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Responding to climate change in cities and in their informal settlements and economies

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NOTES

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SUMMARY

THE CHALLENGES FROM INFORMALITY: One of the greatest challenges for climate change adaptation is how to build resilience for the billion urban dwellers who are estimated to live in what are termed informal settlements. These settlements are concentrated in urban centres in low- and middle-income nations. They have been built outside the 'formal' system of laws and regulations that are meant to ensure resilient structures, settlements and systems. Those who live in informal settlements and those who work in the informal economy form a critical part of each city's economy. But they cannot find 'formal' housing that they can afford. So, they live in settlements that are outside the formal system of regulations for recording land acquisition and for acquiring legal land tenure; also, for getting permission to develop buildings. They are outside the rules and regulations on land-use, buildings and infrastructure and service provision. Most (but not all) are on land that is illegally occupied. Most do not receive the infrastructure and services that should be provided in urban contexts such as reliable, safe water piped to homes, good provision within the household for sanitation, paved roads and paths, storm and surface drains and connection to electricity grids. Most residents of informal settlements also rely on informal services and informal employment.

ELEVATING RISKS: Many informal settlements are on land sites at high risk from flooding and landslides; these sites are chosen by their residents because they are less likely to be evicted as the land is unattractive to developers. Most housing structures in informal settlements are poor quality. The result is that most informal settlements concentrate high levels of risk from infectious and parasitic diseases, accidental fires and natural hazards and pollution. *Thus, the conditions of life in informal settlements elevate risk from most climate change impacts such as higher (and increasing) maximum temperatures and heat waves, more intense precipitation events and riverine floods, wind storms with higher wind speeds, changes in water availability and sea-level rise*.

CONSTRAINTS ON GOVERNMENT ACTION: For city governments, addressing these issues is complicated by the many ways in which informal settlements break laws and contravene regulations. It is also complicated by the fact that in many nations, local governments ignore those living in informal settlements or evict them, even when these settlements house more than half a city's residents and much of its labour force. In other instances, urban governments do commit to building resilience but are hampered by limited technical capacity, lack of funding and political constraints.

ANOTHER PATH: But there is another way for governments to view this issue that was first articulated in the 1960s – to recognize the many positive aspects of informal settlements and to work with the inhabitants and their community organizations in providing needed infrastructure and services and improving housing quality. This 'upgrading' of informal settlements has become common practice in many nations as described in Section 3 – some driven by local governments responding to democratic pressures, some driven by community organizations but supported by local governments.

THE FORMAL SYSTEM: The 'formal' system mentioned above is meant to ensure good quality buildings on safe sites with good quality infrastructure and services – the foundations for their resilience to extreme weather as well as much reduced health risks. In high-income nations, almost all urban dwellers live in housing developed within the formal system and served with what this report terms 'risk reducing infrastructure and services' – which includes piped water, sewers, storm drains, electricity, health care, emergency services …. In each country, the formal system with its legislative and administrative underpinnings developed over time in response to identified risks (and

to political pressures). Responsibility for implementation was mostly located within local governments. For city governments that have taken climate change adaptation seriously, they have moved from a political commitment to act to developing new policies and technical responses. The needed move to greater resilience to climate change happens within the 'formal' world of policies, budgets, rules and regulations overseen by elected city governments.

INFORMAL SETTLEMENTS: But most cities in the Global South[1] have much of their economy and most of their population living and working outside the 'formal' world. Many cities have 30-50 percent of their population living in informal settlements – and this can go higher; Nairobi with 60%, Dar as Salaam with 70%. But in most nations and cities, there are no official statistics on informal settlements. The term informal settlement also covers a large range of settlements from those with permanent buildings and conventional site lay-outs with some infrastructure to those with buildings made of temporary materials with no infrastructure and services. In cities with a high proportion of their population in informal settlements, many lower-middle income groups live there. In many cities, there are also formal buildings that have informal occupation that contravenes health and safety standards such as houses or apartments that have been subdivided into small rental units or converted into dormitories (Satterthwaite 2017).

WHY INFORMAL SETTLEMENTS EXIST: The reason why so many people live in informal settlements is the high cost of 'formal' housing – including the cost of getting legal land title, receiving permission to develop buildings, and meeting rules and regulations on land-use, buildings and infrastructure and service provision. The key issue here is the mismatch between what a large section of the urban population can afford to pay to for housing (or land) and what is available in the formal system. Governments often blame rapid in-migration for informal settlements, but the main reason for the growth in informal settlements is the failure of urban governments to change the functioning of the formal system.

INFORMAL ECONOMY: A high proportion of the economically active population in urban areas of the Global South work in what is termed the 'informal economy'; as with informal settlements, they operate outside the 'formal' system. This includes working in unregistered enterprises, lacking security and working in premises where regulations on occupational and environmental health and safety are not met.

FORMAL-INFORMAL LINKS: Just as informal settlements form a key part in housing the (mostly low-income) population of most cities in the Global South, so too does the informal economy form a key part of the city economy and those that work in it make up a critical part of the labour market. But the interdependence of the formal and informal is seldom recognised by city authorities. There are also close connections between informal settlements and the informal economy – as most of those working in the informal economy live in informal settlements and as many informal enterprises are in informal settlements. So, the issue here is how to ensure the needs of those living in informal settlements and/or working in the informal economy are fully included in climate change adaptation measures and how can formal systems change to support this.

PRIVATE SECTOR AND SERVICES: It is obvious that enterprises that make up "the private sector" have powerful influences on how any city develops and so they also have importance for climate change adaptation (and mitigation). In the absence of 'formal' provision for water, sanitation, health care, schools, solid waste collection, policing…. in informal settlements, alternative (often informal)

[1] The 'Global South' encompasses all low- and middle-income group nations

providers operate. These range from individual water vendors and latrine emptiers to pay-to-use toilets to private utilities that have learnt to operate successfully in some informal settlements.

VULNERABILITY AND EXCLUSION: Certain individuals or groups are more vulnerable to climate change because they are more sensitive to/impacted by particular risks and/or less able to cope and to adapt. Some are more at risk because of the discrimination they face – in getting housing, jobs and services on the basis of (for instance) gender, caste, class or being a migrant. Those living in informal settlements or working in informal employment are often excluded from many services – for instance not being able to open a bank account or get a legal address (on which access to many 'formal' services and getting on the voter register may depend).

FORMAL SYSTEMS AND HEALTH RISKS: Cities range from the most to the least healthy places to live and work – seen for instance in differences in average life expectancy at birth or infant, child and maternal mortality rates. By concentrating people, enterprises, institutions, motor vehicles and their wastes, cities can be very unhealthy. But well-governed cities have effective laws and regulations in place that enormously reduce the health risks these can bring. The main means to do so have been in developing and enforcing (formal) laws, byelaws, rules and regulations on, for instance, building standards, land use, health and safety at home and at work, pollution control, motor vehicle traffic management and household appliances – and on registering land title/rights and their use and sale.

