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Housing and Informal Settlements

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Housing and Informal Settlements

Addressing vulnerability and exposure in the urban housing sector is critical in informal settlements where extreme climate events present multiple risks for millions of people. Understanding the impacts of mitigation and adaptation strategies on the housing sector will help decision-makers make choices that improve quality of life and close development and equity gaps in cities.

Major Findings

- The effects of climate hazards, people's exposure and vulnerability to them collectively determine the types and levels of risk faced by cities. Risks are associated with specific socio economic, political and physical factors exacerbating climate risks in cities. Adaptation actions like mapping of risks, developing early warning systems (EWS), preparedness plans, and preventive risk strategies – especially in informal settlements – can support decision-makers and stakeholders in reducing exposure and vulnerability in the housing sector.
- Developed countries account for the majority of the world's energy demand related to buildings. Incentives and other measures are enabling large-scale investments in mass-retrofitting programs in higher income cities.
- Housing construction in low- and middle-income countries is focused on meeting demand for more than 500 million more people by 2050. Cost-effective and adaptive building technologies can avoid locking-in carbon-intensive and non-resilient options.

- Access to safe and secure land is a key measure for reducing risk in cities. Groups that are already disadvantaged with regard to housing and land tenure are especially vulnerable to climate change.
- In informal settlements, successful adaptation depends upon addressing needs for climate related expertise and resources at different government levels as well as risk-reducing physical infrastructure and social structures

Key Messages

City managers should work with the informal sector to improve safety in relation to climate extremes. Informal economic activities are often highly vulnerable to climate impacts, yet they are crucial to economies in low- and middle-income cities. Therefore, direct and indirect costs to the urban poor should be included in loss and damage assessments in order to accurately reflect the full range of impacts on the most vulnerable and the city as a whole.

Evidence of affordable insurance schemes in developing countries' low-income communities that fulfill adaptation goals is limited. Several implementation-related hurdles that need to be addressed if insurance schemes are to be successful. These are excessive reliance on government and donor subsidies, lack of local distribution channels, poor financial literacy of communities, and overall limited demand.

Retrofits to housing that improve resilience create co-benefits, such as more dignified housing, improvements to health, and better public spaces. Meanwhile, mitigating greenhouse gas (GHG) emissions in the housing sector can create local jobs in production, operations, and maintenance – especially in low-income countries and informal settlements.

11.1 Introduction

Cities across the globe are facing the reality of climate change. Hazards such as floods, storms, and slow-onset sea level rise are affecting human, economic, and environmental assets. Knowledge of the impacts of mitigation and adaptation strategies employed in the housing sector is critical to inform policies and decisions to achieve combined benefits on improving quality of life and closing the development and equity gap in cities worldwide.

While cities contribute to global emissions at various degrees, the impacts of climate change are local and differ across social groups. In developed countries, economic activity, zoning, mobility, and design and construction standards define source contributions to national and global greenhouse gas inventories and their mitigation potential. However, where informal settlements are the dominant urban form, adaptation to climate change is considered necessary to reduce growing socioecological vulnerability (Satterthwaite et al., 2007). In fact, combined strategies for climate change adaptation and mitigation are critical for responding to climate-related challenges in a more cost-effective way, ultimately improving quality of life both globally and locally. Reducing GHG emissions, especially at municipal levels such as waste, transport, and building sectors, appears to be the low hanging fruit of urban GHG mitigation, with cities placing considerable emphasis on energy efficiency because it allows for multiple agendas to be amalgamated (financial savings, energy security, air pollution, fuel poverty, and climate change). Measures that may have larger impacts on GHG reduction, such as low-carbon and renewable energy infrastructure systems, remain the exception (UN-Habitat, 2011). Moreover, actively addressing vulnerability and exposure in sectors such as urban housing, may reduce potential for further decline in the well-being of informal settlement populations. Adopting integrated urban strategies may contribute to closing the development equity gap in cities around the world by reducing the potential occurrence of climate-related shocks and ensuring a level of well-being through those socioecological interventions that address the persistent exposure and vulnerability of the poor (Laukkonen et al., 2009).

This chapter highlights the specific impacts of climate change on the housing sector and responses in the areas of adaptation and mitigation. We address how extreme events have transformed housing and, particularly, what the drivers and impacts of climate-related events are and how they have shaped vulnerability in informal settlements. To do this, coupled socio-environmental research perspectives were reviewed for the latest scientific input of the past decade, and several workshops were conducted to address the question of housing in connection with growing demands at the intersections of formal and informal systems and pre-conditions for adaptation to climate change (see Annex 11.2 Table 1).

While considering a broad spectrum in processes and practices relevant to the housing sector, the focused is geared

toward housing and informal settlements in middle- and low-income countries because of their greater exposure and vulnerability. They account for about 80% of the world's urban population and are likely to house most of the world's growth in the next 10–20 years (Satterthwaite et al., 2013). Such growth does not come without consequences in a globally and climatically changing environment (Jean-Baptiste et al., 2013; UN-Habitat, 2014). The lack of coping and adaptive capacities in urban areas of low- and middle-income nations increase their risk to floods, storm surge, and rise in sea level (Pelling and Blackburn, 2013). Coastal urbanization trends offer increased economic opportunities for both formal and informal economies. Such livelihood prospects will draw the poor toward greater exposure and vulnerability to climate-associated hazards (Porio, 2014).

11.2 Urbanization, Climate Risk, Housing, and Informal Settlements

In 2012, the Intergovernmental Panel on Climate Change (IPCC) reported that populations in Asia, Africa, and small island nations would be the most exposed to floods and tropical cyclones. Demographic changes and urbanization were among the major reasons for exposure (IPCC, 2012). Moreover, coastal urbanization in these regions continues to drive the increases in number of people exposed to the impacts of climate change (UNDESA, 2014).

Today, the majority of the world's population lives in urban areas. Most were originally established along sources of food and water, with many growing cities in Asia and Africa being founded as a result of the property ownership laws and planning practices of their long colonial histories (Huq et al., 2007).



Figure 11.1 Urban climate change vulnerability and risk assessment framework. Source: Mehrotra et al., 2011

While 70–80% of the population of North America, Europe, and Latin America lives in cities today, cities in Asia and Africa will soon be the main source of urban growth worldwide. Moreover, the pace of urbanization in Nigeria, China, and India will soon surpass that of the developed world. Notably, Asia will be home to half of the world's urban population by 2050 (UNDESA, 2014).

The United Nations International Strategy for Disaster Reduction (UNISDR) defines disaster risk as the result of the compounding effect of hazards, exposure, and vulnerability. The pre-existing physical exposure to environmental hazards, urban densities, and social marginalization of informal settlements renders them at the highest risk to the impacts of climate change (UNISDR, 2013). In a globally warmer world, increases in temperature have amplified the likelihood of hazards such as droughts and extreme rainfall events, flooding, rainfall-induced landslides, and rise in sea level. While threatening the safety of communities and the sustainability of cities, these hazards especially endanger those whom urban governance fails, namely, those without access to adequate housing, basic utilities and infrastructure, and social services (Loyzaga et al., 2014).

Disaster risk, which is associated with climate change, is further defined by the IPCC as, “a product of the hazards influenced by climate change and the vulnerabilities of the human systems and ecological systems” (IPCC, 2014). Although the type and intensity of hazards may differ in each geographic region and city, it is the exposure and vulnerability in urban socioecological systems that largely determine the probability, nature, and magnitude of risk. Poverty and housing are the two critical dimensions of vulnerability that drive risk. This is most clearly seen in low-elevation coastal zones where macro- and micro-economic drivers influence not only coastal settlements, but also sources of water, food, and livelihood for both the formal and informal communities (Pelling et al., 2013). The risks of coastal and riverine flooding are further enhanced by human activities with subsidence due to groundwater extraction. While the geomorphology of coastal cities may influence ground movement, the combination of subsidence, tides, and sea level rise further increases the risk of flooding from storm surge and waves in coastal cities of Africa and Asia (World Bank, 2013a).

Today, city governance systems struggle not only to cope with the effects of GHGs from industrial use, rapid land-use change, and land-cover loss, but also from overwhelming population growth. The Urban Climate Change Risk Framework presents risk as the intersection of climate hazards, vulnerability, and adaptive capacity (Mehrotra et al., 2011) (see Figure 11.1).

The World Risk Report of 2014 discusses urban risk and vulnerability in light of susceptibility, coping, and adaptive capacity. While susceptibility may be a characteristic of exposed communities, coping and adaptive capacity depend primarily on the responsiveness of government institutions to current and long-term human needs (Bündnis Entwicklung Hilft, 2014). In cities where 30–70% of the population is without access to clean water or basic health services, this failure in governance is at the root of urban risk to the impacts of climate change (Lavell [2002], cited in Dodman and Satterthwaite 2008; Porio, 2015; Pauleit et al., 2015).

Informal settlements include slums¹, which in addition to the definitions by UN-Habitat (2013) and United Nations (2014), are known as dilapidated “inner-urban settlements with substandard living conditions which are, unlike informal or marginal settlements in peri-urban or newly urbanized areas, originally understood as an emergency accommodation in dilapidated parts of an existing city. Overall housing standards and the infrastructure conditions in slums are correspondingly poor” (Bündnis Entwicklung Hilft, 2014).

The UN Department of Economic and Social Affairs (UNDESA) estimates nearly one billion slum dwellers today, with the potential for growth to as many as three billion by 2050 (UNDESA, 2013). In Asia and Africa, they are estimated to constitute from 30% to as much as 70% of urban populations. Slum dwellers often live in hazardous areas that are generally undesirable or too expensive to develop commercially. Table 11.1 presents the possible impacts of climate change. It integrates the table adapted by Dodman and Satterthwaite with a listing of possible impact areas on slums based on the five deprivations and other characteristics of poor housing as defined by UN-Habitat (2003, 2006/2007). The analysis presents hazards, exposure, and vulnerability as a basis for designing specific and integrated interventions for the informal sector.

Therefore, risk reduction in informal settlements requires a dynamic contextualization in the specific intersections between the social and physical geographies of each city. However, localized decision-making must also be grounded on global political and economic forces, which directly influence human development. Furthermore, this may only be achieved with a shift in conceptualizing disasters as *systems rather than events*. This approach brings both human exposure and vulnerability to the center of the debate on risk. In doing so, this allows for innovative and strategic approaches to be included into policies and practice. Integrated decision-support systems could then incorporate economic, social, health, and environmental considerations into the informal sector. Last, this approach would effectively mainstream their needs into national and local development programs, which should cascade both horizontally and vertically.

¹ The term “slum” – widely debated since the publication of the global assessment of slums in 2003 – is generally described as a heterogeneous type of settlements with a certain degree of deprivation (UN-Habitat, 2003; 2006/2007). Commonly, slums are considered to lack one or more of these five basic housing conditions: (1) durable housing of a permanent nature, (2) sufficient living space, (3) safe access to water, (4) access to adequate sanitation, (5) security of tenure. While we recognize the negative charge and/or connotation associated with the term “slum,” we also realize the futility of attempting to avoid the term in this chapter. The reality is that the term is still widely used and generally conveys deteriorated, overcrowded housing with lack of services, increased diseases, and poverty. Further differentiation between “slums,” “informal settlements,” and “inadequate housing” is offered in Annex 11.2 Table 1 in an attempt to distinguish the terminology most relevant to this chapter.

Table 11.1 *Climate change impacts on urban areas.*

Change in climate	Possible impact on urban areas	Possible impacts areas on informal settlements based on 5 deprivations and other characteristics of poor housing
Changes in means		
Temperature	Increased energy demands for heating/cooling Worsening of air quality Exaggerated by urban heat islands	Disease, morbidity, and mortality Health and life expectancy Access to water and sanitation
Precipitation	Increased risk of flooding Increased risk of landslides Distress migration from rural areas Interruption of food supply networks	Life expectancy Access to water and sanitation Access to adequate living space Durability of dwellings Security of tenure
Sea-level rise	Coastal flooding Reduced income from agriculture and tourism Salinization of water sources	Durability of dwellings Access to water and sanitation Security of tenure Labor and employment
Changes in extremes		
Extreme rainfall	More intense flooding Higher risk of landslides Disruption to livelihoods and city economies Damage to homes and businesses	Durability of dwellings Disease, morbidity, and mortality Life expectancy Access to adequate living space Security of tenure Labor and employment
Drought	Water shortages Higher food prices Disruption of hydro-electricity Distress migration from rural areas	Access to water and sanitation Security of tenure Disease, morbidity, and mortality
Heat- or cold-waves	Short-term increase in energy demands for heating/cooling	Life expectancy Disease, morbidity, and mortality
Abrupt climate change	Possible significant impacts from rapid and extreme sea-level rise Possible significant impacts from rapid and extreme temperature change	Access to water and sanitation Durability of dwellings Labor and employment
Changes in exposure		
Population movements	Movements from stressed rural habitats	Security of tenure Access to adequate living space
Biological changes	Extended vector habitats	Access to water and sanitation Disease, morbidity, and mortality

Critical interventions toward risk reduction for the informal sector lie in adaptive governance that would enable access to social services, incomes, and material resources to immediately enhance coping capacities. Over the long term, it is necessary to design and implement institutional changes at both macro-economic and city levels to reduce historical socioeconomic inequities (Bündnis Entwicklung Hilft, 2014). Although climate change affects both the formal and informal housing sector, it is only by re-conceptualizing risk to specifically include those marginalized by informality that transformative change toward urban resilience can happen. This chapter highlights marginality and informality as both drivers of vulnerability and transformation toward building urban resilience.

11.3 Informality, Informal Settlements, and Vulnerabilities

11.3.1 Understanding informality in the context of development

Cities worldwide have been successful in attracting more than 80% of global economic activities, partly owing to the high concentration of people and goods (World Bank, 2013b). Rapid urbanization often has positive outcomes on human development. In fact, highly urbanized countries also tend to have high incomes, more stable economies, and stronger and better

performing institutions (UN-Habitat, 2006/2007). However, the role of cities, especially their productivity and functionality as engines of economic growth, by and large depends on the quality of their spatial structure, level of basic infrastructure, services, and, not least, on how they are managed (World Bank, 2013b). Thus, cities with poor access to basic services such as potable water, sanitation, power, accessibility, and stormwater control are often congested and have poor housing and insecure property rights or tenure. Such cities are unlikely to attract much investment to invigorate economic growth and improve the well-being of inhabitants. Generally, the capacity of poorly serviced and managed cities to maximize the benefits of urbanization is low because such cities tend to have narrow windows of opportunities to harness their potential as engines of economic growth (World Bank, 2013a).

Most cities in the low-income countries (Africa, Asia, and Latin America) are far from being managed efficiently and effectively. In part, this is manifested in the dominance of informal/unplanned settlements, which have persisted in existing urban plans, laws, and regulations. Currently, informal settlements accommodate between 20% and 80% of the urban population in developing cities. Of the world's 1 billion population living in informal settlements, 61% are in Asia (ADB, 2013) and between 30% and 85% of sub-Saharan Africa's urban population are living in informal housing. In Dar es Salaam, about 80% of the built housing area comprises informal settlements (Kombe and Kreibich, 2006).

The proliferation of informal settlements poses growing challenges to the stability of the social and political fabric of cities because informal settlements lack basic infrastructure services and facilities and have a high concentration of poverty. For instance, Lagos, one of the fastest growing cities in Africa, has 70% of the population living in informal settlements without direct access to piped water or a managed sewerage system. Nairobi, the economic powerhouse of East Africa, has one of the largest informal areas in the world, Kibera, where more than 400,000 people live without basic services (UN-Habitat, 2003). In most cities of developing countries, one also notes widespread informality in terms of income and employment generation, economic activities that are unregulated or do not follow predetermined urban development rules, laws, procedures, and other regulations that are sanctioned by the state or formal institutions (Dodman et al., 2013).

Literature shows that contemporary economic processes of globalization and neo-liberal urban policy responses and their effects on urban labor markets are key drivers of the informal sector income- and employment-generation activities (Watson, 2009). Recent economic trends have led to exploding informality in low-income cities (Watson, 2009).

The informal economy accounts for 60% of the active labor force and provides 90% of new jobs in Africa. Meanwhile, in Asia, the informal sector accounts for about 25–75% of economic activity (Jamil, 2013). The bulk of the inhabitants of

Table 11.2 Summary matrix of climate-related threats and their areas of impact

Threat	Directly Impacted Areas
Increased storm activity in coastal areas	Low-lying settlements Settlements on steep slopes Settlements in ravines
Sea level rise	Low-lying settlements
Increased temperature	All urban residents
Increased rainfall	Low-lying settlements and settlements in or near flood plains
Increased air pollution	All urban residents, though possibly more severe for those near polluting industry and transportation

informal settlements draw their livelihoods from the informal income and employment sectors. Despite varying perceptions and political positions, this sector is expanding rapidly. Some view the informal economy as a symbol of developmental backwardness, whereas others see it as a positive and dynamic sector that enables many to gain access to sources of living in urban areas (Dewar, 2005). Most importantly, in most cities of developing countries, there is an increasing trend toward informalization (Dodman et al., 2013). Informality is also the main force driving and facilitating the poor to secure a living space and thus enhancing their integration and inclusiveness, albeit in precarious forms of employment (Kombe and Kreibich, 2006).

Although informality in terms of categories of income, employment generation, mode of settlement development, or land servicing are unregulated by the state or informal regulatory structures, it is acknowledged that informal social institutions and networks play a critical role in organization and support, particularly in informal settlements (Simone, 2004). They help alleviate vulnerability and other undesirable challenges associated with informality. For instance, informal social networks, norms, and structures play an important role in holding economies and communities together despite daunting economic, political, and environmental challenges (Meagher, 2007). In some countries, especially in Sub-Saharan Africa, social institutions and regulatory networks have been regulating spatial structure in informal settlements and facilitating land markets; they also provide security of tenure. The noble roles being played by social regulators have made a difference in many cases, making informal settlements not only attractive to the poor, but also to the affluent (Kombe and Kreibich, 2006). In other words, informality is gradually becoming a domain for both poor and middle-income households in many developing countries (Roy and AlSaiyad, 2005).

