up over 11 coastal area districts by the Bangladesh Red Crescent Society and is partly funded by the government. Volunteers have been trained to help in cyclone warning, evacuation, rescue, first aid emergency relief and the use of radio communication equipment.

CONCLUSION

Developing countries are suffering from the impacts of climate change and are the most vulnerable to future change. Several developing countries have developed adaptation plans or are in the process of finalising them. These include the National Adaptation Programmes of Action of least developed countries. There is now urgency for developing countries to find ways to implement these plans. Against a backdrop of low human and financial capacity, developing countries lack many of the resources to do this on their own. Multidisciplinary, robust investigations on the links between climate change, migration and displacement are limited. The analysis is constrained by the complexity and interrelatedness of the drivers of human mobility that simultaneously serve as drivers of vulnerability to climate hazards and change. Estimates of migration as a result of climate change must disentangle not only social, political, cultural and economic factors, but also other environmental factors, such as mismanagement of natural resources. Disagreements as to how to link climate change as an environmental stressor with other factors of migration persist. There are multiple challenges with international and internal migration and displacement data, uncertainty about future climate shifts and 'low confidence in quantitative projections of changes in mobility in response to climate change – precisely because of the complex, multi-causal reasons behind human mobility. As such, caution must be exercised and data gaps and challenges identified, to devise policy measures and international agreements that respond to the needs