GOVERNMENT RESPONSES: Government responses to the growth of informal settlements range from upgrading them (which implies some official recognition of their inhabitants' right to be there) to ignoring them (and refusing to provide them with infrastructure and services) to bulldozing them Upgrading informal settlements encompasses measures to improve the quality of housing structures and the provision of housing and community-related infrastructure and services (such as piped water, sewers and storm drains). It may include providing residents with title deeds to their plot.

GOOD LOCAL GOVERNANCE: Upgrading informal settlements and extending trunk infrastructure to them (roads, water mains, sewers, storm drains, electricity…) has become an accepted part of what a city government does in many middle-income nations – especially in Latin America. This paper also gives examples of innovations that have particular relevance – including the work of a national government agency (the Community Organizations Development Institute) in Thailand that catalyzes and supports community-driven upgrading with upgraded settlements being incorporated into the formal systems for water, sanitation and waste collection.

COMMUNITY-LED UPGRADING: The last twenty years have brought many upgrading initiatives driven by community organizations formed by their residents. These include many initiatives by federations of slum or shack dwellers that are active in over 30 nations. These have been supported by Slum/Shack Dwellers International (SDI) and the Asian Coalition for Housing Rights (ACHR). There are also many examples of co-production of services and infrastructure by community organisations working with local governments to reduce development deficits and build resilience. This creates an entry-point for climate finance to be localised to the community level, where structures of accountability and financial management are already in place.

COMMUNITY DATA: One of the main constraints on upgrading informal settlements is the lack of data on their residents and structures, on land tenure - and often even a lack of street names and legal addresses. The community organizations and federations mentioned above have developed methodologies to document and map informal settlements and have applied these in thousands of informal settlements in over 500 cities within 'Know your City' campaigns.[2] These provide the

[2] http://knowyourcity.info/

information needed for community-led upgrading. They are also a mechanism for fostering community identity and organization, prerequisites for inclusive community action. Community-led data collection can also include enumerations of informal settlements where each structure is numbered, and each household interviewed - in effect, a census - and this can also support the formal registering of land titles.

UPGRADING, INFORMAL SETTLEMENTS AND CLIMATE CHANGE: The IPCC's Fifth Assessment recognized that upgrading informal settlements has importance to climate change adaptation. Most upgrading has not been done explicitly to build resilience to climate change but there is considerable overlap between many aspects of upgrading, disaster risk reduction and climate change adaptation. Good quality urban infrastructure and services and better housing quality are at the centre of upgrading and also of reducing risks from extreme weather. Upgrading can also support low carbon development pathways in that most upgrading takes place in dense clusters of housing with densities able to support high levels of walking, bicycling and use of public transport.

MANAGING LAND USE: One essential foundation for resilient cities (and for low carbon cities) is local government capacity to manage land use and land use change within and around the city. This must address

- development issues (especially increasing the supply and reducing the cost of land for housing with infrastructure and services and ensuring adequate public space)
- land value capture (local government with the capacity to buy land before its price is elevated by city expansion to help fund infrastructure and service provision)
- disaster risk reduction and climate change adaptation (including region wide drainage and watershed management)
- climate change mitigation – understanding how support for compact cities (and settlements) and ecosystem services management can contribute to this

LOWERING HOUSING COSTS: There is a need in all growing cities for more good quality housing solutions that low-income groups want and can afford – and that meet appropriate rules and regulations for healthy living. In effect, can city governments provide formal and affordable alternatives to informal settlements. This also means reducing the high costs of most 'formal' housing and changing inappropriate regulations – as was done in Windhoek through smaller plot sizes and cheaper infrastructure. This paper also gives examples of city governments addressing this by developing and selling serviced plots.

LEAP FROGGING: Leap-frogging entails avoiding the less efficient, more expensive or more polluting development trajectories of high-income countries and moving directly to good practice options that can be applied in informal settlements – for instance low-carbon options for transport, settlement designs, home energy use, public space and waste management.

ACTING ON COMMONALITIES ACROSS AGENDAS: There is an obvious need to reconcile five different urban agendas: for economic success; for poverty reduction/basic service provision; for disaster risk reduction – and for climate change adaptation and mitigation. Although there are tensions between these and often competition for resources, there are some obvious commonalities***. Poverty reduction, disaster risk reduction and climate change adaptation all share a focus on identifying and acting on local risks and their root causes, even if they have different lenses through which to view risk.***

POVERTY: One obvious underpinning of informal settlements is the large number of urban dwellers with very low incomes – which also means a very limited capacity to afford housing and access services. The scale and depth of urban poverty has been under-estimated because poverty lines have not recognized the high costs that city dwellers face for rent and for basic services. The upgrading programmes described in this paper certainly contributed to reducing urban poverty – but they cannot remove poverty. One response to upgrading in an informal settlement in Guatemala City was that it was only putting a roof over their poverty.

COMPACT COMMUNITIES AND CITIES: Compact urban forms can contribute to all the above. High population densities with good quality housing, infrastructure and services, mixed land use and good connectivity can be combined with relatively low carbon emissions. Most informal settlements can also be viewed as compact cities with all the potential advantages for low carbon developments – low energy use and land use per person, most trips by walking or public transport, efficient re-use or recycling of wastes. Upgrading can support these to retain their low carbon characteristics, as well as implementing the much-needed improvements in risk reducing infrastructure and services and tenure. In-situ upgrading, particularly when locally driven can also retain and even enhance collective identity and pride in a sense of place – a critical aspect of wellbeing and a resource for resilience.

HOUSEHOLD AND COMMUNITY ADAPTATION: Many case studies of informal settlements have made evident the ways in which households seek to cope with environmental risks including flooding – for instance building on raised plinths or stilts, constructing walls around the home or compound – and for heat stress - improving ventilation. There are also case studies showing community-based risk reduction initiatives – for instance community organizations managing the installing or improving drains. But there are constraints on such actions – community organizations cannot provide the trunk infrastructure system into which their settlement should integrate (paved roads and paths, piped water mains, sewer and storm drainage system, electricity grids) or manage land use in the wider city – for instance in watersheds to reduced flood risk. As noted above, it is usually only when household and community planning and action are supported by local government that effective adaptation is possible.

INFORMATION: Municipal plans need to draw in all key actors, so they come to understand different urban pressures, share relevant data and get agreement on the needed priorities and trade-offs. City governments should not delay this because of insufficient data; for many cities, the issue is more about integrating existing information from different sectors of government and other actors including those in informal settlements and drawing on this to build a greater capacity to act.