Residents in low-income informal settlements are disproportionately more vulnerable due to:

- *Greater exposure to hazards due to geophysical location:* Many settlements consolidate on unstable slopes, low-elevation coastal zones (LE CZ), and in proximity to rivers, making them susceptible to harmful events

- *Land availability*: The lack of access to affordable land for housing influences low-income households to settle outside formal housing markets, typically on unregulated land controlled by informal land dealers
- *Underinvested infrastructure*: Resulting in poor sanitation, lack of drainage system, and limited waste management and water supply services
- *Housing quality*: Poor construction materials used in settlements where there is a lack of economic and financial capital to invest in better structure render settlers more

susceptible to hazards (UNESCAP and UNISDR, 2012; UNESCAP, 2013)

- *Limited relief support* in the event of a disaster (Feiden, 2011)

11.3.2 Informal Settlements

Geographic conditions as well as diverse social groups influence the morphology of informal settlements. Box 11.1 illustrates different types of informal settlements across Africa, Asia, and Latin America and demonstrates that although these types of

Box 11.1 Typologies of Informal Settlements

Informal settlements are diverse and take different forms; thus, addressing risk reduction, adaptation, and mitigation may be complex. While these settlements worldwide share some characteristics and challenges, they cannot be regarded as homogeneous because every one of them has emerged under particular geographic, ethnic, economic,

and historical situations that have determine its composition, typology, construction materials used, and residents. Thus, the vulnerabilities faced by informal settlements in the periphery of Mexico City or Samar will be completely different from those faced in Abidan or Dar es Salaam (Box 11.1 Figures 1, 2, 3, and 4).



Box 11.1 Figure 1 Informal settlements on the outskirts of Mexico City.



Box 11.1 Figure 3 Informal settlements in Dar es Salaam.



Box 11.1 Figure 2 Middle-income housing in Informal settlement, Ibadan, Nigeria.



Box 11.1 Figure 4 Informal settlements in Samar, Manila.

settlements share some common characteristics, they cannot be considered homogeneous.

Increasingly, informal housing and land markets have become a symbol that ascertains citizens' demands for or realization of their rights to the city. Informality is, therefore, the process and force generating and sustaining informal settlements. In most low-income countries, informality (i.e., forms of settlements and housing developments and modes of income generation) has become a *modus operandi* of urban expansion (Kombe and Kreibich, 2006; Castillo, 2000; Roy, 2009; Watson, 2009). It is the major force producing and transforming the socioeconomic life and spatial character of cities in most of the developing countries. On the other hand, it is also the major urban development challenge that cities are confronted with in the 21st century. Primarily, this is because informality generates settlements that are spatially unstructured and socially and economically marginalized, particularly in terms of access to basic services and facilities. Owing to the geographical location of informal settlements on fragile ecosystems, the poor socioeconomic and environmental conditions of the inhabitants, climate change-induced hazards will have a devastating impact (Vedeld et al., 2015). Climate change will accentuate the already stressful living and working conditions in informal settlements that are predominantly occupied by the urban poor in fragile ecosystems.

Although the formal/informal binary debates remain inconclusive, urban settlers often weave between the two modes and strategies of urban life as they deem appropriate. The report "State of African Cities" acknowledges that "inadequate urban governance policies" and "low urban institutional capacities," as well as limited options for the poor to access urban land, contribute to informality and proliferation of informal settlements (UN-Habitat, 2010). In this respect, informality and informal settlements seems closely interlinked and mutually reinforcing. Hernando De Soto (2001) perceives informality through the prism of capital, noting that property occupants of informal settlements in many cities of the developing countries and ex-communist states are unable to capitalize their property and therefore opt for extra-legal business transaction modes. In other words, because the legal property rights system does not provide for poor people's needs and expectations, they have little option but to opt out of the formal system (De Soto, 2001).

Therefore, the central issue regarding informality – especially informal settlements – is how to enable the informal land development sector to perform better and thereby improve the quality of living and working environments created by informal sector actors. First, this implies accepting informality as a mode of urbanization (Duminy, 2011); second, it means supporting and working with those parceling and constructing buildings in informal settlements rather than working against them.

11.3.3 Source and Drivers of Vulnerability of Informal Settlements

At the global level, the main sources of vulnerability are population growth, rapid urbanization, and poverty (Adger, 2006). Urban growth has an impact on housing quality and safety, especially when government institutions and the private sector are unable to cope with the need for adequate and affordable urban housing. As presented in Section 11.2, rapid urbanization, especially in low- and middle-income economies, is often associated with growing inequalities, marginalization, and exclusion of the urban poor from formal service delivery systems, all factors that contribute to climate change-related vulnerabilities (Satterthwaite et al., 2007; McGranahan et al., 2007).

Climate change is set to worsen (directly and/or indirectly) the already existing vulnerability of informal urban housing – the most disaster-prone of all urban areas – where livelihood opportunities are generated by surrounding economic activity (Porio, 2014; Jamil, 2013). Rapid urbanization (McGranahan et al., 2007) and poor spatial planning has increased the concentration of people in LECZs (i.e., less than 10 m above sea level) at risk of sea level rise and extreme weather events. Accommodating human activity in naturally unstable environments such as LECZs requires driving resources from beyond urban, national, and even continental boundaries (Seto et al., 2010) and introducing measures that secure natural coastal protection (e.g., mangrove deforestation, excavations, diversions, soil sealing). This, in turn, increases the risks for people and economic activities that reside in LECZ. Informal settlements in LECZ areas of Asia and Africa are increasingly vulnerable to disaster risks associated with climate change (e.g., incidences of flooding) (UN-Habitat, 2008). This happens as a combination of factors: (1) the decrease of natural coastal protection from factors explained earlier; (2) the fact that informal subdivisions, whether on low-lying areas or on hills and steep slopes, depend on the decisions of informal land dealers and follow the logics of economic profit, which often prevents any intervention with a perspective to reduce risk or promote adaptation (Castillo, 2013); and (3) the morphology and road structure is not compliant with formal urban planning, a factor that may increase risks deriving from excess rainfall on steep slopes or emergency services access for evacuation.

Key drivers of vulnerability in informal settlements are also connected to the partial or total lack of access to resources (natural, financial, social, political, economic, and human) that allow people to prevent potential risks and rebuild after disasters (Moser and Satterthwaite, 2008; Lopez-Marrero and Yarnal, 2010; Romero Lankao et al., 2014; Islam et al., 2014). In addition, the partial or total lack of basic services such as provision of potable water and electricity, solid waste collection, and safe disposal of wastewater increase the sensitivity of informal dwellers to external stressors. For

Case Study 11.1 Water-Related Vulnerabilities to Climate Change and Poor Housing Conditions in Lima

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Keywords	Rainfall, flooding, vulnerability, water, community based adaptation
Population (Metropolitan Region)	9,752,000 (Instituto Nacional de Estadística e Informática [INEI], 2015)
Area (Metropolitan Region)	2,819.3 km ² (Metropolitan Planning Institute [IMP], 2013)
Income per capita	US\$5,950 (World Bank, 2017)
Climate zone	BWh – Arid, desert, hot (Peel et al., 2007)

Between 1940 and 2007, the urban population in Peru increased 9.5 times, whereas the rural one grew only 1.6 times. Peru is one of the ten countries most vulnerable to climate change in the world and one of the most affected by the El Niño System Oscillation (ENSO).

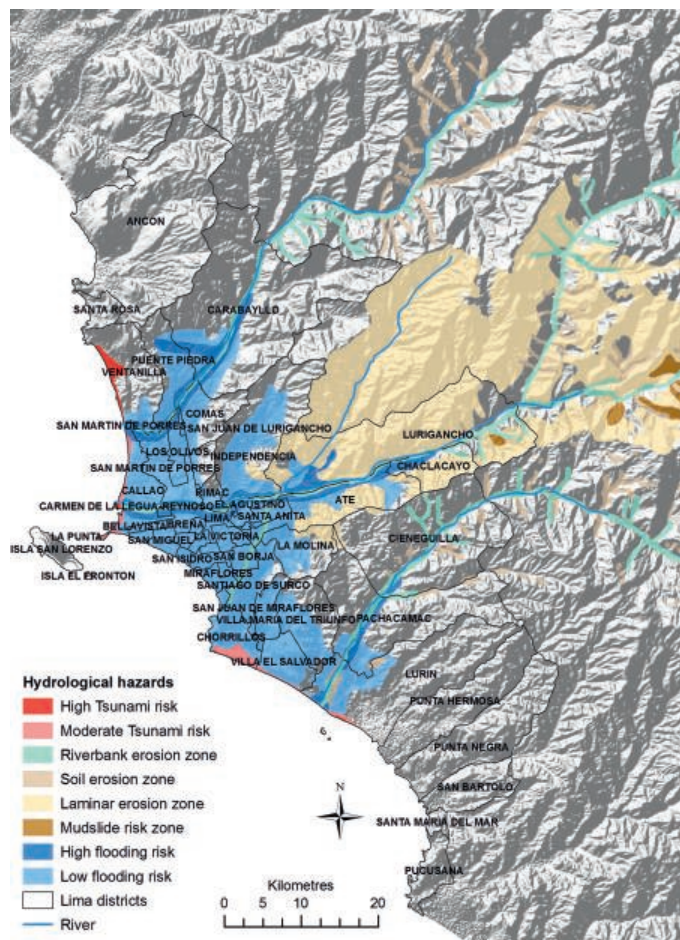
CLIMATE-RELATED HAZARDS AND DRIVERS OF VULNERABILITY

At the national level, experts agree that the country as it currently exists will experience a series of climatic events with extreme peaks forming various regional scenarios ranging from prolonged drought to heavy rains (MML, 2014). According to the Intergovernmental Panel on Climate Change (IPCC), temperatures will rise by at least 2°C and sea level by 1 centimeter (0.4 inches) per year.

The main effects of El Niño are caused by increases in seawater temperature. This raises evaporation levels and causes extreme rainfall, resulting in overflowing rivers and large landslides that seriously affect roads and neighborhoods located on the hills, which are usually inhabited by the urban poor. This negatively impacts the national gross domestic product (GDP) (the Economy Ministry has indicated that, due to climate change, the GDP could decrease by around 6% in future years).

PHYSICAL AND SOCIOECONOMIC VULNERABILITIES

Lima is located on three coastal valleys formed by the mouths of rivers descending from the Andean highlands. The city has more than 9 million inhabitants and is growing by more than 80,000 per year (Miranda and Baud, 2014). The lack of rain in the city (about 9 mm per year) requires SEDAPAL – the water-supply company – to transfer water from the upper basin of the Mantaro River on the other side of the Andean mountain. However, this region faces growing water stress due to melting glaciers and overexploitation of groundwater.



Case Study 11.1 Figure 1 Map of hydrological hazards in Lima.

Source: Miranda et al., 2014b, chance2sustain.

The social distribution of water in Lima is uneven. Inhabitants of the richest areas consume around 460 liters per person per day, while those in poor areas consume less than 50 liters per person per day (SEDAPAL, n.d.; 2007; Instituto Nacional de Estadística e Informática [INEI], 2007).² Those who have no connection to the water network pay 10 times more than those who have a connection, and their consumption is below 25 liters per person per day (Miranda, 2014a).

Usually, these people live in precarious constructions settled on slopes of 20 degrees or greater and at high risk of landslides; on less compact sandy soils; or on the banks and beds of seasonal rivers that overflow during the monsoon. The “Barrio Mío” Program (*My Neighborhood*) of the Municipality of Lima estimates that there are about 600,000 homes built in areas at high risk of disaster during heavy rains (Escudero, 2014).

2 Analyzed by Miranda Liliana and Karin Pfeffer under chance2sustain.

In 2025, Lima will have more than 12 million inhabitants. The urbanization will be by densification rather than by expansion, including the peripheries settled by the most vulnerable. In central districts, modern low-density buildings will be built, and infrastructures and services will be improved. However, in the suburbs, buildings of high density (3.8 persons per room) will continue to grow through self-built construction, thus consolidating urbanization in high-risk disaster areas (Miranda, 2014b).

According to these trends, the peripheral areas surrounding the center of Lima are “slumifying,” becoming overcrowding, vulnerable, polluted, or insecure, while the center has the best residential appeal, equipment, infrastructure, environmental quality, urban green spaces, security, and relatively low population density (albeit higher constructive density). So far, nothing indicates that these trends will change.

EXISTING POLICIES AND APPROACHES ADOPTED TO RESPOND TO IDENTIFIED HAZARDS AND ADAPTATION STRATEGIES

A former president of SEDAPAL said that if each person would save 10 liters of water daily, especially those who consume more, water stress would decrease to the point where it would not be necessary to build new dams in the short term to provide water for everyone in the city. However, this has not occurred, and the water company continues to make large investments to transfer water from the other side of the Andes and to build desalination plants.

During 2011–2014, the Municipality of Lima developed a strategy to adapt the city to climate change based on a reduction of water demand in rich districts and vulnerability in the poorest sectors of the periphery. Thus, while the Program Barrio Mío developed a poverty map of the city, SEDAPAL gave priority attention to projects in underserved areas.

In 2014, the Barrio Mío program articulated usually fragmented Metropolitan Municipality of Lima (MML) investments that prioritized

neighborhoods from twenty district municipalities and invested around US\$115 million to build pedestrian walkways, stairs (60 km), and retaining walls (50 km) in peripheral neighborhoods. With the participation of leaders and neighbors, Urban Integrated Plans have been developed to decide on new infrastructure and services. Barrio Mío has trained 36,430 people in risk management through civil defense, creating 315 community committees and groups for the purpose. Barrio Mío has restored five public spaces and has planted 42,600 trees to help stabilize hills and improve environmental quality, the landscape, and livability. It has also trained another 11,000 people from 17 district municipalities through the “Adopt a Tree Program” (A1A) (Escudero, 2014). All of its work has been done via community organization participation (from prioritization, design, and civil defense groups, as well as community work) integrating the work of citizens and neighborhood organizations with the work of different entities and companies from Lima Municipality, as well as District Municipalities and INDECI (the Civil Defense Institute of Peru).

Despite being an urban intervention program that successfully developed a strategy of comprehensive urban development and achieved excellent results during its short implementation time, the Barrio Mío program was deactivated in January 2015.

SUMMARY AND KEY MESSAGES

This document summarizes the initial findings of a study on the hydroclimatic vulnerabilities of metropolitan cities in the context of climate change, informal developments, and the risk perception of vulnerable populations.

In the future, Lima will experience more extreme weather events. This will exacerbate gaps in the distribution and supply of water, especially among the poor and vulnerable. Given the complexity of the problem, decentralization and intersectoral integration are essential to delineate adaptation strategies to climate change. A combination of infrastructure projects and small-scale local interventions are needed to better define priorities and decide on investments that will reach the most vulnerable.

instance, the inefficiency of solid waste collection in Dar es Salaam (58% of household waste collected) causes drainage channel blockages in many hazard-prone settlements, therefore increasing the likelihood of flooding. An infrastructure backlog characterizes many informal settlements globally and plays a key role in the ability of exposed communities to overcome risk and disasters (see Section 11.4). At the institutional level, informal settlements are considered more vulnerable due to weak governance (including both capacities and resources availability), which in turn manifests in planning deficits and poor technical knowledge of disaster risk and vulnerability (UN-Habitat, 2010; Rojas, 2014).

11.4 Climate Change Threats and Impact of Extreme Weather Events on Housing

Climate threats impact settlements differently, depending on the nature of the hazard and the geographic and sociodemographic characteristics of the area. The 2014 World Risk Index reported that “much of urban growth takes places in highly

exposed coastal and delta regions, particularly in developing and emerging economies” (Bündnis Entwicklung Hilft, 2014) and that, in the 616 cities assessed, river flooding posed a threat to more than 379 million residents, the majority of these living in low-income countries. The housing sector is particularly vulnerable in cities most affected by climate-related hazards and their impacts.

In the United States, the storm surge from Hurricane Sandy covered 16.6% of the land in New York (Koepnick and Weselcouch, 2013) and damaged or destroyed 305,000 housing units and 72,000 buildings in New Jersey (The Furman Center and the Moelis Institute for Affordable Housing Policy, 2013). Estimated repair and response costs for the housing sector was US\$4.921 billion in New Jersey, representing the second highest amount after the business sector, and US\$9.672 billion in New York and surrounding counties, representing the second highest amount after that put forward for schools, utilities, and individual assistance (U.S. Department of Commerce, 2013). In Italy, a recent report (ANCE/CRESME, 2012) highlights the extent of the socioeconomic factors connected to the vulnerability of

Italian territory to natural hazards, especially hydro-geological risk (82% of the territory and 5.7 million people living in risk-prone areas). From 1944 to 2012, the total cost of damage caused by landslides and floods was estimated at more than €242.5 billion (at 2011 prices), about €3.5 billion per year; 75% of this amount is associated with earthquakes and 25% with hydrological hazards.

Notwithstanding high damage costs incurred by the housing sector, cities in high-income countries generally benefit from more readily available resources, more expertise, and stronger governance systems. In contrast, the impacts in low- and middle-income countries are expected to be the greatest because current levels of investments are far from adequate, leading to high vulnerability to climatic impacts. This is termed the “adaptation deficit” (Burton [2004], in Parry et al., 2009) which is of course also a “development deficit”. A 2009 study concluded that removing the housing and infrastructure deficit in low- and middle-income countries would cost around US\$6.3 trillion, resulting in the need to invest US\$315 billion per year over 20 years. But to adapt this upgraded infrastructure to specifically meet the added risks brought by climate change will cost an additional US\$16–63 billion per year (Parry et al., 2009).

There are also huge differences in the way cities are resilient to weather extremes. There is a twenty-fold difference in mortality between the Philippines and Japan when hit by a typhoon of the same intensity. This is the result of differences in the resilience of the building stock and in the effectiveness of government arrangements to develop resilience. Similarly, in Ibadan (Nigeria), a very small increase in the intensity of windstorms caused heavy damage to buildings in the city center (Adelekan, 2010). An event of similar intensity in a high-income city would be unlikely to cause such damage. Therefore, infrastructure and housing that was once resilient under one climatic regime may not be so in another. Hence, strengthening, protecting, and adapting the assets and abilities of households and communities is far more important in low- and middle-income nations rather than in high-income ones (Satterthwaite, 2013).

The compilation of disaster risk and impact information is essential to inform sustainable development and disaster risk reduction. International loss data sources like EMDAT collect global and regional data that is homogenous and comparable across countries, and these data are used by practitioners when validating national data. Instead, national-level data can inform decision-makers about risk trends and support disaster loss accounting, forensics, and risk modeling. Most datasets, however, account for few physical impact indicators (e.g., houses damaged or destroyed) and are very poor at collecting economic loss value (UNISDR, 2015).

These characteristics are also present in disaster bulletins and most academic papers. Table 11.3 presents a list of intensive disasters that occurred in emerging and developing

countries from the late 1990s until now. The list is by no means comprehensive and intends to illustrate the fact that damages and losses in the housing sector are substantial and are, to a large extent, reported in terms of aggregated direct costs and physical damage. Few detailed studies attempt to calculate disaggregated costs (direct, indirect) before, during, and after disasters at the household level (Danh, 2014). These can include damage to housing, including total or partial destruction of housing units and in-house components of electricity and water or supply-sanitation systems, household goods and equipment, and products of home-based micro-enterprises. Whereas, in terms of loss, these can include cost of demolition and rubble removal, temporary loss of rental income, cost of temporary housing of homeless people (met by government, international assistance, and/or the private sector), and the cost of associated transport to/from temporary camps and places of work. What is also clear is that information related to damages and losses in informal settlements is less systematically reported due to the illegal and therefore unregistered status of dwellers and their lack of access to insurance (whether formal or informal).

More significantly, assessing the impacts of such events in terms of value of property damaged or destroyed can be misleading in an informal context; extensive devastation in terms of deaths, injuries, and loss of property may have low economic impact because of the low value assigned to the damaged or destroyed housing. Instead, the meaning and importance of losses and damages to the homes, livelihoods, and services of the urban poor and informal settlers is more complex.

Poor households wrestle with many kinds of risks, as well as with the desire to meet unfulfilled needs and wants, and this leads to tradeoffs between immediate expenditures on household maintenance against investments to recover lost resources or anticipate future risks. This makes it difficult to replace savings or productive assets once those have been spent on coping (Pelling, 2011). To illustrate, for breadwinners whose families’ daily subsistence depend on their earnings (e.g., those in petty services, hawkers), failure to report to work due to flooding could mean food scarcity and hunger for the entire family or no money to pay for water or fuel. Protracted and destructive rounds of coping can lead to household collapse as more fundamental aspects of short-term (health) and long-term social capital fail to materialize. Repeated losses and damages for the poor and those in the informal sector, then, have tremendous implications to their survival, and, considering the importance of the informal sector for many economies, also to the way cities function (Jamil, 2013).

Disaster impacts also lead to the difficult task of rebuilding and rehousing people where further costs and vulnerability may occur but are often left unaccounted. Poorer households in formal and especially in informal settlements often fall short of receiving necessary aid to start the recovery process or lack the means (e.g., insurance) to reconstruct near their sources of livelihood (Porio, 2004; Masozera et al., 2006). Lack of land

Table 11.3 *Selected examples of disaster impacts in emerging and developing countries with emphasis on the housing sector and the urban poor from 1998 until 2014.*

Year	Event	Location (City, Province or Region)	Direct damages of disasters in developing and emergent countries with a focus on housing in low-income areas or slums (where available damages to properties either in housing units or in equivalent value are displayed)
2014	Heavy downpours and flooding	Abidjan (Côte d'Ivoire)	Four shanty towns, home to some 25,000 people are completely destroyed, while 50,000 other informal settlement residents are to be relocated. (1)
2013	Super Typhoon Haiyan	Tacloban City (Leyte Province); Metro Cebu (Cebu); Surigao (Mindanao); townships in Bohol, Panay, Eastern Samar Provinces (Philippines)	11.3 million people affected, 273,375 houses damaged, 153,098 destroyed, and 1.9 million people displaced. (2)
2012	Hurricane Sandy	New York New Jersey (USA)	The surge from Sandy reached nearly 76,000 buildings affecting more than 300,000 housing units (nearly 9% of the total housing units in the city). (3) Estimated repair and response costs for the housing sector are US\$4,921 million in New Jersey and US\$9,672 million in New York and surrounding counties. (4) Due to their extremely low income, low-income renters in New York are particularly vulnerable of being unable to find affordable new housing. (5)
2012	Tropical Cyclone Evan	Fiji (Samoa)	Damaged almost 1,000 houses and destroyed almost 700, both of legal dwellers and informal settlers. Assessment of the 41 informal settlements showed that 177 households were affected. At the peak of the emergency, approximately 14,000 people were in more than 242 evacuation centers. (6,7)
2012	Typhoon Bopha	Eastern Mindanao Region (The Philippines)	Over 6.2 million people affected and over 230,000 houses destroyed. (8)
2011	Flood	Ibadan (Nigeria)	Over US\$1.92 million in direct damage (30 million Nigerian Naira); those living in flood-prone areas were mostly affected. (9)
2011	Heavy rainfall and flooding	Eastern KwaZulu-Natal province (South Africa)	At least 13,000 homes damaged by floods across the country, including thousands of shacks washed away, according to the National Disaster Management Center. Squatter communities known as "informal settlements" have been most affected. The government has put the flood damage at US\$211 million, but this is an early estimate and expected to rise. (10)
2011	Floods	Bangkok metropolitan region (Thailand)	300,000 homes damaged in the greater Bangkok metropolitan region alone, 700,000 total residential units impacted, total economic losses to households estimated at THB84.0 billion (US\$2.7 billion). (11)
2011	Floods	Sindh and Balochistan Provinces (Pakistan)	Damage was estimated at US\$2.5 billion with the housing and agricultural subsectors again being the most affected. (12)
2011–2008	Flooding during four major events	São Paulo and Rio de Janeiro and other cities in South-East Brazil	Losses of more than US\$4 billion in the housing sector (of total US\$9 billion in damages including many other sectors). (13)
2010–2009	Floods	Benin, Burkina Faso, Ghana, Niger, Senegal among many others in West Africa	Benin, US\$131 million in damages (most affected sectors: housing, infrastructure, education, agriculture). Togo, US\$23 million in damages (most affected sectors: housing, infrastructure, education). Niger (29,252 homes destroyed). Senegal US\$56 million in damages (most affected sectors housing, infrastructure, transport, education). (14)
2009	Tropical Storm Ketsana	Metropolitan Manila, Bulacan, Laguna, Rizal, Southern Luzon Provinces (Philippines)	More than 2.2 million people were reported directly affected by the typhoon and approximately 736,000 people were displaced. An estimated worth of damages to property and infrastructure reached 2 billion pesos (US\$43.5 billion) and left more than a million Filipinos homeless. (15,16)
2009	Typhoon Ondoy and Pepeng	Metropolitan Manila (Philippines)	US\$730.3 million in damages to housing. 700,000 people displaced from shelters. The storms severely disrupted livelihoods in informal areas, with about 170 million workdays – equivalent to about 664,000 1-year jobs – lost due to their impacts. (17,18)

Table 11.3 (continued)

Year	Event	Location (City, Province or Region)	Direct damages of disasters in developing and emergent countries with a focus on housing in low-income areas or slums (where available damages to properties either in housing units or in equivalent value are displayed)
2008	Flash flood after Typhoon Frank	Iloilo city (Philippines)	4,139 families were left homeless, the majority of affected are urban poor settlements on riverbanks and foreshore; 22 dead, 174 injured, 1,445 totally damaged structures (statistics does not include affected families from adjacent towns that were also hit by the typhoon). (19)
2008	Tropical Cyclone Nargis	Ayeyarwady and Yangon Divisions (Myanmar)	790,000 houses were damaged or destroyed. (20)
2006	Super typhoon Reming	Mt. Mayon volcano region, Bicol (Philippines)	655 deaths, 2,437 injured, 445 missing, damages (infrastructure and agriculture) estimated 608 billion PhP (around US\$14 billion). (21)
2005	Hurricane Katrina	New Orleans (USA)	134,000 housing units – 70% of all occupied units – suffered damage from the hurricane and subsequent flood. More than 400,000 residents displaced. (22,23)
2005	Floods	Mumbai (India)	US\$240–250 million estimated total loss to marginalized populations in most affected neighborhoods. (24)
2004	Debris flow	Jimani (Dominican Republic)	3,000 people displaced and at least 870 homes destroyed, mainly in informal settlements. (25)
1999	Debris flow	Vargas State (Venezuela)	Estimated 60,000–80,000 houses destroyed or severely damaged with large impacts on informal settlements. (25)
1999	Hurricane Georges	Santo Domingo and surrounding provinces (Dominican Republic)	60% of homes damaged and 25% destroyed, thus displacing 2,500 people. Direct damage US\$1,337 million. (26)
1998	1998 Flood	Dhaka (Bangladesh)	30% of units destroyed (2/3 owned by lower-middle classes and poorest). (27)
1998	Hurricane Mitch	Honduras (Nicaragua) El Salvador (Guatemala)	124,068 houses destroyed or damaged. Total direct damage US\$3,078 million. (28)

(1) IRIN, 2014; (2) The Christian Science Monitor, 2013; Loyzaga et al., 2014; (3) The Furman Center and the Moelis Institute for Affordable Housing Policy, 2013; (4) U.S. Department of Commerce, 2013; (5) Koepnick and Weselcouch, 2013; (6) ReliefWeb, 2012; (7) Shelter Cluster, 2014; (8) UNCHOA, 2013; (9) Agbola et al., 2012; (10) Global Post, 2011; (11) Impact Forecasting LLC and Aon Benfield, 2011; (12) UNISDR and UNESCAP, 2012; (13) The World Bank, 2012; (14) Wielinga, D. and Dingel, C., 2011; (15) The International Federation of Red Cross and Red Crescent Societies, 2010; (16) Abon et al., 2011; (17) Baker, J. L., 2012; (18) Government of the Republic of the Philippines; The World Bank, 2009; (19) Shack/Slum Dwellers International, 2008; (20) Oxfam International, unknown; (21) Orense and Ikeda, 2007; (22) Geaghan, 2011; (23) The Data Center Research, 2014; (24) Hallegatte, 2010; (25) Doberstein, 2013; (26) U.S. Agency for International Development, 1998; U.S. Department of Homeland Security, 1998; (27) Alam and Rabbani, 2007; (28) Charvériat, 2000.

tenure is also an impediment to accessing government-driven housing reconstruction. Often, these types of schemes are targeted at people who can prove their title to land or buildings, thus discriminating against informal settlers, particularly tenants (Payne, 2004). For instance, the cash-for-shelter program implemented after the Pisco earthquake in Peru was abandoned after at least three-quarters of the intended beneficiaries could not prove their property ownership. With lack of documentation, it is difficult to prove evidence of a claim to these sites (Ferradas et al., 2011). In these situations, the ability to leverage social networks and political connections becomes crucial for reclaiming land, whereas people with poor social networks risk falling into further vulnerability.

Under market and political pressure, post-disaster housing processes in low- and middle-income countries often follow

one-size-fits-all approaches despite geographical and cultural differences across countries. Little attention is given to the visual and physical aspects of buildings and there is poor consideration of people's lifestyles (e.g., selling crafts or farming) and complex social contexts (Esther [2011] in Tran et al., 2013; Schildermann and Lyons, 2011; Boano, 2009; Ruwanpura, 2008; Williams, 2008; Norton and Chantry, 2008). For example, in Andhra Pradesh home owners abandoned their reinforced concrete and "cyclone-resistant houses" because they began cracking during winter and were too hot during summer. As a result, many households rebuilt traditional *kutchas* huts as living space or made adjustments to their concrete house to improve thermal comfort. This scheme, subsidized by local nongovernmental organizations (NGOs) and the state government, also generated significant debt on low-income families (Bosher, 2011).

Case Study 11.2 Vulnerability and Climate-Related Risks on Land, Housing, and Informal Settlements in Dar es Salaam

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Keywords	Heat, droughts, sea level rise, resilient development, vulnerability, urban infrastructure, housing
Population (Metropolitan Region)	5,166,570 (National Bureau of Statistics [NBS], 2015)
Area (Metropolitan Region)	1,393 km ² (NBS, 2013)
Income per capita	US\$900 (World Bank, 2017)
Climate zone	Aw – Tropical savannah (Peel et al., 2007)

Dar es Salaam, located on the Tanzanian Eastern coastline bordering the Indian Ocean, is one of the ten largest cities on the African continent in terms of population and by far the largest city in Tanzania. The population increased from 270,000 in 1967 and already reached 4.5 million in 2012 (United Republic of Tanzania [URT], 2012). It accounts for around one-third of the urban population in Tanzania and it continues to grow at annual rates of between 4% and 8% due to rural-urban migration and high fertility rates (Hussein, 2013; World Bank, 2002; START, 2011). The metropolitan area, including eight offshore islands, stretches over approximately 1,350 square kilometers. Dar es Salaam is the commercial, industrial, and administrative center of Tanzania; some 40% of the manufacturing industry is located there (Hussein, 2013).

Dar es Salaam lies in the Inter Tropical Convergence Zone (ITCZ) and has two rainy seasons: the long rainy season lasts from mid-March to the end of May (*Masika*), the short one takes place from mid-October until the end of December (*Vuli*). Between May and September, the rains are influenced by the southeast monsoon winds, and the northeast monsoon winds influence the area from October to March. In addition, El Niño Southern Oscillation (ENSO) and tropical cyclones influence the rainfall distribution across the region (START, 2011).

In the city of Dar es Salaam, the mean annual maximum temperature is 30.8°C and the mean annual minimum temperature is 21.3°C (START, 2011). Extreme rainfalls are experienced between March and May and can reach up to 50 millimeters. Recorded floods triggered by strong El Niño influences were first reported in 1983. Since then and until 2014, more than ten severe flood incidences were

recorded. The latest floods in April 2014 and May 2015 resulted not only in material and agricultural losses but also caused dozens of human losses.

HAZARDS

Temperature: Mean annual temperatures are expected to further increase in Tanzania. Projections suggest temperatures to rise between 2°C in the northeastern parts and 4°C in the central and western parts until 2075. Increases in mean annual temperatures are expected to result in intensified and frequent droughts in different regions of the country, also impacting its capital city Dar es Salaam. These result in food shortages, food insecurity, water scarcity, and power shortages (URT, 2011).

Precipitation: Rainfall patterns decreased over the past decades. Rainfall patterns within the two rainy seasons also shifted in timing. While *Masika* tends to start earlier than usual, the *Vuli* rains “become almost negligible” in terms of timing (URT, 2011). However, other scenarios project an increase of rainfall during *Vuli* of up to 6% by 2100 (START, 2011). Hence, there is uncertainty regarding climate change impacts in terms of precipitation.

Sea level rise: Sea level rise is a major concern for the Tanzanian coastline and for Dar es Salaam in particular because currently some 8% of the city lies below sea level, threatening at least 143,000 people (START, 2011). Impacts of a sea level rise include “loss of land, accelerated coastal erosion, loss of coastal and marine ecosystems, saline water intrusion in freshwater bodies, inundation of low-lying coastal areas and reduced freshwater flows” (URT, 2011: 118). In terms of monetary losses, an expected sea level rise of 0.5 meters could add up to US\$48–82 million in losses for Dar es Salaam only. These figures exclude associated losses and challenges for inhabitants dependent on fishery and tourism in the region.

Drought: Tanzania in general and Dar es Salaam in particular are subject to droughts. In 2006, the country suffered the consequences of a drought event that particularly affected access to clean water and food, causing diseases and malnutrition. Furthermore, periods of drought affect the availability of electricity due to its dependence on water (e.g., hydropower) (START, 2011).

VULNERABILITY

Multidimensional aspects of vulnerability in Dar es Salaam are related to the urban morphology and existing infrastructure of the city. Unplanned and informal settlements play a major role in this regard. These settlements such as the Msasani bonde la Mpunga, Msimbazi Valley, Jangwani, Tandale, Suna, Kunduchi and Bahari Beaches, the Ocean Road beach area, and the Tembeke River Kizinga areas, as well as the city center, are often prone to flooding (Pauleit et al., 2015; Jean-Baptiste et al., 2013; John et al., 2014). Vulnerability in terms of housing is high, with more than fifty-five unplanned settlements accommodating 70% of the city’s population (URT, 2011; START, 2011). These settlements show limited access to health services, solid waste management, sanitation, and clean water. This situation could worsen with a changing climate in the region. This would imply further cases of waterborne diseases such as cholera, malaria, lymphatic filariasis, and diarrhea.

The different forms of income generation in Dar es Salaam are related to informal modes of economic activity and micro-enterprises. Statistics from 2000 reveal 42% of the population was employed, 43% were self-employed, and 38% remained in poverty (START, 2011).

Drainage, particularly during flood events, is a mayor challenge. The city possesses 1,100 kilometers of ditches as well as 600 kilometers of piped stormwater drainage, all lacking maintenance. Water supply is also of concern in terms of quality, distribution, and availability.

INSTITUTIONAL ADAPTIVE CAPACITY

Today, urban planning in Dar es Salaam is still regulated by the city's master plan of 1979. Thirteen years later (1992), a subdivision plan, prepared by the City Council and the Ministry of Lands and Human Settlements allowed housing units to be constructed in areas previously marked as hazardous in 1979. To counterbalance this development, the National Land Policy of 1995 focused on the need of proper land management. In 2000, the National Human Settlements Development Policy was set up to explicitly restrict ongoing construction in hazardous areas. Despite these policies, constructions continued to rise in flood-risk areas.

Among concrete programs and projects that address urban planning and development as well as risks in Dar es Salaam are:

1. The Strategic Urban Development Plan (SUDP) of 1992, which dealt with urban management in several flood-prone areas. Despite enormous resources used, SUDP was, however, not adopted by the government, primarily due to conceptual weakness and apprehension among bureaucrats. Preparation of a new master plan is in progress.
2. The Community Infrastructural Upgrading Program (CIUP), which aimed not only at upgrading urban infrastructure in informal settlements but also at building community capacities to participate in planning and maintenance of their infrastructure.

CIUP was supported by the World Bank and UNDP and was implemented in two phases from 2004 until 2011.

3. The African Urban Risk Analysis Network (AURAN), set up in 2004, which focused on the reduction of disaster risks in urban areas. AURAN regroups NGOs, community-based organizations, and African universities and has been responsible for several projects, including three case studies in Dar es Salaam on health risks and disaster prevention.

Initiatives regarding formalization of properties are ongoing in Dar es Salaam. These include provisions of land or property licenses as well as rights of occupancy. This will ultimately allow the provision of basic infrastructure services including stormwater drainage, water supply, waste collection, and tenure rights (Kyessi and Kyessi, 2007).