LIVELIHOODS AND THE INFORMAL ECONOMY: Most informal enterprises face comparable constraints to residents of informal settlements. This includes being fined or arrested for contravening some regulation. Many informal enterprises also lose income because of unreliable electricity, water supplies and waste disposal. The informal economy often has large roles in service provision in informal settlements and usually includes many home-based workers (mostly women). Most of these would benefit from upgrading and better-quality services.

WATER/SANITATION/DRAINAGE: For most cities in sub-Saharan Africa and many in other regions of the global south, there are very large deficits in all these. UN estimates suggest that over 700 million urban dwellers in low- and middle-income nations lack what is termed safely managed water – and so must make do with water that is contaminated or irregular or difficult to access or expensive (or often most or all of these). For sanitation, UN estimates suggest that more than 1.6 billion urban dwellers in low- and middle-income nations lack ‘safely managed’ sanitation. Most of these are using

toilets or latrines unconnected to sewers and many have no toilets in their home and have to rely on shared, community or public toilets. There are also comparable deficits in storm and surface drains.

ECO-SYSTEM SERVICES: Green and blue infrastructure provide a wide range of ecosystem services for urban areas that are significant for human wellbeing, climate mitigation and adaptation and can be significant for disaster risk reduction. These include provisioning services (such as food and water supplies), regulating services (such as temperature control), cultural services (such as recreational space) and supporting services (such as nutrient cycling). Low-income groups are typically more dependent on ecosystem services – for instance in obtaining food, water, fuelwood and medicinal plants. But informal settlements also develop in watersheds or other places where ecosystem services are damaged. Again, we return to the key role of local government (or governments) to work with informal settlement dwellers to resolve this

LOCAL GOVERNANCE FOR URBAN ADAPTATION: More accountable and capacitated urban governments are central to so much of what is needed to build cities' resilience to climate change. They are also key to making a high quality of life compatible with low carbon emissions. They are also important not only for what they do but also for what they encourage and support among other actors – especially those living in informal settlements.

GLOBAL AGENDAS: But so much of the international discourses around the Paris Agreement, the Sustainable Development Goals and the New Urban Agenda are focused on national governments. Urban governments may be mentioned but always in a subsidiary role. There is a very large imbalance in cities in most of the global south between the tasks and responsibilities of local governments and the resources and capacities to meet these. Both low-carbon and climate-resilient urban development are likely to be inhibited by the same constraints that have hindered more conventional forms of development: weak government and governance structures, scarce resources (including little investment capacity), constrained local powers, limited delivery capacities, vested interests, political disinterest in the urban poor and the presence of multiple competing priorities

GLOBAL FUNDS SUPPORTING LOCAL ACTION: One of the sternest tests for global climate finance is to develop the institutional channels through which to encourage and support hundreds of locally-driven upgrading initiatives in informal settlements within which resilience enhancement is embedded. This means having to work with local governments and with the grassroots organizations and federations formed by the inhabitants of informal settlements.

1: Introduction

One of the greatest challenges for climate change adaptation is how to build resilience for the billion urban dwellers who are estimated to live in what are termed informal settlements. These settlements have been built outside the 'formal' system of laws and regulations that are meant to ensure safe, resilient structures, settlements and systems. But how is it possible to build resilience for those living outside the formal systems and usually working within the informal economy?

Much of the infrastructure and services considered as part of conventional (formal) urban development is intended to reduce health risks. This paper highlights the importance for climate change resilience of what the IPCC's Fifth Assessment termed 'risk reducing' infrastructure and services (see Box 1) – and to how the lack of provision for such infrastructure and services is at the core of a lack of resilience (Revi et al 2014). For infrastructure, this lack of provision includes no paved roads and paths to each dwelling, no regular, good quality water piped to homes, inadequate or no provision for sanitation, waste water disposal, electricity, street lights and storm and surface drains. For services, this includes a lack of health care, emergency services, household waste collection and policing. As this paper will make clear, those living and/or working in informal settlements lack most or all of these – with very serious consequences for the risks they face, for their health and for building resilience to climate change impacts.

In cities in high-income nations, there is close to universal provision of these. But for most cities in low- and middle-income nations, there is only partial and fragmented infrastructure investments – for instance ignoring informal settlements. Rather than reducing risks, these investments can increase, shift or concentrate risks: road development can accelerate storm run-off while increased concretisation can increase air temperature. Investments in storm and surface drains in one location can increase flooding risks downstream. Infrastructure expansion may also be a key factor in evictions for informal settlements. A focus on risk reduction, whether focussed on proximate or root causes, challenges local governments, planners and communities to work at city scale and with integrated development of the infrastructure that should serve all urban dwellers.

Informal settlements are concentrated in urban centres in low- and middle-income nations. These are characterized by poor quality (and generally overcrowded) housing, lack of legal land tenure and lack of the 'risk-reducing' infrastructure and services listed in Box 1. Many informal settlements are located on sites at high risk from floods or landslides or from other risks (for instance on unstable waste dumps or very close to railway tracks) because the risks make them unattractive to developers. In most informal settlements, there are no legal addresses. Informal settlement residents usually have difficulties engaging with local governments or at best are trapped in clientelist relationships that perpetuate poverty and risk.

Box 1: Resilience and risk-reducing infrastructure and services

Resilience to climate change for cities comes from risk-reducing measures taken in anticipation of the hazards that such change is bringing or will bring, preparedness to cope with the impacts and beyond this to adapt (to lower future risks). The effectiveness of a resilience agenda depends on a city-wide approach and on how well it understands and responds to the needs of vulnerable groups. Resilience also implies a capacity to cope with unexpected or uncertain risks - or as in climate change, to not only increasing risks but increases and changes in increasing risk.

Much urban infrastructure provision is to reduce risks: water piped to homes and workplaces that is safe to drink and regular; connections to sewers, storm and surface drainage, electricity grids (as electric lights reduce fire risks from candles and kerosene lamps and street lights make neighbourhoods safer) and paved/all weather access roads and paths.

Most urban services also contribute to reduce risks or their impacts: health care and emergency services/ambulances/fire engines, policing, regular solid waste collection and latrine emptying. Also, the availability of insurance for homes and possessions.

There are obvious interconnections: all weather roads and paths are also important for emergency service vehicle access; street lights need electricity; functioning drains usually depend on household solid waste collection. There is also a valuable literature on the characteristics of resilient city systems that include responsiveness, redundancy, safe failure, capacity to manage and protect ecosystem services and capacity to cope with and adapt to unexpected changes (Brown 2012, Tyler and Moench 2012, Vugrin and Turnquist 2012) – but of course you need the systems in place to be able to apply these

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In almost all nations in the Global South, more than half the urban workforce work in informal employment; the proportions are particularly high in South Asia (82 percent in informal employment) and sub-Saharan Africa (66 percent) (Chen 2014, Chen, Roever and Skinner 2016). These face challenging conditions of work including poor occupational health and safety, insecurity, no social protection and low incomes (Chen 2014). Many of those working in informal employment live in informal settlements – including those that work in home-based enterprises.