Adaptation to climate change at a national level through the National Adaptation Program of Action (NAPA) remains weak due to financial constraints. In Dar es Salaam, concrete plans include tree planting along beaches, roadsides, and open spaces with a particular focus on managing exposed coastal areas (START, 2011). The Kinondoni Integrated Coastal Area Management Project (KICAMP) formulated a comprehensive plan to protect land, mangroves, and water resources in coastal areas. This has led to banning the excavation of sands in critical areas such as Kunduchi Beach and Bahari Beach (Baker, 2012).

Despite the uncertainty in projected rainfall patterns in Dar es Salaam, the intensity of heavy rainfall should be expected to persist, which increases the risk of flash floods throughout the city. While several projects on adaptation and mitigation focus on expected impacts for agricultural production, forestry, and wildlife conservation, there is a need to address current and future socio-economic consequences for coastal urban dwellers and consider multilevel actions that can render benefits in both short and long terms.

11.5 Options and Processes for Adaptation in the Housing Sector

11.5.1 Addressing Disaster Risk and Adaptation in Informal Settlements

Most climate change adaptation is ex-ante (anticipatory) and top-down, lending itself to large-scale, technological solutions (Tanner and Mitchell, 2008). This approach largely ignores the social determinants of vulnerability (Earnson et al., 2007; Prowse and Scott 2008; Cutter, 2009), resulting in a range of more inductive community-based approaches to adaptation that build on the existing risk-coping strategies³ of individuals and communities (Reid and Huq, 2007; Dodman and Mitlin, 2011; Robledo et al., 2012; Wamsler and Lawson, 2011). The distinction between coping and adapting is also becoming increasingly

accepted (Wamsler and Brink, 2014; Haque and Dodman, 2014; Pelling, 2011). Typically, “coping” stands for short-term and “survival today” responses that individuals, households, and governments take with the assumption that actions taken during previous events can serve as a guide for similar events (Wisner et al., 2004). A significant structural change like migration or decreasing dependence from a certain livelihood activity (e.g., shifting from farming to livestock rearing, innovative housing designs, and insurance schemes) would be an expression of adaptation.

Coping strategies can be both preventive of risk or help post-disaster recovery. Cases from Mombasa, Kenya, and Esteli, Nicaragua (Moser et al., 2010); Dhaka and Khulna, Bangladesh (Jabeen et al., 2010; Haque and Dodman, 2014); San Salvador (Wamsler and Lawson, 2011); and Bonde la Mpunga and Magomeni Suna in Dar es Salaam (John et al., 2014) reveal a

³ “Risk coping strategies” is one way of using the term “coping.” Wamsler and Lawson (2011) noted that many nuances of the term exist, such as “local coping capacity,” “local coping strategies,” and “local adaptive capacity” without being properly defined.

large diversity of both structural and non-structural measures at both household and community levels (see Table 11.4). Non-structural measures involve the use of households or community finances as a preventive or recovery measure. Examples of preventive measures at the household level are the pursuit of property legalization to increase house value. Various forms of mutual help with the expectation of obtaining direct or indirect compensation in times of need can be undertaken with the expectation of prolonged periods of drought or for post-disaster recovery. Recovery measures can be donations, formal and informal credit, remittances from relatives and family living abroad, income diversification, and riskier strategies such as borrowing money from the informal sector. Structural measures relate to preventing loss or damage to housing structures and interiors or preventing loss or damage by temporarily reinforcing neighborhood structures. In some cases, we see the combination of recovery actions, such as the use of locally sourced materials to repair damaged houses, with actions that have mitigation co-benefits (e.g., allow vegetation to grow on rooftops to increase strength and natural cooling during heat waves).

While authors recognize the diversity and importance of such strategies, they are very often insufficient to keep pace with the growing impacts of climate change and their related uncertainty and magnitude. Wamsler and Lawson (2011) recognized the following limitations of using non-structural coping strategies by residents of informal settlements: (1) households may default on their obligations toward relatives and neighbors; (2) different income levels in informal settlements may lead better-off households to opt out of mutual arrangements; (3) generally, informal settlers have little to sell; (4) informal settlers need to compete economically, which often privileges specialization rather than diversification; and (5) because they are forced to make tradeoffs between household maintenance, recovery, and anticipated future risks, they can easily experience continuous vulnerability even after a disaster is over.

Compared with strategies undertaken by individuals and households, community-level strategies are characterized by a high degree of self-organization and the ability to network with other partners, to document what they achieve, and to lobby governments to increase the scale and scope of their actions (Satterthwaite, 2013; Satterthwaite, 2011; Cruz-Mudimu, 2013; Archer, 2012; Rayos and Christopher, 2010).

11.5.2 Saving Schemes

Saving schemes take various forms mostly designed to encourage savings through small but regular deposits or deductions from salaries for various purposes. In the context of adaptation, saving schemes commonly serve as coping strategies that allow households to overcome the impact of an event. There are limits, however, to the amount of savings that organized community

groups can collect, which do not normally extend beyond small loans for housing improvements. To achieve a lasting impact, communities and civil society organizations have started looking toward larger schemes established within a district, a city, and even at a national level.

Community development funds (CDFs) are up-scaled funds of larger programs from the Asian Coalition for Community Action (ACCA) of the Asian Coalition for Housing Rights (ACHR). Also, institutions such as Slum/Shack Dwellers International (SDI)⁴ play a role in creating responsive relationships between local government and residents living in informal settlements. For instance, members of the Namibian Shack Dwellers Federation were included in Namibia's larger housing program, which aims to build 185,000 dwellings by 2030. The Federation's loan fund is expected to receive a portion (approximately US\$5 million of local government funds to address the needs of those living in informal settlements. The Federation has so far supported 5,591 households and constructed 3,403 houses (Mitlin, 2014).

CDFs can bolster the credibility of smaller savings groups and attract funding from larger international agencies. For instance, the Homeless People Federation Philippines Inc. (HPFPI) obtained funding from the GIZ, the World Bank/Cities Alliance (WB/CA), and the Asian Development Bank/Japan Fund for Poverty Reduction (ADB/JFPR). The group also worked with network partners, such as the Slum/Shack Dwellers International (SDI), the Asian Coalition for Housing Rights (ACHR), and other institutions like the Latin American, Asian, and African Social Housing Service (SELAVIP), Homeless International (HI), and the International Institute for Environment and Development (IIED). One of the community-scale projects supported by the SDI in 2014 focuses on housing improvement and community/settlement upgrades in response to recent flooding events in Lilongwe, Malawi. This project involves repairing houses damaged by recent heavy rain and storm events affecting the southern region of Malawi, including buildings as well as social and technical infrastructure. The project has had an impact on government policy, allowing urban poor to increase their position in annual plot allocations and develop their own resource mobilization skills. Based on community saving schemes, the federation has developed expertise in composting toilets and the use of adobe and compressed earth block for constructions. Challenges include the fact that the Malawi Homeless People's Federation was unable to implement the revolving fund process at the start of the project. In consequence, the labor charge for builders was not repaid.

This type of community finance helps provide affordable long-term assets to the poor. The ACCA program in particular has boosted hundreds of saving schemes across Asia. While the ACCA works as an aggregator of financial capital at the local

4 SDI is a transnational network of community-based organizations operating 115 projects through the Urban Poor Fund International (UPFI, 2014) in thirty-three countries of Africa, Asia, and Latin America. This network is organized in different cities as federations and has been known to mobilize vulnerable groups, develop strategies for community upgrading, set up public amenities, and advocate for alternatives to eviction (Dodman et al., 2010).

Table 11.4 Summary of preventative and impact minimizing coping strategies.

Preventive and recovery coping strategies	
Nonstructural measures (socioeconomic)	
HOUSEHOLD LEVEL	COMMUNITY LEVEL
Formal and Informal credits (e.g., micro-finance, borrowing from informal sector lenders at higher interest rates)	Informal financial services (e.g., illegally accessing formal insurance mechanisms)
Informal donations and formal monetary compensations	Community emergency funds (through community savings)
Diversifying income (in the form of multiple jobs, subletting spare rooms to other tenants, domestication of animals to secure alternative food sources and income)	Creating/leveraging linkages with government and (mostly) non-governmental institutions
The selling price of acquired assets	Mutual Help Associations
Pursue legalization of property to enhance selling price of dwelling if funds are needed	
Various forms of mutual help (pre-/post-disaster actions in the hope of obtaining direct or indirect compensation, e.g., money or object lending, taking care of neighbors' children)	
Remittances from abroad (risk sharing)	
Structural measures (physical/built environment)	
HOUSEHOLD LEVEL	COMMUNITY LEVEL
<i>Modifications within/around the house:</i> Building up stores of food and sealable assets (increase the height of furniture and plinths, arrange higher storage facilities, build retaining walls around homes, improve housing materials, use of wood planks flooring to prevent waterlogging, create perforated bamboo partitions between floor and roof to enhance ventilation, spread wood and ash on slippery mud floors, reinforce foundations, build steps with tires). Use of locally sourced materials to repair damaged houses in a cost-effective way (local varieties of leaves for roofs and woods for walls) or corrugated sheets and allow vegetation to grow on it to increase strength and cooling during heat waves; use mud from rivers to restore mud plinths	<i>Upgrading of neighborhood's physical environment:</i> Use sandbags, clean up drainage pipes, dig drainage tunnels, construct elevated bamboo pathways during waterlogging; mobilize senior inhabitants reach out to local authorities regarding needed repairs

level, CDFs instead represent the institutionalization of community-scale savings at a city scale (Archer, 2012).

While these schemes come closest to housing finance, they generally require some subsidy for land or infrastructure development. Although responsibility for repayments is spread across individuals to communities, thus increasing the business risk for lenders, community finance helps build community engagement toward asset maintenance and social cohesion (e.g., by allowing individuals to rely on neighbors rather than costly money lenders in the event of emergencies). This kind of finance also tries to fill the gap of market failures in the supply of housing finance. In fact, the ACCA operates in countries where mortgage finance is unavailable at a cost that exceeds the cost of government borrowing, with the exception of Vietnam. Community finance also differs from micro-finance for its collectivist approach, government investment, and long-term support aspects.

11.5.3 Relocation

Human mobility was identified as one of the effects of climate change in the first IPCC report published in 1990 (Houghton et

al., 1990). Subsequently, although a substantial body of work has been developed on various forms of human mobility from the development, humanitarian, and disaster risk perspectives, those coming from the climate change spectrum will not only have to navigate through existing terminologies, but will also need to venture through relatively new territory with regard to relocation. Ferris defines relocation as “the physical movement of people instigated, supervised, and carried by State authorities (whether national and local)” (Ferris, 2014: 8). Relocation practices that are temporary are known as *evacuation*, whereas more permanent efforts to counteract slow onset effects of climate change imply resettling in another area and usually require planning. The idea of planning relocation comes to the fore when the associated implications for living with climate change means that certain places will be inhabitable. This is the case for Small Island Developing States (SIDS); communities of the Cateret Islands, Papua New Guinea; Vunidogoloa and Narikoso Villages in Fiji; and Funafuti Atoll, Tuvalu.

Relocation is a multisectoral issue that needs to be addressed in various parts of local government. Relocation touches not only aspects of urban planning and infrastructure, but also concerns

Box 11.2 Community Finance through Community Development Funds and the Asia Coalition for Community Action Program

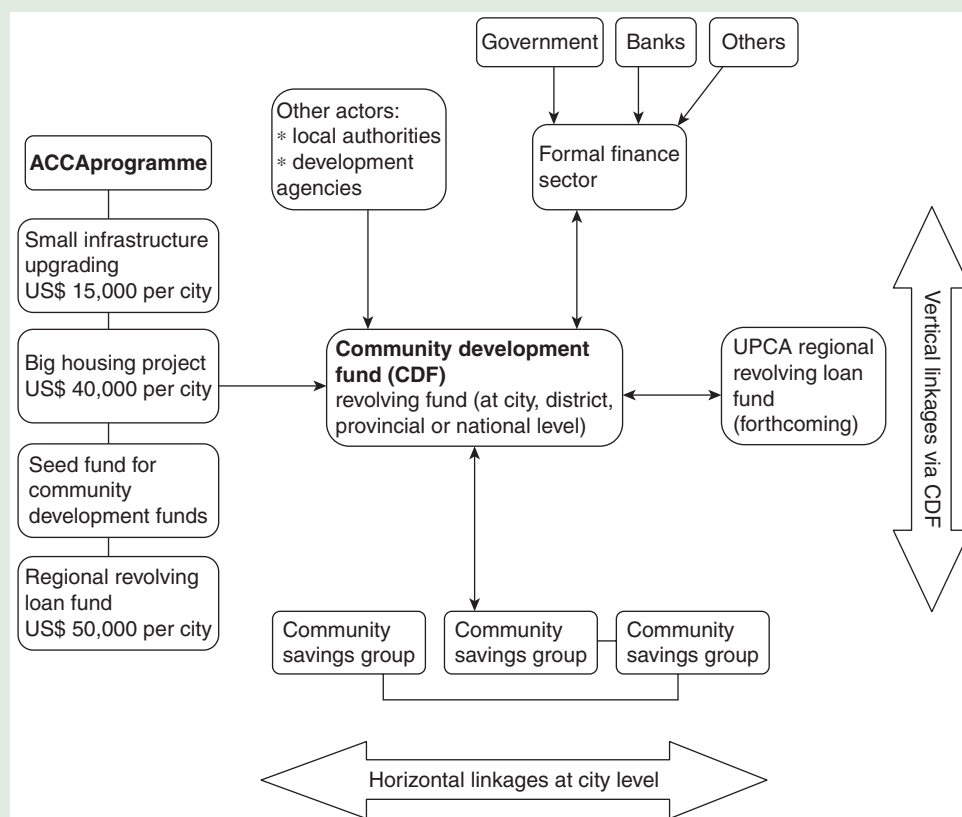
The Asian Coalition for Community Action (ACCA) is a 3-year program that has set out to transform development options for Asia's urban poor by supporting a process of community-led change in 150 cities in fifteen Asian countries. The program began in November 2008. By 2014, it had expanded to 165 cities in nineteen countries (Asian Coalition [ACHR], 2014).

The program consists of a series of coordinated, comprehensive activities initiated by a community. The program implements four functions: it provides a small grant to the community for small-scale infrastructure (up to US\$15,000 per city); it then provides a loan to the community for larger housing project (up to US\$40,000); it helps the community design its own housing and infrastructure by providing architectural and planning assistance; and it helps the community acquire formal land title by negotiating land purchase, a land grant, or a long-term lease from the owners (World Bank, 2013a; Archer, 2012). To access funds, communities are required to organize into a community development fund (CDF) by linking together their savings. The amount of savings each member contributes varies. For instance, one community may decide to invest 40% of its savings in the CDF and keep the rest as contingency funds in case of emergencies. The injection of money in the fund puts the city CDF in evidence and encourages contributions from other city actors and formal financial sector organizations, potentially

including climate funds. Committees comprised of community representatives manage CDFs while local authority representatives act as chairs in an advisory role (Archer, 2012). A regional revolving fund provides 2-year loans for up to US\$50,000 to country groups at 4% annual interest, and it is currently experimenting with lending and repayment in local currency, which lessens the burden of fluctuating exchange rates (ACHR, 2014). So far, six cities in Nepal, Cambodia, Sri Lanka, and the Philippines have used eight loans.

Basic services are a key area of activity for small projects with improvements in water, sanitation, drainage, solid waste, and electrical services. The projects also often include embankments and roads and bridges to connect settlements to city grids (Boonyabancha and Mitlin, 2012). The rationale of small projects is to make collectively undertaken physical upgrading visible to local authorities, thus bringing the community together and strengthening its negotiating powers toward authorities. As of November 2014, the total amount of small projects approved in 3 years was 1,424, although those actually implemented amount to 2,139 in 2,021 communities spanning 207 cities.

The total budget approved was US\$2,859,100 coming from a variety of sources, including 24% from ACCA, 17% from communities, 53% from government, and 6% from other sources, including donor agencies (ACHR, 2014).



Box 11.2 Figure 1 The Asian Coalition for Community Action (ACCA) program as a linking mechanism between different funding sources.

(a)



(b)



Box 11.2 Figures 2a and 2b Before and after shots of the paved alleyway that links 150 poor households in Block 3, Ward 5 in the city of Ben Tre, Vietnam.

EXAMPLE OF SMALL PROJECTS IN VIETNAM

Figures 2a and b depict the before and after of the paved alleyway that links 150 poor households in Block 3, Ward 5 in the city of Ben Tre. Like all Vietnamese ACCA cities, the communities in Ben Tre use ACCA small project funds as loans (at 4–6% annual interest) through their CDF, rather than as grants, so the money can revolve and help more communities. And, like most other small projects in Vietnam, this community used the ACCA loan (US\$3,369) to leverage a much bigger amount from community members (US\$3,190) and from their Ward Office (US\$5,199) to replace a muddy and perpetually flooded walkway with a paved road they built themselves (World Bank, 2013a).

ACCA's intent is not to simply address individual households' needs but rather to catalyze change through a people-driven approach to housing interventions. ACCA's large projects focus largely on housing. Funds for big projects serve two purposes: to finance the project and to seed (or add to) a city-based CDF. The project loans are channeled through this fund, and repayments are made back to it. As of November 2014, 51 housing projects were completed, with 41 underway. Twelve projects were unable to begin due to difficulties related to land. Only 19% of the big projects (28 projects) involved the relocation of whole communities, whereas more than 47% (69 projects) had been able to upgrade or reconstruct in-situ. Twenty-two percent of the projects (32 projects) provided loans for housing improvements to households in scattered locations, and 12% (17 projects) created new communities of previously scattered squatters on new land (ACHR, 2014). As of 2014, the big projects budget amounted to 5% contributions from ACCA, 12% from community, an impressive 80% from government, and 3% from other sources.

EXAMPLE OF PROJECTS IN THE PHILIPPINES

In a context where relocating poor communities to remote resettlement sites is still the norm, the housing project being built by the Binina Homeowners Association is an important example of "in-barangay" relocation. These seventy-six squatter families collectively bought a small piece of private land (1,260 square meters) in the same barangay for US\$71,820, partly with their savings and partly with loans

from the Community Mortgage Programme. The US\$40,000 from ACCA is being used to seed the new citywide revolving loan fund, with the first batch of housing loans going to the families at Binina to construct double-unit rowhouses, with one loft unit up and one down (ACHR, 2014).