The interest in 'informality' was particularly notable in relation to employment from the early 1970s but this interest widened so the term "informality" is commonly used to describe a range of behaviours and practices that are not regulated or controlled by the state or formal institutions, including those related to income generation, service provision, and settlements (Chen, Roever and Skinner 2016).

Informal settlements and the informal economy fall outside the 'formal' – formal livelihoods and labour markets, formal premises, formal land/property titles and formal housing (and formal land for housing) markets for tenants and owners. They also fall outside many services – for instance for most informal settlements no government provided public services. Most fall outside infrastructure networks. Most informal settlement dwellers cannot open a bank account or get a legal address (on which access to many 'formal' services may depend). They fall outside government systems for land use planning and management. Many transactions may be 'informal' – for instance selling of housing or land for which the seller does not have a formal title. Despite the importance of informal employment to city economies and the importance of informal settlements to housing most of the low-income labour force (and their families), both are still viewed negatively by many governments.

Table 1 summarizes the different impacts from climate change on urban populations living in informal settlements and urban residents working in the informal economy. Most extreme weather disaster deaths in urban centres are in low- and lower-middle-income nations (UNISDR 2009). Risks are concentrated in informal settlements where the occupants are typically more exposed to climate events with limited or no risk-reducing infrastructure, low-quality housing, and limited capacity to cope (UNISDR 2009, IPCC 2012, Revi et al 2014). At the same time, residents of informal settlements typically have smaller ecological and carbon footprints than those of higher socio-economic status elsewhere in the city.

These issues raise questions about whether and how those living in informal settlements and those working in informal employment are more at risk from the impacts of climate change. They also require consideration of what can be done to address these risks while also attending to advancing human development and climate mitigation agendas.

*Table 1**: Likely impacts from climate change on urban populations living in informal settlements and working in the informal economy***

Projected changes	**Examples of likely impacts**	**Implications for residents of informal settlements and people working in the informal economy**
Changes in simple extremes		
Higher (and increasing) maximum temperatures, more hot days and heat waves - over nearly all land areas	Rise in mortality and illness from heat stress in many urban locations	Many informal settlements very dense with very little open/public space and often with uninsulated corrugated iron roofs and poor ventilation that contribute to higher indoor temperatures. Largest impacts among groups particularly vulnerable – infants and young children, the elderly, expectant mothers, those with certain chronic diseases. Health risks for outdoor workers
Higher (increasing) minimum temperatures: fewer cold days, frost days and cold waves over nearly all land areas	Decreased cold-related human morbidity and mortality. Extended range and activity of some disease vectors – including mosquito and tick-borne diseases	Most informal settlements without public health measures to control or remove disease vectors and without health care systems that provide needed responses. Infants and young children particularly vulnerable
More intense precipitation events and riverine floods	Increased flood, landslide, avalanche and mud-slide damage resulting in injury and loss of life, loss of property and damage to infrastructure. Increased flood run-off often brings contamination to water supplies and outbreaks of water-borne diseases	Many informal settlements concentrated on sites most at risk of flooding with poor quality housing less able to withstand flooding and a lack of risk-reducing infrastructure. Homes, possessions and assets for generating income are not covered by insurance.
Wind storms with higher wind speeds	Structural damage to buildings, power and telephone lines, communication masts and other urban infrastructure	Corrugated iron roof sheets blowing around during high winds; they were not nailed down because they could be sold if needed and the price was less if they had nail holes (Wamsler 2007)
Changes in complex extremes		
Increased summer drying over mid-latitude continental	Decreased water resource quantity and quality; increased risk of	Informal settlement residents usually facing more water constraints and with residents

interiors and associated risk of drought	forest/bush fire; decreased crop yields and higher food prices	more vulnerable to food and water price rises
Increased tropical cyclone peak wind intensities and mean and peak precipitation intensities	Increased risk to human life and damage to property and infrastructure; risk of infectious disease epidemics; increased coastal erosion and damage to coastal ecosystems	So many informal settlements are on sites most at risk, having poor quality housing and lacking risk-reducing infrastructure
Intensified droughts and floods associated with El Niño events in many different regions	Decreased agriculture and range-land productivity in drought-prone and flood-prone regions	Impact on food availability and prices in urban areas
Increased Asian summer monsoon precipitation variability	Increased flood and drought magnitude and damages in temperate and tropical Asia	In many cities in Asia, most of those most at risk of flooding are low-income groups living in informal settlements
Changes in the mean		
Water availability	Reduced water availability in many locations – with obvious impact on agriculture and on cities where fresh water availability declines significantly	In cities facing constraints or shortages of freshwater supplies, it is likely that low-income areas will be the most affected (and least able to afford alternative sources). Difficulty in accessing water for informal livelihood activities.
Sea-level rise	Coastal erosion, land loss, more floods from storm surges; hundreds of millions of urban dwellers living in low elevation coastal zones	Many informal settlements close to the sea with poor quality housing and lacking drainage infrastructure
Higher average temperature	Disease vector range spreading, worsening air quality, higher water demand and water loss	Those living in informal settlements so often not served with the infrastructure and health care measures needed to counteract these

SOURCE: Drawn from Table 3.9 in Mitlin and Satterthwaite (2013) that drew on McCarthy et al 2001 and Parry et al 2007

It is important to consider both the direct and the indirect impacts of climate change – although there is no agreement on how these are defined. For this paper, the direct impacts of climate change include extreme weather events that cause death, illness or injury, loss of or damage to property/assets and displacement. The indirect impacts include impacts on larger systems that then impact people so it would include economic impacts that can be city wide, disruption to or close down of public transport and health care or other public services, disruptions to labour markets including access to workplaces or markets, more scarce or expensive food or water, and greater risks from infectious and parasitic diseases. If people have to move to temporary camps, there are the risks these can pose. Indirect impacts can be particularly serious for low-income groups – where sources of income are lost or prices of food increase.

The next section of this paper describes the circumstances and extent of informality in cities in low- and middle-income countries. Section 3 reviews what has been learned from upgrading informal settlements. Although few of the case studies on upgrading informal settlements mention climate change, they are describing a process that is perhaps the most important means by which low-

income urban dwellers unable to afford formal housing and relying on informal livelihoods can get more resilience to climate change impacts – as well as reducing risks they face from everyday hazards and disasters. This discussion of informality also requires attention to how living and working in 'formal' settlements and employment provides a stronger foundation for adaptation and mitigation, and the means by which those in informal settlements can acquire this foundation.

Section 4 considers the ways in which informality shapes risk and vulnerability in terms of urban form, housing, industry and livelihoods, water and sanitation infrastructure and urban ecology. Section 5 discusses governance with a focus on what city and municipal governments and local civil society organizations can do to achieve more inclusive, low carbon, and climate resilient development in towns and cities around the world. Section 6 draws some conclusions.

But first, there is a need to clarify the urban focus of this paper. The urban population of any nation can be divided into 'cities' and urban areas that are not cities. There is no agreed definition for what a city is – although it is understood to be an urban centre with some importance – for instance a large population and the seat of district or provincial government. There is also no agreed definition for urban centres and each nation has its own particular definition (see United Nations 2015) but in most nations, urban centres are settlements with a population above a particular threshold – for instance 2,500 or 5,000 inhabitants.

There is very little literature on informal settlements or the informal economy of small urban centres – for instance if we define small urban centres as those settlements defined as urban by governments with populations up to 50,000 inhabitants. Most of the literature on informal settlements is in cities with populations exceeding a million. So the paper uses the term city to acknowledge how little it covers small urban centres. But small urban centres (including many with only a few thousand inhabitants) generally have local governments with the least capacities to assess climate change risks and to act; one study of a small urban centre in Malawi was sub-titled 'Where there is no local government' (Manda 2013).

2: Informal settlements, economies and services and risk

2.1 The scale of informal settlements

The term 'informal settlement' refers to urban settlements or neighbourhoods that developed outside the formal system that is meant to record land ownership and tenure and without meeting a range of regulations relating to planning and land use, built structures and health and safety. The definition used by the OECD is "areas where groups of housing units have been constructed on land that the occupants have no legal claim to or occupy illegally" or "unplanned settlements and areas where housing is not in compliance with current planning and building regulations (unauthorized housing)."[3] As discussed in more detail below, many informal settlements are not on illegally occupied land.

Consideration of urban populations and informal settlements needs to include internally displaced people and refugees. UN estimates suggest that 65.6 million people were forcibly displaced globally in 2016. This included 40.3 million that were internally displaced (remaining within their country's boundaries) with the rest being refugees and asylum seekers (UN 2017). The proportion of displaced people moving to urban areas is growing; for instance, by 2016, 60 per cent of refugees were living in urban areas rather than in camps (ibid, Archer and Dodman 2017). Refugees and internally displaced person are seen as the responsibilities of humanitarian agencies providing emergency

[3] https://stats.oecd.org/glossary/detail.asp?ID=1351

responses but for those that live in informal settlements, they need to be included in discussions of how to improve conditions.

The term 'informal settlement' is used instead of the terms 'slum' or 'illegal settlement' because it is less pejorative; terming a settlement a slum can legitimate bulldozing it (see Gilbert, 2007). But importantly informal settlements and slums are not the same. Definition of informal settlements are based on contraventions of specific laws, rules and regulations. Definitions of slums are usually based around measures of housing quality, service provision and overcrowding. There are informal settlements that would not be considered as slums. These include settlements on land acquired from the owner (and thus not illegally occupied) but that were illegally sub-divided. These can have plots in a regular grid plan (and may even meet municipal regulations), houses built with permanent materials and good provision for water and sanitation.

There are also neighbourhoods that are termed slums that are not informal settlements because they were not built illegally. These include houses or apartments that met formal standards when they were built that have been subdivided into small rental units or deteriorated due to poor maintenance. In many cities, these include poor quality and poorly maintained public housing (Rojas 2018).

In most low- and middle-income nations, there are no official data on the population living in informal settlements or slums. Information on housing conditions and service provision are usually drawn from censuses and national sample surveys (including the Demographic and Health Surveys). Most censuses do not identify 'informal settlements' or 'slums' as a category, and national sample surveys have sample sizes too small to be able to report on the scale of informal settlements or on conditions there. While there are many case studies of informal settlements (e.g. Moser 2009, Perlman 2010) and some city-wide studies (e.g. Karanja 2010, Livengood and Kunte 2012), these represent a small sample from among hundreds of thousands of urban centres and informal settlements. However, case studies of cities in low- and middle-income nations show many with more than a third of their population in informal settlements with some showing a much higher proportion – for instance for Nairobi, 60% (Weru 2004, Lines and Makau 2017) and for Dar es Salaam 70% (Kiunsi 2013).

The United Nations does not have data on the population living in informal settlements. It does have data on the population living in what it defines as 'slums' and it classifies households as 'slum households' if they lack one or more of four criteria: lack of durable housing, inadequate living space (3 or more persons per room) improved water and improved sanitation (UN-Habitat, 2016). Originally, households were to be classified as slum households if they lacked secure land tenure, so this would have contributed to global estimates on the number of informal settlement dwellers. But this was dropped from the definition because there were no data on this for most nations.

UN Habitat's global and regional estimates of the number of urban households that are 'slum' households, are likely to include most residents of informal settlements. These estimates suggest that there were 880 million 'slum dwellers' in 2016, including some 56 per cent of the urban population in sub-Saharan Africa and more than 30 percent of the urban population of South Asia (UN-Habitat 2016, p. 203). But the accuracy and validity of this data on slum households is contested, especially the inappropriateness in the indicators used for assessing water and sanitation provision in urban areas. If the indicators were appropriate to dense urban contexts, UN estimates of the number of slum dwellers would increase (Mitlin and Satterthwaite 2013; Satterthwaite 2016).

In considering this and considering the population living in informal settlements that are not within the slum population estimates, it is likely that at least a billion urban dwellers currently live in informal settlements.

Informal settlements grew (and in many nations still grow) because their residents could not find accommodation that they could afford to buy, build or rent in formal settlements. It is also because urban governments refused to address their needs – or lacked the capacity to do so. This is also linked to the inappropriateness of many 'formal' rules and regulations and the cumbersome, time consuming and often expensive procedures needed to be 'formal' (Watson 2009, Porter 2011). It is also because international aid agencies have not seen upgrading informal settlements as a priority.

Informal settlements are usually defined or characterized by the many ways they contravene some 'imagined ideal' of planned cities (see Porter 2011, Watson 2011). An informal settlement will commonly differ from a formal settlement because of unclear (often illegal) land occupation, because the settlement and its buildings did not receive official permission, and/or because the site layouts and structures contravene regulations (for instance, plot sizes are smaller than the minimum specified by planning regulations). In many cities, informal settlements are so common and house such a high proportion of the population and the workforce that they cannot be seen as a "state of exception" from the formal city (Roy 2005). If laws and regulations are deeming illegal the homes and livelihoods of much of the city population, then it is their legitimacy that should questioned.