Community networks in several countries are using ACCA support for disaster relief and rehabilitation. By the end of October 2014, a total of thirty community-driven disaster rehabilitation projects had been approved in eleven countries: Cambodia (one project), Nepal (one project), Myanmar (three projects), Philippines (eight projects), Vietnam (four projects), Lao PDR (one project), Sri Lanka (one project), Thailand (one project), Pakistan (one project), and Japan (one project). This represents an almost equal outcome compared to 2012, where the same number of projects were implemented in ten countries (ACHR, 2014). It can be argued that many of the small and big projects also contribute to reinforce disaster prevention and recovery, since access to reliable basic services, better housing and resettlement policies, good drainage, and paved roads can all contribute to climate adaptation.

An independent review of selected ACCA program locations (World Bank, 2013a: 2) concluded that CDFs "offer a reliable alternative in the provision of housing and infrastructure for low-income communities. This alternative does not aim to replace already existing institutional and financial structures, but through its incremental process, promotes deep transformational and systemic changes." This is underscored by policy revisions being undertaken in several countries as a result of the ACCA program. Examples include new national housing policy based on community-driven or partnership-based upgrading projects in Cambodia, political support in four Indonesian cities for infrastructure upgrading, in-situ upgrading of riverside settlements and free land for housing, and first cases of informal settlement upgrading and long-term land leases in Lao PDR" (World Bank, 2013a).

One of the greatest challenges for maintaining CDFs is the ability to retain flexibility in the management of the schemes (which is one of the main reasons communities choose this option) without accumulating bureaucratic rigidities or recreating local elite powers dynamics (Archer, 2012).

human rights. For instance, existing tribes in Washington State in the United States are working with government officials and universities to develop an adaptation scheme in line with their traditions, preserving indigenous land rights and avoiding forced relocation. Those engaged in discussion with policy-makers on mobility argue that the question of relocation must be placed under the umbrella of a national plan rather than disaster risk and climate change alone. The cost of relocation at a community scale is extremely high (e.g., US\$400 million for Kivalina, Alaska). Many communities have to bear these expenses themselves, which is unfeasible for residents of low-income countries. This highlights the need for adequate climate financing, in particular, the need for high-income countries to meet their commitment to mobilize US\$100 billion in climate financing by 2020 (OECD, 2015).

It is frequently argued that there are ethical and social limits related to relocation among low-income households and communities (UNHCR, 2014). Several scholars have argued over the loss of traditional and cultural identity through relocation (Cernea, 2009; Ferris, 2012; Modi, 2009). The extent to which those affected by sudden or recurrent events are entitled to draw on resources greatly depends on the capacity of the surrounding system, which in turn may still exacerbate vulnerability. In Fiji, the relocation site chosen by the government was considered unattractive to fishermen. In Magomeni Suna, the relocation site located 30 kilometers away from Dar es Salaam's business district was highly criticized by resettlers, who were faced with mobility issues (e.g., distance to and from their place of work) and livelihood safety issues (e.g., loss of clientele from petty traders), as well as loss of social networks and capital. Experiences with relocation largely depend on whether affected communities are given a choice. *Voluntary relocation* versus *forced relocation* depends on the extent to which communities are driving the process and whether existing frameworks and guidelines are put in place to support them.

Because relocation may occur at various scales, successful practices will depend on actions taken at various levels. On a global scale, there are opportunities for more international engagement, policy, and approaches on relocation:

1. *National Adaptation Program of Action (NAPA)*: If relocation is included in such a framework, developing countries that usually lack the financial resources will have a way to access funds for relocation. Such references have already been made to NAPA from small islands such as Solomon Islands, Kiribati, and Tuvalu (McDowell, 2013).
2. *Adaptation frameworks* (Cancun agreements) emphasize the need for countries to take measures concerning relocation.
3. *Loss and damage* (Decision3 CP/18) that calls for understanding the impact of climate change on patterns of migration and human mobility. One limitation is that the focus is largely on impacts of extreme weather events and less on slow-onset events. Additionally, it is estimated that mechanisms to respond to slower changes could take 15–20 years or longer to deliver adequate finances whereas solutions on the ground require more urgent actions.

4. *Peninsula principles*: A set of international principles put forward by a group of scholars under the coordination of NGO Displacement Solutions to establish the rights of people displaced by climate change. The set of eighteen principles aim to provide a “comprehensive normative framework” based on existing international law and human rights values. The principles address inland migration issues and put forward protection and assistance that are consistent with international guiding principles such as the UN internal displacement chart. The Peninsula principle considers relocation as a last resort and uses a participatory approach to deal with displacement actions at community levels.

11.5.4 Insurance Mechanisms

Weather-related insurance claims have increased fifteen-fold over the past 30 years. According to many climate models, one of the primary and immediate risks of climate change is a likely acceleration of that trend, with more frequent severe weather events (Zurich Financial Services Group, 2009). In events such as flooding and other natural disasters that may cause housing damage or destruction, the insurance industry can act as a bridge between public and private sectors by addressing risk awareness through assessment and mapping, physical recovery through policies and regulations, and financial preparedness. The demand and supply challenges to provide property-related insurance in relation to climate hazards are significant. They include, on the supply side, the issue of insurability (i.e., that climate uncertainty may lead to an inability to quantify hazards accurately and the risk of excessive amounts of claims) and factors that push premiums higher and threaten affordability. On the demand side, populations need to be aware of risks, should be willing to insure, and should be able to afford the premiums (Lamond and Penning-Roswell, 2014).

The latter is particularly difficult in low-income settlements and virtually nonexistent in informal settlements. As explained in the initial paragraphs of Section 11.1, in times of natural events and disasters, the poor and those living in informal settlements largely rely on informal risk strategies and their social capital and trusted networks for assistance and recovery support (Kabisch et al., 2015).

The micro-finance industry may offer some windows of opportunity to lower income settlers, although adjustments to lending practices may be required for the sector to fulfill adaptation goals. Agrawala and Maëlis (2010) found that micro-finance in Bangladesh (the world's largest micro-finance industry) and Nepal worked as a good option for the small and short-term transactions involved in adaptation because there are strong links between the existing activities funded through micro-finance and what is required for adaptation. Property-related micro-insurance, however, is infrequent with only few examples mentioned. For instance, the Integrated Development Foundation (IDF) in Bangladesh provides long-term loans

(eight-year loans with flexible repayment times) to disaster-affected clients in order to build safer houses with more resilient materials and specific housing loans to support the construction of weather-resistant houses with locally sourced materials. In general, evidence of affordable insurance schemes for low-income communities that fulfill adaptation goals at the same time is very poor.

The combination of both risk financing and risk reduction for developing countries is important for spreading losses spatially and temporally (Linnerooth-Bayer, 2011) and can influence behavior in terms of reducing moral hazard context (when insurance can lead to risky behavior) or as an incentive (where insurance triggers risk reduction investments or the undertaking of prevention measures). However, evidence of the existence of flood-related schemes showing a link between risk reduction and risk transfer, especially in least developed countries, is very poor and not based on empirical observations (Surminski and Oramas-Dorta, 2014). Recently, the Munich Climate Insurance Initiative (MCII) proposed a closer link between risk reduction and insurance through

incentives, along with considerations for risk reduction activities to be prerequisites for participation in climate risk insurance.

Evidence of the implementation and effectiveness of measures is, however, very limited, with scholarly debate mainly focusing on insurance in developed countries. In 2014, the European insurance industry was the largest in the world (35%), followed by North America (30%) and Asia (28%), whereas Latin America, Oceania and Africa accounted for 6% (3% each) of global insurance premiums (CEA, 2011 in Surminski and Oramas-Dorta, 2014). There are also wide differences in insurance schemes for agriculture and flooding. A review of 123 risk-transfer initiatives, part of the International Labor Organization's Micro-insurance Compendium in middle- and lower-income countries, highlighted that very few nonagriculture-related schemes are currently operational or running as pilot schemes, and those that exist mainly focus on indemnity (what is paid by the insurance after loss). The highest concentration of flood insurance schemes is in Latin America and the Caribbean, whereas Sub-Saharan Africa has no recorded scheme (Surminski and Oramas-Dorta, 2014).

Case Study 11.3 Sheltering from a Gathering Storm: Urban Temperature Resilience in Pakistan

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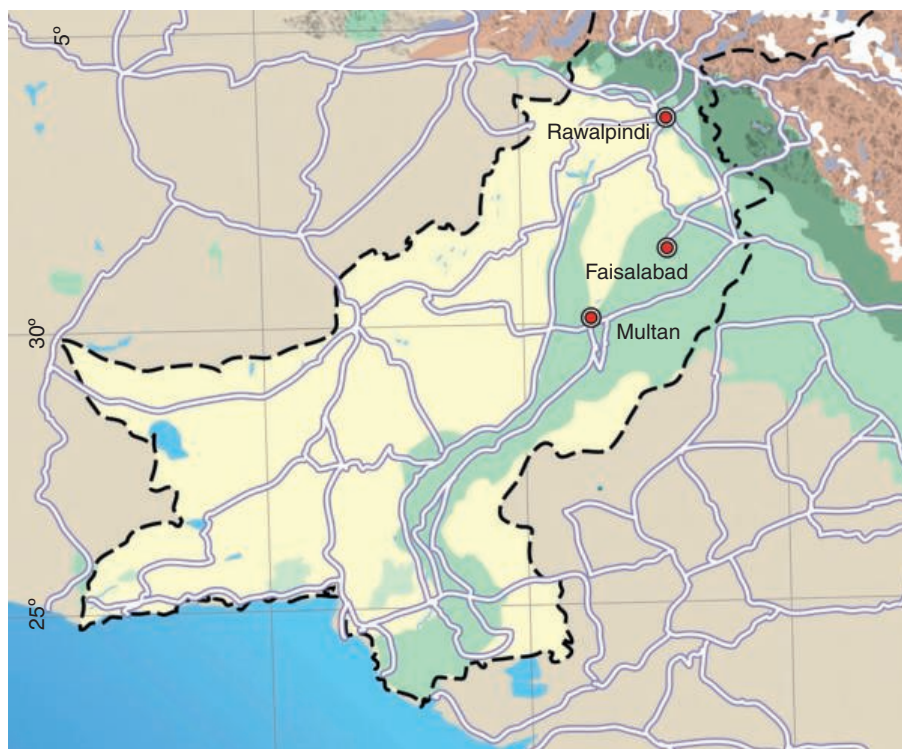
Keywords	Resilience, urban heat island effect. temperature minimums, cooling, shades
Population (Metropolitan Region)	Rawalpindi-Islamabad: 2,590,000 Multan: 1,950,000 Faisalabad: 3,675,000 (Demographia, 2016)
Area (Metropolitan Region)	Rawalpindi-Islamabad: 427 km ² Multan: 207 km ² Faisalabad: 181 km ² (Demographia, 2016)
Income per capita	US\$5,580 (World Bank, 2017)
Climate zone	Rawalpindi: Cfa – Temperate, without dry season, hot summer Multan: BWh – Arid, desert, hot Faisalabad: BWh – Arid, desert, hot (Peel et al., 2007)

Changes in temperature are the most accurately predicted consequence of global climate change. Summer temperatures in Pakistan have increased by an estimated 3°C from 1961 and 2007. The impacts of temperature changes and the return on investment in climate-resilient shelter in Rawalpindi, Faisalabad, and Multan were studied. Temperature increases will make cities unaffordable

for the poor. Shelter design modifications (i.e., passive cooling) to reduce heat impacts are likely to have positive economic returns at the household level; however, these measures need to be supplemented by measures to improve the provision of municipal services.

Pakistan is experiencing a considerable increase in temperatures. Heat wave events are a major cause of weather-related morbidity and mortality in Pakistan. Rawalpindi (at the foot of the Hindu Kush mountain range), Faisalabad (in the central plains), and Multan (in the hot desert) represent a range of conditions in Pakistan and rank among the top five most populous cities in the province of Punjab (see Case Study 11.3 Figure 1) and some of the fastest urbanizing centers in the world. In all of these locations, increases in temperature are a central concern. Summer peak temperatures of 50°C in Multan have been officially recorded, with unofficial sources reporting temperatures that exceed 53°C. Even Rawalpindi, at the base of the mountains, has recorded temperatures in excess of 46°C.

Climate extremes may often cause damages linked to structural and owned assets – however, in the case of heat in Pakistan, heat does not affect the housing structure but causes direct harm to the people who live in these shelters. Shelter design can alleviate or exacerbate the extent of heat stress. Newly migrated (in the past 20 years) low-income households residing in formal and informal settlements in Rawalpindi, Faisalabad, and Multan are often well-established, with brick and reinforced concrete houses. Brick houses in these cities have a high thermal mass and little to no ventilation, which make them vulnerable to current and future heat extremes and the associated health impacts (Vandentorren et al., 2006). The thermal performance of concrete, the most common roof material in Pakistan, makes it an unsuitable construction material for heat-resilient housing. Concrete roofs elevate nighttime temperature within houses by approximately 3°C. Households in Multan are already spending half of their income on measures to reduce heat stress and health care costs arising from heat exposure. Expected temperature rise due



Case Study 11.3 Figure 1 *Vulnerability study sites in Pakistan – Faisalabad, Multan, and Rawalpindi.*

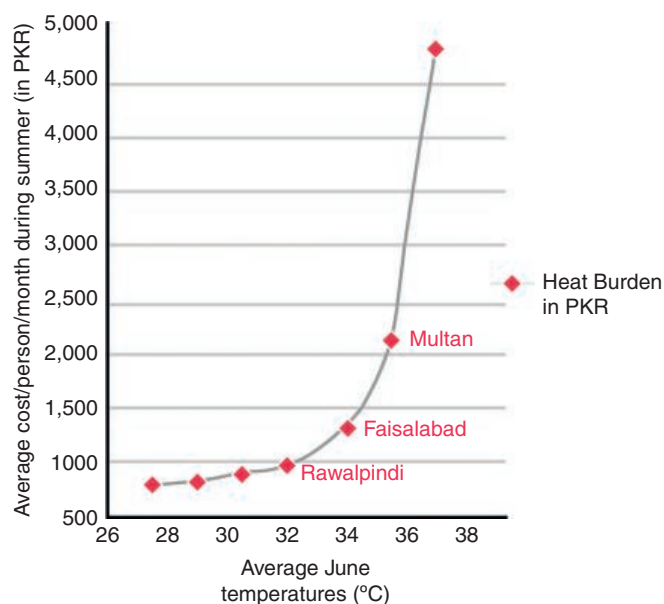
to climate change would make these costs higher than the income of these households in all locations except Rawalpindi, which will exhibit conditions similar or worse than present-day Multan according to current climate change projections.

IMPACT OF HEAT WITH RISING TEMPERATURES

Temperatures within settlements currently reach levels that have a substantial impact on human health and productivity, and these levels are likely to increase substantially over time due to climate change (see Case Study 11.3 Figure 2). Temperatures in the northern cities of Pakistan are projected to increase markedly over the coming decades. Temperature maxima during the hot season are projected to increase by 2–2.5°C, whereas temperature minima are expected to increase by 2.5–3°C. Projections show that heat-related impacts on people and infrastructure will start earlier in the year, be more intense throughout the summer, and last longer in the fall.

While the impacts of rising daily maximum temperatures can be somewhat addressed through various strategies such as providing shade, it is particularly the increase in consecutive nights with very high minimum temperatures and humidity (measured through the heat index) that are of concern (Zahid and Rasul, 2008; Mustafa, 2011). Currently, heat stress increases significantly when nighttime temperatures exceed approximately 28°C, with even more significant physiological impacts as minima approach 37°C for more than three consecutive days. Nighttime temperatures exceeding 37°C are expected to more than double in the coming three to four decades (Cheema et al., 2010). The heat-related economic burden increases disproportionately with every degree of temperature increase (see Case Study 11.3 Figure 2). In addition, the projected loss of overnight respite will affect how well the human body can recover from daytime heat exposure and thus affect health and productivity. With

few resources, poor infrastructure, and inconsistent electrical supply, the poor will struggle to adapt as the need for active cooling increases. These impacts will affect women in particular due to cultural norms that have them more likely to stay inside their homes and due to infrastructural failures that prevent those homes from being cross-ventilated.



Case Study 11.3 Figure 2 *Heat-related expenditures in different temperature scenarios.*

TEMPERATURE RISK REDUCTION OPTIONS

Shelter design modifications (i.e., passive and active cooling) to reduce the impact of heat are likely to have positive economic returns at the household level under current conditions in cities like Multan and for most cities with projected climate change. Cost-effective techniques for reducing the impact of peak daily temperatures on in-house conditions primarily involve increasing shading and reflectivity and improving insulation. Improvements in ventilation would also improve conditions greatly but would require concurrent improvements in overall sanitation within neighborhoods. Importantly, no interventions currently available can address the impact of extended high ambient temperature minima. Insulation, shading, and similar interventions can ensure that temperatures inside houses remain well below daytime peak temperatures. They cannot, however, reduce temperatures below nighttime minima, particularly when nighttime minima remain high for extended periods.

IMPLEMENTATION

More resources need to go into material and shelter in climate change adaptation design research for temperature resilience. Data and knowledge-sharing can help to predict and plan for these risks. Knowledge generation and dissemination at the local level may be the best place to start. This primarily involves training

and awareness-building among local masons and contractors as a means to integrate climate-resilient principles in housing construction.

There are, however, fundamental challenges to creating and implementing change. With lack of financing and insurance mechanisms in the housing sector, which are a reflection of the inability to enforce property rights, the state and national levels of government cannot be expected to play a significant role in either incentivizing or enforcing climate-resilient designs. However, provision of services such as electricity, water, and sanitation could greatly alleviate the burden of heat stress in the medium term. Unplanned settlements, when assimilated into municipal boundaries, lack basic services such as water and sanitation, as well as open areas. These deficiencies already impact the health of millions of people, and the situation will only be exacerbated by the expected climate change.

In Pakistan, the most common cause for families to fall into poverty is repeated health shocks (Heltberg and Lund, 2008). Improvement in health services now may generate the resources needed by poor households to deal with heat stress better in the future. Conversely, relief from temperature stress may help households to better deal with health problems. However, in the longer term, more radical adaptation strategies may be needed to cope with large-scale heat stress.