2.2: Informal land markets, services and employment

The process of buying or selling land and buying, selling or building housing in compliance with legal requirements is often unnecessarily complicated and costly (Payne et al., 2014; Burns, 2015, Berrisford et al 2018). Getting formal land tenure (and the legal document to verify this) is usually complicated by difficulties and expenses of getting formal land title documentation (and there may be no land information system to support this). Land for informal settlements may be obtained from traditional chiefs with widely accepted rights to allocate land – but outside any formal government system to record land titles. Or land may be obtained from informal brokers. Urban land markets may be further complicated by speculation by real estate agents, overlap with traditional tenure systems and/or political interests, which contribute to opaque land ownership and decision-making structures (Durand-Lasserve, Durand-Lasserve and Selod 2015; Andreasen et al., 2011; Leck and Roberts, 2015).

In most cities, there is considerable diversity among the informal settlements in regard to the illegality (or not) of the land occupation and use, the quality of the site, the accessibility to labour markets, the risk of eviction, housing size and quality, provision for infrastructure and services and extent of tenants within the settlement's population (Hardoy and Satterthwaite 1989, Roy, 2005; Payne *et al.*, 2014, Krishna et al 2014). As Roy 2005 notes, there is spectrum of "differentiation within informality" and differentiation in power, exclusion and legitimacy (p. 149). At one end of the spectrum, many informal settlements include multi storey buildings (Hasan 2010, Lanzt and Engqvist 2008). There are also buildings that are not 'informal' but that provide 'informal' accommodation – for instance where legal buildings have been converted into cheap boarding houses with dormitories where beds can be rented that contravene regulations on density and water and sanitation provision.

Much of the urban population (especially those living in informal settlements) rely on informal providers of goods and services because of the lack of provision from formal providers/utilities. This informal provision can cover water (purchased from tankers, vendors or kiosks), pay-to-use public or community toilets (because of no toilets in the home), electricity (from illegal connections to grid) and a range of services (household waste collection, day care, schools, health care….). But there are usually serious deficiencies in the quality of provision and high cost.

UN statistics show the scale of the urban population that lacks good provision for water and sanitation in their homes. Most of this population is likely to be in informal settlements. The 2017 report of the WHO and UNICEF Joint Monitoring Programme suggests that over 700 million urban dwellers in low- and middle-income nations lack what is termed safely managed water (WHO and UNICEF 2017). So they have to make do with water that is contaminated or irregular or difficult to access or expensive (or often most or all of these). Many nations had a lower percentage of their urban population with water accessible on premises in 2015 compared to 1990 (Satterthwaite 2016). UN estimates suggest that more than 1.6 billion urban dwellers in low- and middle-income nations lack 'safely managed' sanitation. Most of these are using toilets or latrines unconnected to sewers; many cities in Asia and sub-Saharan Africa have no sewers or sewer systems that only serve a very small percent of their population. There are no comparable statistics for drainage – but given the very large deficits in trunk infrastructure for water and sanitation, it is likely that there are comparable deficits in storm and surface drains.

The introduction noted how in almost all nations in the Global South, more than half the non-agricultural workforce work in informal employment. Women generally have a higher proportion in informal employment than men (Chen 2014). In most cities in the Global South, much of the informal economy is located in informal settlements (including many home based enterprises) although there are many in informal employment in the formal economy – and enterprises in informal settlements that are 'formal' in the sense that they are producing for or servicing external markets.

The informal economy includes the production and employment in unincorporated small or unregistered (informal) enterprises and *informal employment* - employment without legal and social protection that includes construction workers, domestic workers, home-based producers, street vendors, transport workers and waste pickers, plus many low-end service occupations (Chen 2014).

The informal economy also represents an important part of the national economy – and many informal firms and workers are producing for or serving formal firms (Chen 2014). But many governments do not recognize informal workers as economic actors or the contribution of the informal economy to city and national economies. Many enforce punitive government regulations such as arresting or fining street trader or confiscating their goods or evicting workers – as home-based workers are evicted. Urban renewal and infrastructure projects often include the eviction of street traders (ibid).

Where informal settlements house a significant proportion of a city's population, they also house a significant proportion of its labour force (including many working in the formal economy). And many informal settlements have large and diverse informal economic activities. It is common for informal settlements to develop close to ports, markets, industrial areas and airports/bus/rail terminals, as many of their inhabitants provide the labour these depend on (see, for instance, Farouk and Owusu 2012). Many informal settlements develop large and varied economies of their own – serving their

population or fabricating goods or providing services to external markets (World Bank 2016, Lantz and Engqvist 2008). Inadequate provision for essential services, including the lack of electricity, water piped into their premises, sanitation/drainage and solid waste collection also constrain enterprises in informal settlements (World Bank 2016).

As Ela Bhatt, founder of the Self-Employed Women's Association (SEWA) put it: 'The challenge is to convince the policy makers to promote and encourage *hybrid economies* in which micro-businesses can co-exist alongside small, medium, and large businesses: in which the street vendors can co-exist alongside the kiosks, retail shops, and large malls … Just as the policy makers encourage bio diversity, they should encourage *economic diversity*. Also, they should try to promote a *level playing field* in which all sizes of businesses and all categories of workers can compete on equal and fair terms' (quoted in Chen 2014).

Box 2: The full spectrum of risk

Understanding the full spectrum of risk facing urban populations means understanding all the risks that can impoverish, injure, sicken or kill any individual. Due largely to the lack of 'risk-reducing infrastructure and services' (see Box 1 for details), everyday risks pose a constant "everyday" threat to residents based on their living and working environments – from, for example, indoor air pollution, fire risk, and poor-quality water and provision for toilets. In informal settlements in particular, what can be termed every day risks often contribute more to premature death and serious illness or injury than disasters just by dint of their frequency, pervasiveness and likelihood. Certain population groups are more vulnerable to different risks - for instance the greater susceptibility of infants to food-borne or water-borne diseases. Different categories of risk are distinguished by the scale of their potential impact and the frequency of their occurrence. Disasters may be seasonal, such as flooding, or once-in-a-hundred years.

Understanding the full spectrum of risk as faced by residents of informal settlements can help assess which 'risk-reducing' infrastructure and services need to be prioritised – such as affordable and accessible clean piped water, sewer connections, or health centres and emergency services. Data on risks (and many health determinants) can be gathered through censuses and hospital or police records, but to be useful, they need to be 'disaggregatable' - available at the neighbourhood or street level, to show concentrations of risk. This is where local populations can supplement information bases, through their own surveys or maps (see section 3 for examples), or through focus group discussions and interviews.

Source: Satterthwaite and Bartlett, 2017, Manda and Wanda 2017, Bull-Kamanga, Diagne, Lavell et al 2003)

It is obvious that enterprises that make up "the private sector" have a powerful influence on how any city develops and so they also have importance for climate change adaptation (and mitigation). But the term the private sector encompasses all the enterprises in the informal economy as well as the formal economy and so it ranges from street vendors to the largest companies. In regard to climate change adaptation, those companies working within a city's formal and informal land markets influence the price, availability and location of land for housing and the form that city expansion takes.

In the absence of 'formal' provision for water, sanitation, health care, schools, solid waste collection, policing…. in informal settlements, so alternative (often informal) providers develop. These encompass individual water vendors and latrine emptiers and private utilities that have learnt to operate successfully in some informal settlements – for instance providing electricity or water through kiosks. In many informal settlements, inhabitants have to rely on private pay-to-use toilets because they lack toilets in their homes or plots. Many informal service providers have links to the

formal - for instance as water tankers and vendors draw water from government mains and as some household waste collection and latrine emptying services rely on government managed collection or disposal points.

2.3 How the 'formal' helps to reduce risk

Cities range from the most to the least healthy places to live and to work – seen for instance in differences in average life expectancy at birth or infant, child and maternal mortality rates (Mitlin and Satterthwaite 2013, Eze et al 2017). By concentrating people, enterprises, institutions, motor vehicles and their wastes, cities can be very unhealthy. But well-governed cities have measures in place that enormously reduce the health risks these can bring. The main means to do so has been in developing and enforcing (formal) laws, byelaws, rules and regulations on, for instance, building standards, land use, health and safety at home and at work, pollution control, motor vehicle traffic management and household appliances – and on registering land title/rights and their use and sale.

Social, political and health focused studies of the history of cities in what are today high-income nations show how such laws and regulations were developed – including the political complications of doing so (and where and how these were or were not overcome) (Wohl 1983). But over time, these established a wide-ranging set of rules and regulations (and regulatory bodies to ensure compliance) – most directly or indirectly about reducing risk or its health consequences. In addition, they were developed (and where needed changed) within particular local contexts in response to locally identified needs.

The households, enterprises and institutions who function within these laws, rules and regulations can be seen as the 'formal' – living in 'formal' housing with a 'formal' address on land for which there is formal title (and where tenants have formal contracts with the land or house owners) and working in 'formal' enterprises or institutions. Also, where there is 'formal' infrastructure and services. No city will have all its population, workers, enterprises and institutions working entirely within all these aspects of the 'formal' but in cities in high-income nations, nearly all will be.

For those in the formal city, all or nearly all live and work in buildings that meet formal standards for health and safety. They have legal addresses – that are often required to get on the voter register, open a bank account, get 'formal' connections to water, sanitation and drainage infrastructure and access entitlements and welfare payments such as support to those unable to work and pensions. Almost all have reliable legal household waste collection and electricity services, receive water of drinkable quality piped to kitchens, toilets and bathrooms, are connected to sewers, have provision for storm drains that are maintained. Households have access to paved roads and footpaths, street lighting, as well as policing, emergency services, schools and healthcare. Residents will have insurance for their home and possessions (facilitated by having access to bank accounts and legal documents) and buildings and building plots are registered and occupied or rented out by their legal owner.

Taken together, these laws, rules and regulations have brought very large gains in health outcomes and provision of key health determinants in cities in high-income and many middle-income nations. They have also reduced susceptibility to harm from extreme weather events and other shocks and stresses. However, it is worth noting that it took decades of political organization and pressure to get many of these and there is still need for progress and greater effectiveness in some. But what deserves our attention is the contribution of all of this to resilience (including building adaptive capacity to climate change) and to providing the instruments for mitigation.

City and municipal governments usually have responsibilities for ensuring compliance with a large and diverse range of standards for housing and other buildings, infrastructure and enterprises (much of it for environmental or occupational health and safety). Where such standards are appropriate and affordable - and enforced - this has underpinned improving conditions, including the resilience of buildings and infrastructure to extreme weather.

But in many low and middle-income nations, standards and regulations for housing and land use are based on imported models – including many that date back to colonial rule. What they require in, for instance, very large minimum lot sizes help make them unaffordable for most of the population. Infrastructure standards can also have the same effect – so rather than reducing risks, they exclude large sections of the urban population from the protections that standards are meant to provide.

The laws, rules and regulations that formally guide urban development should complement and support those applied to buildings and infrastructure – and help local authorities and utilities to manage urban expansion, including extending infrastructure and service provision to un-served and under-served parts of the city. They form an important part of urban planning, management and governance to help public agencies to achieve their desired urban forms and functions (MacDonald *et al.*, 2014). This could include climate-related aspirations such as promoting compact urban development, ensuring sufficient good quality accessible green space, and protecting watersheds. However, in many cases, either the content of laws, rules and regulations or their application contribute to the growth of informal settlements.

The proportion of individuals and households that live in informal settlements is in effect a measure of the failure of formal systems. Inappropriate building and infrastructure standards and land use regulations act to push up the cost of the cheapest formal house beyond what most households can afford. Informal markets pick up those unable to find or afford (or occasionally want) accommodation in formal housing markets. So informal settlements exist largely because their inhabitants could not afford to buy, build or rent formal legal housing, and because governments have not responded effectively to this market failure. People choose to live in informal settlements either because it best meets their needs (especially for access to jobs and services) and limited capacities to pay - or because this is the only place where they can obtain or afford accommodation. The inhabitants of informal settlements will not consider moving to formal settlements unless they compare favourably with their current accommodation on issues such as price and location, as well as quality and tenure. Living in an informal settlement underlies most of the risks that residents face to their lives, health, home, livelihoods and assets – to which climate change is adding or exacerbating or will do so.

3: Responses to informal settlements

3.1 The potential offered by upgrading

Upgrading is a term given to government measures to improve the quality of housing structures and the provision of housing and community-related infrastructure and services (such as piped water, sewers and storm drains) to settlements that are considered to be (or officially designated as) ‘slums’ or informal settlements. It accepts the validity of government agencies working in informal settlements – homes and settlements that contravene laws, regulations and standards. This includes connecting them to public infrastructure and service systems. As discussed later, upgrading came to include community-driven upgrading too and upgrading undertaken by local government-community organization partnerships

Upgrading has particular importance to climate change adaptation where the upgrading includes addressing the risks that climate change is bringing or exacerbating. Upgrading informal settlements has not been done explicitly to build resilience to climate change but there is a very large overlap between many aspects of upgrading and climate change resilience – for instance better quality housing, functioning piped water, sewer and storm drainage systems, paved roads (that allow emergency services to function in informal settlements) and paved footpaths, reliable public transport and electricity supplies, and solid waste collection.