Source: Adapted from Khan, F., Malik, S., & Rehman, A., 2014. Sheltering from a gathering storm: Temperature resilience in Pakistan. ISET-International.

Some challenges for flood- and physical risk reduction insurances are lack or unreliability of risk data (modeling and exposure information), obsolescence of networks and data infrastructure, and unreliable government asset databases. Specifically for insurance, implementation is hindered by excessive reliance on government and donor subsidies, lack of local distribution channels, poor financial literacy of communities, and overall limited demand (ClimateWise, 2011; Surminski and Oramas-Dorta, 2014).

11.5.5 Early Warning Systems and Risk Mapping

The purpose of early warning systems (EWS) is to warn the population of potentially fatal phenomenon that might cause potential casualties or structural damage to housing or infrastructure. EWS are recognized as contributing to disaster reduction, but are also an effective adaptation measure because they strengthen the database needed for assessing climate-related vulnerabilities. Designing, implementing, and maintaining EWS can require enormous amounts of resources. EWS demand scientific, managerial, technical, and social components integrated with communication systems. In this respect, they require governments that mainstream disaster risk into policy processes and design and maintain the system. EWS demand local community participation to ensure that risk is adequately communicated.

Sophisticated and more expensive EWS tend to appear in larger cities, driven by the high concentration of people and assets, more complex logistics, and coordination. For example, Makati City in the Philippines set up Command, Control, and

Communication Centre (C3) under the Makati City Disaster Reduction and Management Council to act as city liaison between and among national government agencies, NGOs, and other city stakeholders in times of disasters and to issue warnings to communities (UNESCAP and UNISDR, 2012). Similar efforts to decentralize disaster risk management are ongoing in Sri Lanka, where, since the 2004 tsunami, localized disaster risk management centers were established, national risk-level profiles issued, and a vulnerability atlas prepared based on information and participation of locally affected communities. Preparedness has also been strengthened. For example, repeated evacuation exercises are shortening the response time during alert trials and the first mass alert warning system for Sri Lanka, the Disaster and Emergency Warning Network, now issues public alerts through cell broadcasts (Weeresinghe, 2013).

By decentralizing disaster risk reduction resources from a national to local level, municipalities (e.g., Chacao, Venezuela) have found ways to introduce less complex disaster risk management systems, including wireless technology. Other examples include monitoring equipment that feeds into real-time slope stability measures on a city scale (e.g., Ancona, Italy). The presence of a strong local leadership also helps to reinforce decentralization efforts. For instance, the Mayor of San Francisco City in the Philippines, who received several awards for his efforts in building disaster resilience, has been engaging children in programs for risk assessments, community drills, and simulation exercises. These have also helped to increase disaster resilience and reduce social vulnerability by including early school leavers in training exercises, rescue simulations, and emergency response (UNESCAP and UNISDR, 2012).

Box 11.3 Principles of Climate Compatible *in Situ* Development in Informal Settlements

The African Center for Cities (ACC) and the Climate and Development Knowledge Network (CDKN) developed a vision for adaptive African cities. This vision comes from an attempt to embed the concept of “climate-compatible development” (CCD; Mitchell and Maxwell, 2010) within the growth and development of African cities. In a nutshell, CCD addresses the overlaps among development, adaptation/resilience, and mitigation strategies. When developing the eight principles, the ACC and CDKN take into account that adaptation overlaps naturally with development because vulnerability and poverty reduction strategies contribute to increasing adaptive capacity. From a development perspective, climate change will surely affect production possibilities and prices. Consequently, investing in high-emission solutions to achieve energy security is likely to commit African cities to higher fuel costs in a world where fossil fuel may be constrained and oil prices uncertain. Therefore, although climate mitigation agendas are not and should not be a priority for low-income countries, it makes sense to look for mitigation benefits when designing development strategies. According to ACC and CDKN, CCD interventions in informal settlements need to be designed to:

1. Achieve tangible and rapid results in improving people’s safety and quality of life that incrementally generates a driving force for larger scale, longer term transformative change – working toward a *hierarchy of improvements*. For example, start with local, off-grid, safe, affordable, renewable energy technologies to generate energy for local cooking and lighting, but with a view to getting the network infrastructure in place for local generators to sell excess energy into the citywide grid.
2. *Demonstrably reduce climate vulnerabilities based on careful assessment and tracking, while looking for interventions and innovations that provide both climate adaptation and mitigation benefits (i.e., emissions reductions) where possible.* This might require new expertise and project partners in addition to those who would otherwise be included in a traditional development project that doesn’t explicitly factor in current and future changes to the climate.
3. *Include affordability as a key criterion in the design of technologies and service-delivery models, not simply for installation/construction but also for ongoing maintenance and repairs,* to ensure widespread access and financial sustainability. In this respect, smart, innovative design and low-tech options that meet the adaptation needs of the urban poor should be given priority. For example, look at the feasibility of distributed, locally administered savings cooperatives to finance the maintenance of neighborhood bio-gas digesters to reuse waste, reduce methane emissions, and produce a local source of energy rather than relying solely on government support programs.
4. *Match the selection of technologies and servicing models with local skills to deliver, install, and maintain*

thus strengthening existing livelihood portfolios rather than creating new competing markets. This might require initial “up-skilling” and training of trainers, seeking to avoid ongoing reliance on outside expertise (linked to the affordability principle just described) and to create local employment opportunities. For example, look at registering and improving the capability of existing informal food vendors to refrigerate and store fresh food under conditions of increasing heat and humidity while improving education about nutrition and health rather than removing informal stalls and forcing people to travel further to large retail chains to access food.

5. *Push for softer forms of regulation that support informal practices of entrepreneurship, social innovation, and private service provision* in slums while protecting consumers and employees by enforcing basic standards and limiting negative impacts on human health and the environment: for example, extending food safety standards to accommodate street food and having health inspectors visit street food vendors in informal settlements to discuss methods for increasing hygiene and to set a date for a return visit to measure improvements before facing a fine. This may become increasingly important under changing climate conditions as heavier rainfall events lead to more contaminants in water and higher temperatures encourage pathogens.
6. *Work toward enhancing security of land tenure,* fostering a sense of stability and a shared future. This can help shift the perception of (previously) informal settlements from being temporary and marginal in need of removal to that of being a legitimate, integral, and valuable part of the city as a whole – as places for investment in and servicing of permanent, higher quality infrastructures that are more robust against a range of climatic conditions including heavy rains, strong winds, hotter temperatures, and the like (e.g., insulated ceilings, paved footpaths, and vegetated parks).
7. *Take a reflexive learning approach* to factor in complexities, contingencies, and uncertainties, allowing for adjustments within the project cycle. Informal settlements are highly dynamic settings and are poorly understood (i.e., minimal plans, maps, census data). Similarly, climate change is a new and emerging field of knowledge, especially on the local scale, so many local climate dynamics and feedback loops are still unclear, especially in under-researched cities. However, we know enough about both to recognize an imperative to act. So we need to act and learn iteratively, with clear goals in mind but with the flexibility to adjust our approach as we progress (i.e., building adaptive capacity), documenting and sharing new knowledge as it is produced.

Source: Taylor, A., and Peter, C. (2014)

The incorporation of climate-related considerations into the disaster profile of cities also requires new capacities and measures. For instance, city leaders in Surat, India, understood that the likelihood of flooding overflow would only increase and, with support from the Asian Cities Climate Change Resilience Network (ACCCRN), are improving their EWS by turning it into an end-to-end system that will improve communication among many stakeholders, thus reducing flood warning announcement time (Brown et al., 2012). Similarly, person-to-person and person-to-city horizontal knowledge transfer can improve disaster risk reduction by spreading knowledge of facts learned from experience or observations and thereby contribute to EWS (i.e., knowledge of storm routes, wind patterns, cloud formations, animal behavior) (ADPC, 2009).

The essential components of EWS, risk mapping, and communication present a series of challenges in informal settlements. Lack of general infrastructure, census data, and cadastre data makes it difficult to identify and map risks. On the one hand, government-led efforts to generate usable data are often viewed suspiciously by settlers as they seek to remain undetected by official authorities. On the other hand, collecting household data is complicated by the expectation that slumlords, tenants, and subtenants have regarding upgrading or relocation, which may result in practices that cloud data

collection (e.g., slumlords registering all houses to themselves rather than their tenants, families overstating their numbers to receive more plots). Building on efforts that communities already undertake is one way to deal with these complex situations. For instance, since 2000, the Homeless People's Federation of the Philippines (HPFP) began many enumeration initiatives that led to more reliable data on structural, tenure, and sanitation information of flood-prone settlements thereby easing the identification of disaster reduction project beneficiaries (Satterthwaite, 2011).

Communities alone cannot address conditions that create disasters in the first place. It is coordinated efforts by civil society's organizations, organized communities, and government support that can reduce the underlying causes of vulnerability. A case in point is the city of Manizales, Colombia, that since the early 1990s integrated disaster risk into city planning through a collaborative process involving the municipality's agencies, universities, and citizens. The disaster risk reduction program achieved several goals by mixing community-led risk mapping, a risk management index, taxation mechanisms, voluntary insurance premium, school education, and women-led slope monitoring (Warner et al., 2007; Hardoy and Velasquez Barrero, 2014). Undoubtedly, there is a need for institutional environments that recognize and support the contribution of community-level organizations to

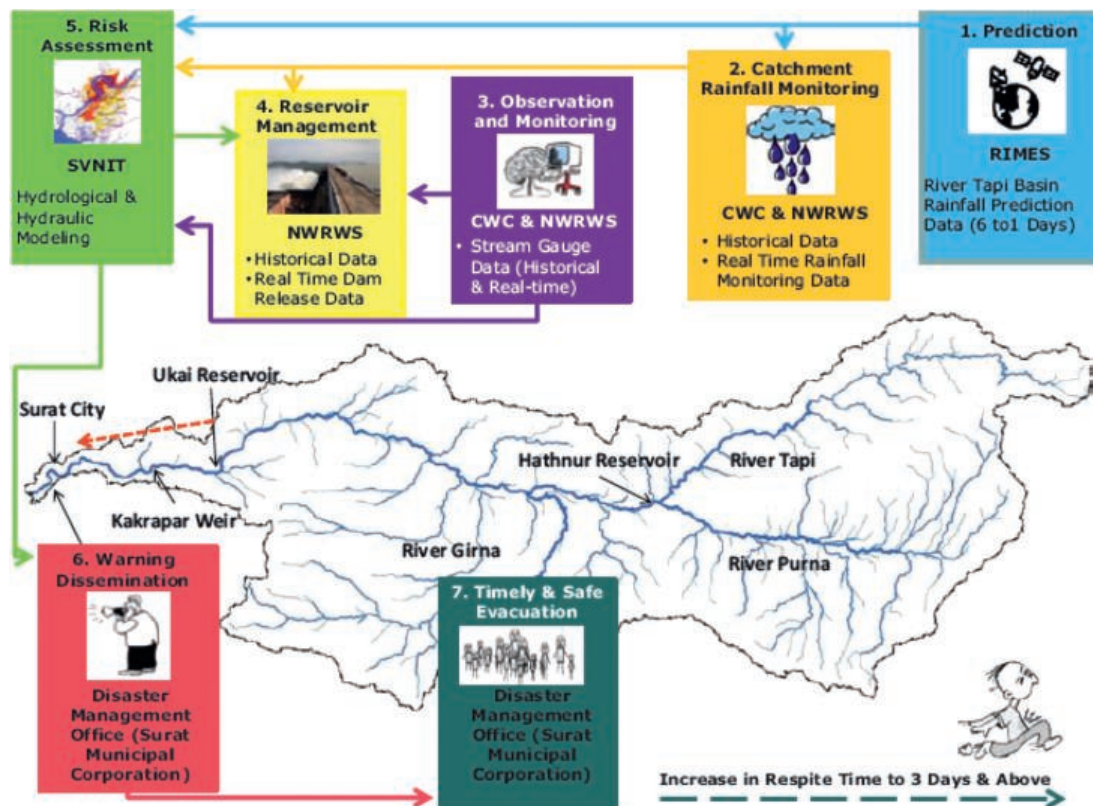


Figure 11.2 End-to-end early warning system in Surat, India.

Source: Brown et al., 2012

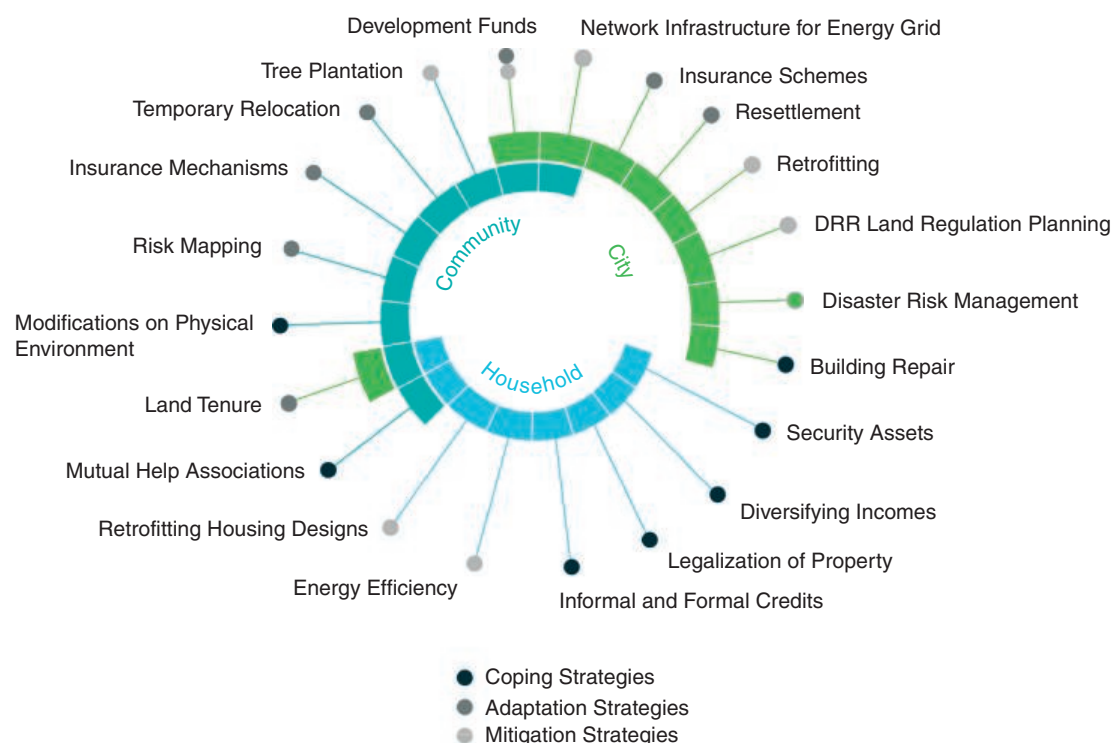


Figure 11.3 Overlapping coping, adaptation and mitigation at household, community and city-wide scales.

reduce disaster risk and a financial environment that allows them to address broader issues than only climate change (Pelling, 2011; Satterthwaite, 2011). Fig. 11.3, shows that many adaptation and mitigation actions at household, community and city scale are all associated with each other and should engage with each other to achieve meaningful and enduring resilience.

11.6 Options and Processes for Mitigation of Climate Change

Evidence of links between housing and climate change is commonly described in terms of global trends in housing emissions. These are mainly CO₂ emissions from various combustion sources across cities based on different economies, geographical context (regional climate variation, hot/cold weather), and building types (commercial, residential). The International Energy Agency estimated residential areas were responsible for 18% of direct CO₂ emissions in 2008 (WHO, 2011). The level of energy consumption per unit of space is lower in middle- and low-income households than in high-income ones. However, as cities continue to grow and more households gain access to electricity for cooking, lighting, and cooling, the impact of the household energy sector in developing countries will be relevant to address building-related emissions. Hence, the housing sector has the potential for reducing GHG emissions provided cost-effective and adequate technologies exist.

Mitigation solutions related to this sector can be implemented in a shorter period of time compared to other sectors (e.g., transport, agriculture, forestry, waste) (WHO, 2011). Current global trend equations need to consider issues of housing density, growth of informal settlements, and urban infrastructure services for the poor. While energy consumption in buildings varies widely across developed and developing cities, it is important to consider a broader range of factors beyond economic development that influence housing emission; these include built character of cities (forms of urban sprawls and density), quality of buildings, urban infrastructure, climate variation, policies, and environmental behavior.

Significant pressure on cities – and hence energy usage and related emissions – is occurring by the increased access for billions of people in developing countries to adequate housing, electricity, and improved cooking facilities. Substantial new construction taking place in developing countries represents both a significant risk and an opportunity from a mitigation perspective. By mid-century, energy consumption may triple when compared to levels in 2010, or it may decline if adequate land-use planning, best cost-effective practices, and more efficient technologies are applied and broadly diffused. In any case, it is clear that ambitious and immediate measures are urgent due to the very long life spans of buildings and other urban infrastructure. To avoid locking-in carbon-intensive options for several decades, a shift to electricity and modern fuels needs to be accompanied by energy-saving solutions (technological, architectural), as well

as renewable sources, adequate management, and sustainable lifestyles.

Modern knowledge and techniques can be used to improve vernacular designs. Principles of low-energy design often provide comfortable conditions, thereby reducing the pressure to install energy-intensive cooling equipment such as air conditioners. These principles are embedded in vernacular designs throughout the world and have evolved over centuries in the absence of active energy systems (Lucon et al., 2014).

Furthermore, addressing fuel poverty requires ensuring a certain level of consumption of domestic energy services (especially heating and cooking) in an affordable way and preventing impacts such as indoor air pollution. A cleaner fuel used in efficient devices (e.g., improved cooking stoves) in well-built households (avoiding leak heat outside) is a way of providing better services while saving costs. Treated pumped water, lighting, and basic refrigeration are needs that can also be supplied efficiently, bringing about co-benefits such as improved public health.

Effective GHG reduction strategies are to be implemented both in developed and developing countries, taking into account scenarios for the next 20–30 years both in terms of changing climate and socioeconomic development. The major role played by the construction sector within this challenge comes from the big share of life cycle emissions (from extraction of raw materials to building construction and management) attributed to buildings (about 40%). This is coupled with the relative cost-effectiveness of emission reductions through increased energy efficiency of about US\$35/tCO₂, compared to US\$10/tCO₂ and US\$20/tCO₂ in the transport and power sector, respectively (Metz et al., 2007).

Existing building stock conditions and projected building-sector growth represent key factors to assess mitigation measures to be implemented (see Table 11.5). A major distinction among developing and developed countries is represented by the

focus given to new construction or building retrofitting in view of potential value of the market and its “green share” (see Figure 11.4). This is intended as an opportunity to achieve significant results in terms of energy efficiency and environmental quality, given that developed countries currently account for the majority of the world’s existing building-related energy demand and CO₂ emissions.

In developing countries, the housing sector will show a high share of new construction due to the need to provide shelter for more than 500 million people (and provide access to electricity for an estimated 1.5 billion people) by 2050. In this context, the green building paradigm for new construction also entails significant economic benefits compared to a “business as usual” approach and calls for green retrofitting over residential buildings’ life spans.

Developed countries, by contrast, should primarily implement measures to meet the ambitious goals on CO₂ emissions reduction set up at the international level (e.g., G8 countries’ target of –80% by 2050 or European Union (EU) targets of –20% by 2020). Given the limited share of new construction, the priority is to implement measures and incentives enabling large-scale investments in mass retrofitting programs. Indeed, as outlined by the European Climate Foundation, “it is virtually impossible to achieve an 80% GHG reduction across the economy without a 95 to 100% de-carbonized power sector” (European Climate Foundation, 2010, Volume 1), thus requiring a significant transformation in the way energy is produced and distributed (shifting from fossil fuels to renewable energy and carbon capture and storage).

11.6.1 Housing Design

In developed countries, the transition toward a financially sustainable “green retrofitting” paradigm appears to be increasingly feasible thanks to the availability of technologies and relatively low-cost processes (see Table 11.6). Depending on climate zones, different residential retrofitting approaches

Table 11.5 Comparison of key indicators connected to CO₂ emissions variation for different countries, 2050 projections (derived by chapter authors from literature and expert knowledge).

	Economic growth	Population growth	Urbanization	CO ₂ emissions
Western Europe	=/+	=/–	=	=/+
Russia	=/+	=/–	=/+	+
Japan	=/+	=/–	=	=/+
USA	=/+	+	=/+	++
India	++	=/+	++	+++
China	++	=	+++	+++
South-East Asia	++	=/+	++	+++

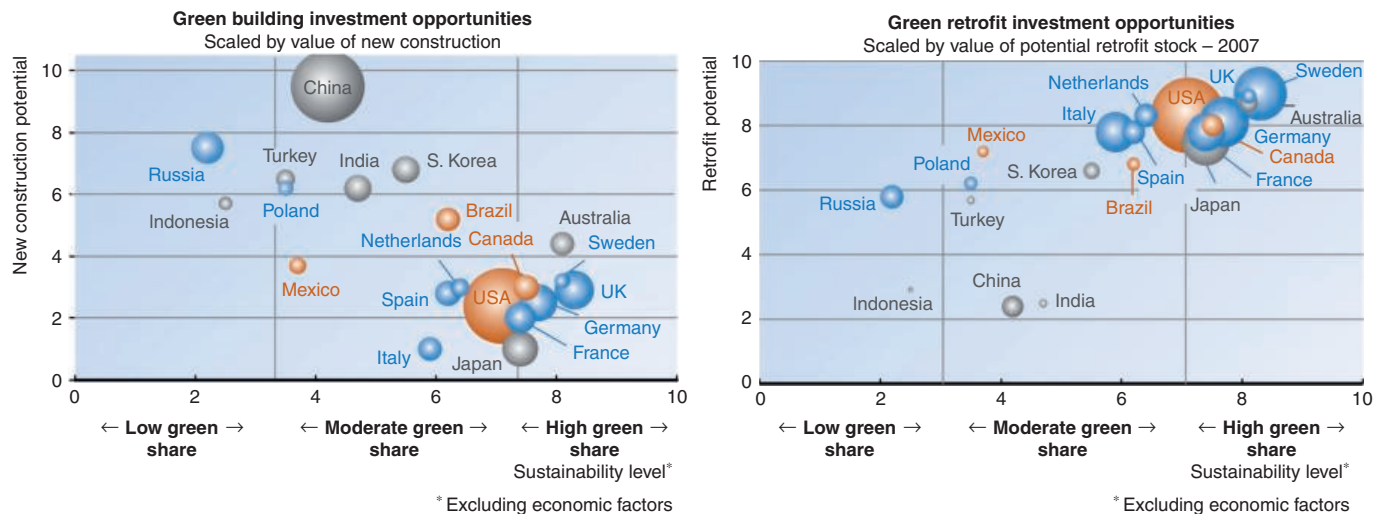


Figure 11.4 Expected value of potential new construction and retrofitting markets for representative countries compared with the achievable share of “green” construction.

have been experimented in the past decades, especially in the United States and the European Union, addressing the energy performance upgrade of building envelopes and technical systems. This is aimed at reducing energy demand and maximizing energy production from renewable sources. Although, on the one hand, in colder climates space heating on average represents 60% of residential energy consumption, followed by domestic hot water (DHW) at 18% (UNEP SBCI, 2007), on the other hand, regions in the developed south show the highest consumption in hot seasons. This is mainly due to widespread use of conventional air conditioning systems that also entails a significant increase in the urban heat island (UHI) phenomena and the consequent increase in energy demand and CO₂ emissions.

Housing retrofitting in developed countries is based on the application of either “passive” or “active” technologies. In the case of passive technologies, bioclimatic concepts (such as orientation, thermal insulation and inertia, natural ventilation, and daylight) are exploited to balance the local climatic conditions and reduce thermal exchange with the external environment, thus reaching comfort conditions with a limited need of heat, ventilation, and air conditioning (HVAC) and artificial lighting systems. The “active” approach is based on the efficient and combined use of new technologies for clean energy production (building integrated photovoltaic, micro-wind turbines, advanced glazing, domestic appliances, etc.) and automated building management systems.

More recently, different standards and operational scenarios have been tested with the aim of balancing desired energy performance levels with cost-effective solutions. A number of studies suggest that energy retrofitting in the housing sector should address a target value of 50–60% energy demand reduction to achieve 2050 climate goals, thus requiring a

“whole-house” approach (cf., among others, IEA, 2013; Boermans et al., 2012).

At the same time, national and international energy policy goals require residential mass retrofitting programs to be implemented, addressing the majority of existing homes in developed countries. As an example, the 2020 EU target of 20% energy saving would require an “average of 40% savings in half of the existing housing stock if all sectors and all end-uses within each sector were to contribute equally” (Neme et al., 2011).

To this aim, following the success of the Retrofit for the Future program, the United Kingdom launched ambitious housing retrofitting programs in which the Technology Strategy Board (TSB) funded private owners to achieve 80% carbon savings (TSB, 2013). The target for 2015 includes attic/loft insulation for 10 million houses (about 50% of UK single-family housing stock) and wall-cavity insulation for 7.5 million houses (plus solid-wall insulation for 2.3 million houses by 2022). The next phase is linked to the “scaling up retrofit” program, aimed at the market uptake of housing retrofitting through the funding of consortia to develop commercial design and technical solutions as assessed in relation to the unit cost and the achievable benefit in terms of kWh/m² reduction.

In France, mass retrofitting of residential stock started in 2007 with the Grenelle Environnement, aimed at mitigating climate change impacts and managing energy demand. Retrofit interventions concern both historical buildings and social housing complexes. In particular, the effort of social housing agencies that manage about 5 million houses in France aims to renovate 800,000 residential units with energy consumption of above 230 kWh per square meter by 2020 – about 70,000 per year – with an average energy saving of 40% and the aim of reaching a Factor 4 reduction in CO₂ emissions by 2050.

Table 11.6 *Summary of the major opportunities for green housing in different countries.*

Building retrofitting		New construction
Developed Countries	Key focus Housing stock under efficiency levels compared to current regulations (e.g., EU) Housing stock durability increase (e.g., Japan) Appliance efficiency (e.g., United States) Obsolescence of multifamily buildings (e.g., Europe)	Secondary focus High potential to meet green standards (such as zero-carbon, zero-waste, and low-impact materials) thanks to advanced building regulations (e.g., United States and Japan).
Developing Countries	Secondary focus Informal housing lacking of energy efficiency standards (e.g., Brazil) Obsolescence of multifamily buildings (e.g., China, Brazil, and Russia) Single homes lacking of minimum liveability requirements such as basic electricity, better cooking fuels and durability (e.g., India)	Key focus Huge housing shortage and opportunity for green buildings through public and private financed new housing (e.g., India, China, Brazil, Russia, and other emerging economies)

In the United States, residential buildings account for about 60% of all cost-effective energy efficiency potential in 2020 within the building sector, of which two-thirds are associated with the improvement of building envelopes and HVAC system efficiency (McKinsey, 2009). Single states have defined specific targets, such as retrofitting 100% of existing housing stock by 2030 in Maine or the Prescriptive Whole House Retrofit Program in California, in which a performance-based approach has been established to support market penetration of residential retrofitting by defining a progressive logic for the measures to be implemented by private owners (1) air sealing (2) insulation (3) HVAC systems (4) DHW systems, and (5) renewables.

In the southern regions of Europe (e.g., Italy, Spain, or Greece), while the regulatory field has taken steps forward, significant gaps still exist in reaching the minimum acceptable level of sustainability for interventions. Gaps include, among others, the effectiveness of public programs and are mainly due to the low technical and operational levels of local administrations, enterprises, and professionals compared to northern EU regions (Dioudonnat et al., 2014).

In addition to the specific approaches of different countries, a shared vision emerges from mid- to long-term retrofitting strategies in developed countries. In the European Union and the United States, after the initial phase of best-practices, the need for widespread actions on the built-up area required the definition of governance strategies aimed at improving the market uptake of whole-house retrofits through complementary regulations for public and private initiatives and the fostering of technological innovation to promote cost-effective techniques and a performance-based approach to deep-retrofit design.

On the pathway to 2050, it is expected that a major focus will concern a customized “additive” design approach and the role of contractors in the retrofitting processes. In fact, even

though public incentives have proved to give a significant boost to private action, the financial effort required to deliver, within a single-step housing refurbishment, adequate measures to address the 2050 goals still represents an obstacle in achieving mass retrofitting using a “deep” and “whole-house” approach. The role of designers and contractors is to support a gradual improvement of housing energy efficiency through a customized sequence of actions and by raising households’ awareness of the expected benefits of each measure to be implemented on both building envelope and technical systems.

Such a systemic approach to housing retrofitting should also include enhancing households’ awareness of the energy retrofitting potential in a long-term cost-benefit perspective by highlighting a suitable sequence of retrofitting actions to be implemented over time and the need for integrated actions that allow cost-benefit maximization (e.g., air tightness and insulation; HVAC + DHW generators), as well as the potential co-benefits (e.g., in terms of aesthetics, air quality, comfort, durability).

Achieving mass-scale implementation of deep residential efficiency retrofits will require a multipronged strategy that is focused on both driving demand and ensuring adequate technical and market capacity to deliver quality work. To this aim, as shown in Figure 11.5, the delivery strategy should be based on the active engagement of private-sector product and service providers, financing institutions, government authorities, community organizations, and the market, eventually including performance-based obligations on one or more entities in the market (Neme et al., 2011).

The example given by the main programs promoted in Europe and the United States highlights the adjustment of international directives to local contexts by allowing access to public funding. Moreover, many opportunities arise from the potential transfer of regulatory frameworks, construction process models, and design principles from high-income to emerging economies in

view of the definition of a competitive economic framework for urban regeneration and building retrofitting as a key priority for climate change mitigation.

11.6.2 Improving Housing Energy Consumption

Following the principle of climate-compatible development (CCD) (Mitchell and Maxwell, 2010), mitigation measures in the housing sector should achieve GHGs reduction benefits while simultaneously improving the existing standard of living of individuals, households, and communities in urban areas. This should be in line with ensuring minimum standards for household energy services to support a decent standard of living. This is also supported by foundations like the Gold Standard, which encourages sustainable development impact assessments of mitigation measures based on criteria such as environmental, economic, and social benefits in relation to existing baselines, as well as governance and capacity building. A recent study by the foundation (Gold Standard Foundation, 2014) in both urban poor and middle-income communities in New Delhi assessed the feasibility of a series of mitigation measures in the housing sector based on available national government support programs and subsidies and on existing evidence of performance. This assessment was key to rule out options that would be unsuccessful in the specific context of Delhi's poor and middle-income communities. For instance, according to the Energy Environment Partnership of Southern and East Africa, the use of renewable biomass briquettes for cooking was ruled out due to operational challenges such as inconsistent supply of raw feedstock, supply chains for biomass briquette production and sale, and inconsistency in the quality of the finished product. Similar challenges are indeed also found in East African countries where briquette markets are particularly

vibrant (Energy and Environment Partnership/Southern and East Africa, 2012).

Suggested options in Delhi ranged from replacing inefficient, kerosene-based cook stoves used by poorer communities with improved stoves (e.g., that significantly reduce the need for wood fuel or do without it entirely) or with solar cookers; replacing inefficient kerosene lamps or incandescent light bulbs with either solar lamps or CFL/LED bulbs; shifting from liquid propane or electric geysers to solar water heaters; moving from electric fans for space cooling to either solar-powered fans or efficient cooling appliances; using composting instead of open landfilling (as an option, compost can not only be marketed in Delhi's agricultural belt, but it can also reduce waste dumping that exacerbates flooding). Table 11.7 presents some of the preferred mitigation options for Delhi's communities with the addition of adaptation benefits (where they exist).

These climate-friendly housing policies and measures can crucially contribute to closing what the World Health Organization (WHO) calls the "health quality gap." The emergence of low-energy appliances and access to solar electricity can reduce the health impacts of, for instance, fuel-based lighting or conventional cooling measures such as air conditioning systems because those exposed to the noise and heat island effect may be among those who can least afford air conditioning (WHO, 2011).

Mitigation measures in low-income countries and informal settlements should seek local production, operation, and maintenance, thus stimulating local job creation. According to the International Energy Agency (2013), an estimated 952 TWH of electricity will be required annually under a



Figure 11.5 Governance strategy for mass retrofitting performance-based delivery.

universal access scenario. Measures that are locally administered through, for instance, a social cooperative model, are also more likely to ensure affordability of upfront and maintenance costs of devices distributed for electricity, water, and gas connection. The experience of the iShack Project is instrumental in this respect (see Box 11.4). The brand name is used to develop and implement a sustainable enterprise model for delivering ecological services and utilities (like solar electricity) to people living in shacks on an affordable pay-as-you-go (PAYG) basis in the informal settlement of Enkanini, Cape Town.

Accessing carbon finance for urban mitigation actions is not easy, particularly in peripheral municipalities. It depends on

institutional arrangements requiring expertise in climate change science, political awareness of low-carbon technologies, and competency in international climate finance. A favorable regulatory environment, financial credibility, and information awareness at a local level are also crucial (UNDP, 2011; Corfee-Morlot et al., 2012). Moreover, urban mitigation projects represent less than 10% of the “compliance market” (the Clean Development Mechanism [CDM] and Joint Implementation) of all projects and are concentrated in sectors such as water, waste, and energy efficiency and distribution networks (Clapp et al., 2010; World Bank, 2010). This investment gap was also acknowledged in a statement by the Cities Climate Finance Leadership Alliance during New York’s Climate Summit in 2014. The Cities Development Initiative for Asia (CDIA) suggested that to deal

Table 11.7 *Sustainable development assessment with adaptation benefits.*

Activity	Mitigation measure	Sustainable development dimension	Criteria and impact (compared to baseline)
Energy (cooking, heating)	Improved cook stove; solar cooker; solar water heater	Environment	Improvement of indoor air quality
		Social	Fuel cost saving; time saving in fuel collection
		Economic and technology development	Skilled/unskilled employment provided to local people for operation and maintenance/social cooperatives; know-how training
		Adaptation	Reliable solar source during blackouts due to disasters
Lighting	Solar lighting	Environment	Improved air quality
		Social	Fuel cost saving, access to renewable energy and lighting, increase safety
		Economic and technology development	Skilled/unskilled employment provided to local people/social cooperatives for operation and maintenance; know-how training;
		Adaptation	Reliable light source during blackouts due to disasters
Solid Waste Management	Composting	Environment	Improved solid waste management practice
		Social	Improved social cohesion
		Economic and technology development	Skilled/unskilled employment provided to local people/social cooperatives for operation and maintenance; income earning opportunities
		Adaptation	Improved drainage clogging
Water & Sanitation	Zero energy water filters; solar water disinfection	Environment	Indoor air quality improvement
		Economic and technology development	Access to clean drinking water
			Skilled/unskilled employment provided to local people/social cooperatives for operation and maintenance
		Adaptation	In connection with rainwater harvesting a reliable drinking water access during disasters

Box 11.4 Solar-Powered Shacks in Informal Settlements: Toward a Financially Viable Social Enterprise Model in Enkanini (Western Cape Town, South Africa)

Enkanini is a large informal settlement 1.5 kilometers north-west of the municipality of Stellenbosch (Western Cape), where about 8,000 people live. The settlement is predominantly made up of young job seekers who left the Eastern Cape to find employment in the city. Enkanini is strategically positioned next to transport linkages and employment opportunities in nearby Stellenbosch. The settlement began in 2006 on municipal-owned land and fast outgrew the limited water supply and bulk toilet facilities set up by the municipality in 2009. By 2012, the initially provided numbers of toilets and tap services were largely insufficient, forcing people to share services and creating congestions. The areas farthest from the center of the settlement do not have access to toilets nor tap points. The municipality maintains that connecting the settlement to the electricity grid is impossible due to the steep slopes and low cost recovery. Also the land is not yet zoned for residential use, so the residents are still some years away from attaining secure tenure and formal, household-denominated services. This means that residents spend a significant amount of their income on heating, cooking, and lighting using paraffin, coal, gas, wood, and candles (Smith, 2012).

In 2011, a group of Stellenbosch post-graduates from the Sustainability Institute (SI) at Lynedoch began a research project whose aim was to co-produce knowledge with a variety of groups in order to seek and implement alternative logics of infrastructure upgrading in the settlements. One of the first results of this process was an 18-month transdisciplinary project that resulted in a concept dwelling called the iShack, where the “i” stands for “improved” shack. Following this exploratory academic process, the iShack has now become a the brand name (iShack Project) to develop

and implement a sustainable enterprise model for delivering ecological services and utilities (like solar electricity) to people living in shacks on an affordable pay-for-use basis. While many articles have already reported on the broader ecological design principles that can be used to improve a shack-type dwelling (Smith, 2012; Earthworks Magazine, 2012; Hope Project, 2012; www.sustainabilityinstitute.net/programmes/ishack), the focus of the iShack Project is now in the process of establishing a viable and sustainable enterprise model to deliver ecologically designed products and services in an informal settlement, starting with the provision of solar electricity. One of the key steps has been to secure a contract for service delivery with the local municipality. The municipality’s contribution will be up to 25% of the running costs to help ensure the sustainable delivery of the basic solar electricity service without the municipality having to invest large, centralized electricity infrastructures prior to formalization of tenure. An important part of the business model is to leverage the energy service for other social and economic multipliers for the community, such as skills development and job creation.

Most of the technical installation and maintenance work is done by local residents who have been recruited and trained by the project. Eventually, a core team of iShack Agents will run the service as micro-franchisees and will be incentivized financially to ensure a high level of service maintenance to their clients. By mid-2015, 12 Enkanini residents had been trained not only in operating, maintaining, and repairing the solar systems but also in client services and marketing. Depending on their level of training, they earn between R3500 and R5800 per month (1 Rand = US\$0.083). People willing to subscribe contribute a down



Box 11.4 Figures 1 and 2 Visiting students from neighboring Kayamandi are educated about solar electricity and the iShack project. On the right, solar-fitted homes in Enkanini.

Photos: iShack Project

payment of R150 if they bring along another neighbor; otherwise, the fee is R320. This payment will grant access to the first month of electricity and TV service. After installation, iShack clients pay a set monthly fee (currently R150) that goes toward the maintenance costs of the service. The pricing is set factoring in the municipal subsidy and is subject to changes based on more accurate information about true running costs – which depend on factors such as the life span of batteries. People who cannot afford the standard monthly fee have been included in a pay-as-you-go (PAYG) pilot within the project to test the viability of more flexible pricing structures. Currently the PAYG pilot has approximately 50 clients while the standard contract counts about 600 users. Around 50–70 new households sign up monthly. The system is also modular and able to integrate more complexity following the income and expenditure patterns of households (e.g., fridge upgrade option). Some of the challenges to this model include keeping the PAYG viable and accessible by creating smarter platforms and dynamic pricing based on daily usage levels across the community, retaining clients in highly transient places like informal settlements, and ensuring high payment compliance. By December 2014, the project had installed 700 solar systems in 700 shacks with roll-out commencing in October 2013 (Personal Communication with Damian Conway, Manager of the iShack Project and director of the Sustainability Institute Innovation Lab June 2015).

Preliminary evaluations on a limited number of users reveal that households with access to solar electricity spend far less money on other unhealthy and unsafe fuel sources such as paraffin and candles. Access to solar electricity is also more reliable than candles and, in some cases, even of conventional electricity (which, in South Africa is currently subject to nationwide load-shedding due to serious capacity constraints). Children can stay up longer to finish homework, and, in some cases, mothers feel safer when their kids are at home watching TV rather than outside wandering alone (Personal Communication with Damian Conway, Manager of the iShack Project and director of the Sustainability Institute Innovation Lab June 2015).

The project is a case in point for the added value that collaboration among universities, municipalities, grassroots organizations, corporations, and citizens can bring to find solutions for complex urban development challenges. The project brings together Stellenbosch University's Tsama Hub, the Sustainability Institute Innovation Lab, Stellenbosch Municipality, Enkanini residents, and Specialized Solar Systems (the corporation supplying the solar systems). All training material is also translated into "how to" videos that can be easily used in other informal settlements in South Africa. The iShack Project is now using its acquired experience to develop a franchise model in order to support other organizations in adaptively replicating the social enterprise model in other contexts around the world.

with this shortage municipalities should request technical assistance and create partnerships with NGOs, the private sector, and other non-state actors to access climate finance in the first place (Beltran, 2012).

Municipalities are learning from Cape Town, where CDMs have attracted financing for a housing energy-efficiency measurement system. City leaders have made use of their findings and momentum to attract bilateral donor money and decide for themselves how to make use of it in relation to green energy and efficiency. Through the intervention of policy-makers from the Environment and Resource Management department, the Mamre Ceiling Retrofit project was framed as an issue of improving the city's housing stock by focusing on providing insulated ceilings to nearly half of the low-quality houses built under the post-apartheid Reconstruction and Development Program (RDP). The project employed locally trained workers and mobilized NGOs such as ICLEI — Local Governments for Sustainability Africa. Findings from the project reveal that although at least 31% of the people involved in the project still struggle to meet the current costs of energy, there has been a significant decrease in the use of unsafe heating sources (such as wood fires), which has also reduced the circulation of hazardous toxins and reducing instances of tuberculosis in households. Although the overall amount of energy used in the household

was not reduced, insulated ceilings allowed for homes to stay warmer and route energy from heating to power other appliances or to be used as savings to support other livelihood activities (Bulkeley et al., 2015). By aligning mitigation measures to existing policy imperatives, the project was able to harness climate change discourse and finance to generate direct economic impact and longer term social considerations, such as the right to dignified housing and household health improvements. Therefore, to be successful, interventions should seek to deploy multiple instruments (not just finance, but capacity development, technical assistance, network building) and multiple stakeholders from different ministries and geographical or sectoral foci.

For scaling up and replicating interventions, the Organization for Economic Cooperation and Development (OECD) also emphasizes the importance of at least three types of information: first, the project itself and its environmental performance; second, the project's financial structure and the strategies used to overcome economic or financial barriers; and third, information about the broader context within which the intervention is situated to ensure that changes required for replication in other areas can be accounted for (Kato et al., 2014). For instance, the initiative to install solar hot water (SHW) in social housing by the Housing and Urban Development Company (HUD.C.) in

São Paulo, shows how the success of a pilot of fifty SHWs in the peripheries of the state expended to 35,000 installations and is gaining traction in the metropolitan centers. This, however, required metabolic adjustments to higher urban densities and land values, emphasizing that low-carbon experimentation is not only about rolling out new technologies, but also about how these technologies “interact over time with pre-existing technological arrangements as well as final users” (Bulkeley et al., 2015).

11.7 Conclusion

Past climatic events have had severe consequences on the human, economic, and environmental capital of cities. Extreme events experienced in the past decade have resulted in both financial and social losses. Since Hurricane Katrina in 2005, the world has seen heavy flooding across Africa and Asia in 2009, 2011, and 2013; severe damage caused by Hurricane Sandy in North America and the Caribbean islands in 2012, as well as the destruction from Super Typhoon Haiyan in the Philippines; and high economic losses in Europe due to damaging flooding events in 2013 and 2014.

Variable weather patterns and booming processes of urbanization will make the whole issue of housing even more relevant in the future. The housing sector will need to address long-term, complex, and nonlinear socioenvironmental processes as cities transform toward becoming more stable, stronger, and better performing urban ecosystems. Yet cities don't perform equally. Low-income states face greater development challenges and less opportunity to harness existing resources for growth. This is evident, as the pressure coming from the housing sector and the proliferation of informal settlements remains a widespread settlement structure. Approximately 1 billion people experience lack of basic infrastructure, insufficient living spaces, low-quality housing, and insecure land tenure.

What options and processes for adaptation and mitigation exist, given that the geography and economy of cities determine the nature and dynamics of disaster risk? While savings schemes and CDFs continue to scale up to larger financial programs among low-income communities, the insurance industry is gaining momentum by addressing risk awareness through assessments, policy recommendations, and physical recovery in higher income cities. EWS and risk mapping are being recognized as effective adaptation measures because they strengthen the information base needed to address vulnerability and also serve as great tools for mainstreaming climate change data and disaster risk across governmental sectors. Such measures can be tailored to reflect the degree of complexity in logistics and coordination of actions in large, medium, or small cities. In this vein, the decentralization of risk management procedures is key.

In addition to adapting to the different effects of climate change, mitigation measures should also be considered,

particularly in environments where substantial new construction is taking place (Asia and Africa). As cities continue to grow, so will the housing sector and the impact of building-related emissions. This calls for cost-effective best practices and efficient technologies to avoid locking-in carbon-intensive options for several decades. Buildings have long life spans. Therefore, energy-saving solutions should consider, on the one hand, housing design options relative to the building's envelope and retrofitting and, on the other hand, the improvement of housing energy consumption. The latter may well contribute to closing the “health quality gap” between economies stipulated by the WHO. For example, replacing inefficient kerosene-fired cook stoves offers co-benefits such as better indoor air quality, improved living standards, and reduced use of wood-based fuel.

The dichotomy of communities living in poverty in informal settlements is that their challenges are demanding on many fronts and their options are limited. Adaptation and mitigation technologies (passive or active) must be cost-effective and ultimately integrate measures that can lead the poor toward a more resilient path. If climate change data as well as disaster risk and impact information are to inform sustainable development, these need to take into account self-organization modus operandi and the complex manner in which the informal sector operates. These also need to consider the different scales at which adaptation and mitigation measures are most effective.

Annex 11.1 Stakeholder Engagement

Overall, five international workshops were organized from February until July 2014 in Africa, Asia, and Europe. They aimed at gaining a better understanding on existing limitations that have resulted in increasing impacts in the housing sector and particularly in informal settlements.

The first workshop on climate change adaptation among marginal communities in Asian cities took place in Chiang Mai, Thailand, in February 2014. The workshop focused on identifying the drivers of vulnerability in environmentally degraded environments. The adaptation options identified included housing and livelihood-based support from local governments and NGOs, and international rehabilitation. The second workshop was conducted in Dar es Salaam, Tanzania, in March 2014. The workshop aimed at sharing the specific impacts and innovative responses toward climate adaptation at the intersection of formal and informal settlement processes. The discussions were sensitive to ongoing processes in informal settlements such as relocation, housing finance, and investment, as well as urban planning. The third workshop took place in Bangkok, Thailand, in June 2014 within the frame of the Asian ministerial meetings on disasters. The exchanges focused in particular on building the capacities of local governments as well as stakeholders from informal settlements on participatory and gender-sensitive risk

Annex 11.1 Table 1 Stakeholder engagement strategy.

Stakeholder/ organization	Description
Participation and contribution in international conferences	
ICLEI-LOCS – Local Climate Solution for Africa 2013 Congress (Dar es Salaam, November 11, 2012–January 12, 2013; http://locs4africa.iclei.org)	UFZ chaired Session A3 on “Research Driving Innovation: Strengthening the Science-Policy Interface in African Local Governments,” providing a platform for discussing how to bridge the knowledge–action and science–policy divides on climate change resilience at the local government level. The session touched on the latest research addressing climate change issues such as “Prediction of Climate Change Impacts in Tanzania Using Mathematical Models,” “The Role of Green Infrastructure for Adapting African Cities to Climate Change,” and “Social Vulnerability and Building Structures.” These initial discussions served as a good starting point to investigate the state of the art of urban planning implications, which are also reflected in informal settlements and buildings, particularly in the Global South
IAPS Conference on “Transitions to Sustainable Societies: Designing Research and Policy for Changing Lifestyles and Communities” (Timisoara, Romania, June 23–27, 2014)	UFZ is organizing a symposium within the conference in the Frame of IAPS’s Housing Network. The symposium, titled “Housing in a Changing Environment: Assessing Vulnerability and Promoting Resilience,” focuses on specific impacts and innovative responses toward climate adaptation in housing particularly at the intersections of formal and informal systems. It will put forward the following themes: 1. Asian perspective on housing and informal settlements and the impact of climate change 2. Quality and ownership of housing after flooding in Europe 3. Vulnerability and resilience of urban built structures and lifelines in African cities Results from these exchanges will be synthesized into a Symposium Protocol that will feed into this chapter.
Organization of Thematic Workshops	
Thematic workshop on climate change adaptation in Asian Cities (Asia-Pacific Sociological Conference, Chiang Mai, Thailand, February 14–15, 2014)	The workshop focused on identifying the drivers of vulnerability among vulnerable, marginal communities in Asian cities as well as marginal communities’ adaptive capacities, given their environmentally degraded environments. Adaptation included strengthening their housing and livelihood bases, and support from local governments, NGOs, and international rehabilitation agencies.
Thematic workshop on adaptation strategies and housing and informal settlements (Tanzania, March 2014)	The workshop focused on past deficiencies that have resulted in the proliferation of informal settlements: Land-use planning and regularization (2) legal systems, and (3) land markets and tenure. Stakeholders were asked to pinpoint the challenges faced as they attempt to adapt to climate change at local levels with regard to the roles and capacities of local governments.
Thematic workshop on climate change and disasters (Asian Ministerial Meetings on Disasters, Bangkok, Thailand, June 25–27, 2014)	The workshop focused on assessing climate change impacts and building adaptive capacities of both local governments and informal settlements. The workshop included recommendations for investing in community resilience-building programs (e.g., training in participatory risk assessment, gender-sensitive risk assessment and planning, and community-based disaster risk reduction and management.
Thematic workshop on the cross-cutting theme of economics and finance (Germany, June 2014)	The workshop focused on the linkages among informal settings, co-benefits in adaptation and mitigation, and economics and finance. Chapter authors as well as practitioners were invited to discuss how the topics interlinked and what strategies can be implemented to bridge gaps between scientists and stakeholders.
Thematic workshop on public–private partnerships in building urban resilience, organized by Manila Observatory in partnership with Zuellig Foundation and the Romulo Foundation, July 8–9, 2014	This workshop aimed at identifying investments in building urban resilience through public–private partnership. In particular, the session chaired by Antonia Yulo-Loyzaga outlined the challenges in bridging investments across public–private sectors, especially urban communities and civil society organizations.
Interviews with Key Stakeholders	
Stakeholder interviews allow stakeholders to comment on, evaluate, and feed into elaborated drafts.	Key organizations identified are: • Slum Dwellers International (SDI) • Asian Coalition for Housing Rights (ACHR) • Local government authorities • Union of Cities and Local Government (UCLG) • Inter-American bank officials • IIED and SEI scholars • International Housing Coalition • C40 Regional Director for Africa, Hastings Chikoko • Sustainability Institute, Stellenbosch University, Cape Town

assessments and planning. In parallel, in June 2014, a fourth workshop was conducted in Bonn, Germany, following the ICLEI Annual Conference on Resilient Cities. Discussions centered on the linkages among informal settings, co-benefits in adaptation and mitigation, and economics and finance. Finally, the Manila Observatory organized a thematic workshop on public–private partnerships in building urban

resilience in July 2014 in the Philippines. Part of the discussions was devoted to the challenges in bridging investments across different sectors, especially the urban communities and civil society organizations. Annex 11.2 Table 1 summarizes the activities conducted to elicit ideas and feedback from a range of stakeholder for this chapter on housing and informal settlements.

Annex 11.2 Glossary of Terms

Annex 11.2 Table 1 *Glossary of terms.*

TERM	DEFINITION	ORGANIZATION	SOURCE
Informal settlements	1. Areas where groups of housing units have been constructed on land that the occupants have no legal claim to, or occupy illegally; 2. unplanned settlements and areas where housing is not in compliance with current planning and building regulations (unauthorized housing).	United Nations Statistics Division Glossary of Environment Statistics	United Nations (2014), <i>Environment Glossary</i> , Accessed September 22, 2015: http://unstats.un.org/unsd/environmentgl/gesform.asp?getitem=665
Slums	Areas of older housing that are deteriorating in the sense of their being underserved, overcrowded, and dilapidated	United Nations Statistics Division Glossary of Environment Statistics	United Nations (2014), <i>Environment Glossary</i> , Accessed September 22, 2015: http://unstats.un.org/unsd/environmentgl/gesform.asp?getitem=1046
	Slums are operationally defined by inadequate access to safe water, inadequate access to sanitation and other infrastructure, overcrowding, insecure residential status, and poor structural quality of housing	UN-Habitat (2003)	UN-Habitat (2003), in UN-Habitat (2010), <i>The Human Settlements Financing Tools and Best Practices Series, Informal Settlements and Finance in Dar es Salaam, Tanzania, Nairobi</i> , UN-Habitat
Inadequate housing	Housing is not adequate if: 1. Its occupants do not have a degree of tenure security 2. Its occupants do not have availability of services, materials, facilities, and infrastructure 3. If its cost compromises the occupants' enjoyment of other human rights 4. If it doesn't guarantee physical safety or adequate space 5. If the specific needs of disadvantaged and marginalized groups are not taken into account 6. If its location is cut off from services and infrastructure or is located in dangerous areas 7. If it doesn't take into account the expression of cultural identity	Office of the United Nations High Commissioner for Human Rights/ UN-Habitat	Office of the United Nations High Commissioner for Human Rights/ UN-Habitat, <i>The Right to Adequate Housing</i> , Fact Sheet No. 21/rev. 1. Accessed September 22, 2015: http://www.ohchr.org/Documents/Publications/FS21_rev_1_Housing_en.pdf
Adequate housing	For housing to be adequate it must, at minimum, meet the following criteria: Security of tenure; availability of services, materials, facilities, and infrastructure; affordability; habitability; accessibility; location; and cultural adequacy	Office of the United Nations High Commissioner for Human Rights/ UN-Habitat	Office of the United Nations High Commissioner for Human Rights/ UN-Habitat, <i>The Right to Adequate Housing</i> , Fact Sheet No. 21/rev. 1. Accessed September 22, 2015: http://www.ohchr.org/Documents/Publications/FS21_rev_1_Housing_en.pdf
Squatter settlements	Areas of housing units that have been constructed or erected on land to which the occupants do not have a legal claim. See also <i>informal settlements</i> .	United Nations Statistics Division Glossary of Environment Statistics	United Nations (2014), <i>Environment Glossary</i> , Accessed September 22, 2015: http://unstats.un.org/unsd/environmentgl/gesform.asp?getitem=1077
Marginal settlements	Housing units that, lacking basic amenities, are not considered fit for human habitation.	Glossary of Environment Statistics, <i>Studies in Methods</i> , Series F, No. 67, United Nations, New York, 1997.	Glossary of Environment Statistics, <i>Studies in Methods</i> , in OECD Glossary of Statistical terms. Accessed September 22, 2015: http://stats.oecd.org/glossary/detail.asp?ID=1592

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