The IPCC has long recognized the importance of upgrading informal settlements for climate change adaptation. The IPCC's Third and Fourth Assessments from Working Group II recognized the higher risks facing those living in informal settlements because of poor quality housing and inadequate services and because many are located on hazardous sites (Scott et al 2001, Wilbanks et al, 2007). The Third Assessment stated the need to "Regularize property rights for informal settlement and other measures to allow low-income groups to buy, rent, or build good quality housing on safe sites" (Scott et al 2001, page 406). The Fourth Assessment noted how "Informal settlements within urban areas of developing-country cities are especially vulnerable, as they tend to be built on hazardous sites and to be susceptible to floods, landslides and other climate-related disasters" (Wilbanks et al 2007, page 372); also "how the poor tend to live in informal settlements, with irregular land tenure and self-built substandard houses, lacking adequate water, drainage and other public services…. "(ibid, page 373). These issues were also mentioned in the 4th Assessment (WGII) chapter on health – and this also highlighted risks facing those in poor housing in high density urban areas (Confalonieri et al 2007).

The chapter on urban areas in the Fifth Assessment (Working Group II) notes: "Reducing basic service deficit could reduce hazard exposure, especially of the poor and vulnerable, alongside upgrading of informal settlements, improved housing conditions and enabling the agency of low-income communities" (Revi et al 2014, page 562). This chapter also mentions examples of good experiences with community-driven 'slum' or informal settlement upgrading in reducing risk and vulnerability to extreme weather events. It notes how "it has become more common for local governments to work with community-based organizations in upgrading their homes and settlements in disaster risk reduction and with community-based adaptation building on these experiences and capacities" (page 581). Other references to upgrading point to how informal settlements that become incorporated into the formal city often mean "an increased expectation on the state to reduce vulnerability, including long-term and strategic adaptation investments through access to schools, health care, infrastructure, and safety nets" (page 581). It therefore highlights that informality both shapes the consequences of climate change impacts, and that upgrading has the potential to contribute significantly to urban resilience.

Government responses to informal settlements range from bulldozing them to ignoring them to 'upgrading' them. Often all three responses are evident in a city as the government response for each informal settlement differs depending on particular characteristics of each settlement. Within bulldozing, responses range from forced eviction to evictions that are negotiated. Within those that are negotiated, some provide for resettlement of the evictees and these include instances where the evictees were engaged in organizing and managing their move and choosing the resettlement location (Patel et al 2002, Lines and Makau 2017). Upgrading, either by the government or by communities themselves, represents a radical change in approach.

Upgrading informal settlements may also lead to the first map of the settlement and provide each household with a legal 'formal' address. This then allows or facilitates residents' access to entitlements such as enrolling their children in public schools, getting on the voter registers, receiving social protection or subsidized food and fuel. Having a legal address means being able to receive post and may be required for getting connection to (formal) piped water and electricity, a bank account, insurance for homes and possessions or a phone line (although mobile phones, if affordable, overcome this constraint).

All the above represent a shift in informal homes and settlements towards the formal (with its laws, rules and regulations) that can contribute to increased resilience. But as discussed below, this being an incremental process, the final outcome may not meet all official regulations (or which might catalyse changes in official regulations to lower the cost of 'formal' housing (see Mitlin and Muller 2004).

For the inhabitants of informal settlements, their preference is usually upgrading rather than resettlement since this improves conditions but with no need to move and find alternative accommodation (although there may be temporary relocation during reblocking or infrastructure installation). This has particular importance for residents of informal settlements that are well located in relation to labour markets because this keeps down time and transport costs. But these are also generally the settlements whose central location makes their land valuable and with government and real estate interests keen to evict the residents and redevelop the site. For informal settlements that have many renters, the benefits of upgrading may be captured by their landlords as they increase rents or deny the tenants access to (for instance) toilets.

3.2 Types of upgrading

Upgrading informal settlements was recommended in the 1960s (see Mangin 1967 and Turner 1968) and it received strong endorsement by the governments meeting at the First UN Conference on Human Settlements in 1976, by which time upgrading was receiving support from the World Bank and from UNICEF. By the mid-1970s, many city governments were implementing upgrading schemes although some also continued to bulldoze informal settlements (typically those in the most valuable locations) and continued with (mostly ineffective) public housing programmes (Hardoy and Satterthwaite 1981). As discussed later, there are also public schemes that are described as be upgrading where the inhabitants get displaced while their settlement is bulldozed and new apartment blocks built, but where there is no guarantee that those displaced will be able to return (Patel 2013).

Viewing the documented experiences with upgrading up to the present, there are very large differences in what the upgrading provided, what it cost per house served, who implemented it, who paid for it and the extent to which it engaged the population (and served their needs). Upgrading ranges from some rudimentary provision of infrastructure – for instance public water points where water can be collected or purchased and a storm drain – to a full range of 'risk reducing' infrastructure and services, often community facilities and sometimes income generation or support for house improvement or extension) and land tenure granted to the occupiers (see for instance Stein with Castillo 2005, Almansi 2009).

Comprehensive upgrading can be expensive – costing several thousand dollars per house – Almansi 2009, Rojas 2018). The legal costs of sorting out tenure for the occupiers can be particularly high as

the legal landowners' demand compensation and there are the costs of preparing a cadastre to define and register ownership of plots and their boundaries. Land titling programmes are also not only expensive and complicated, they are also beyond the capacity of many urban governments (Burns 2015). The costs of upgrading are usually paid for by the public agency implementing the initiative although as discussed below, it may include a household or community contribution, or a mixture of government provided loan and grant – or funding drawn entirely from households.

3.3: Lessons from upgrading initiatives

Upgrading schemes vary from conventional 'projects' organized and managed by government agencies (national, state or municipal) that usually contract out much of the work, to building companies, to initiatives in which the inhabitants and their own grassroots organizations have much larger roles. Experience in community-led upgrading and co-production (communities working with local governments) in particular offers potential for climate change resilience-building because of its recognition of local hazards, its reflection of community priorities, and its ability to contribute to enhanced adaptive capacity.

3.4: Government-led upgrading

Where government upgrading works well, it has proved to be very effective as it greatly improves housing conditions, infrastructure (including links to city-wide systems for paved roads, water, waste water and storm drainage that contribute to resilience) and access to services. It removes or greatly reduces the risk of eviction. It builds on the investments that those living in informal settlements had made before the upgrading – and, crucially, does not require residents to move to another settlement (with all the costs this brings as well as disruptions of social networks and almost always with less favourable locations). As such, upgrading contributes much to reducing risks for a range of risks that climate change is bringing, may bring or will bring and to capacities to cope and adapt. In future, upgrading schemes could consider (often minor) adjustments could increase safety margins for a range of climate change impacts. They could usefully integrate disaster risk reduction into these considerations: if a city starts working in DRR it will necessarily have to address informality issues, urban planning, services and infrastructure, housing, participation and governance. It is worth repeating that good development, disaster risk reduction and climate change adaptation all focus on identifying and acting on local risks and vulnerabilities and there are many beneficial overlaps between them (Satterthwaite, Bartlett, Roberts et al 2016).

But care is needed in upgrading schemes not to impose costs that cannot be afforded – for instance as households now having to pay more than they can afford for water, sanitation and electricity. There is also the need to ensure good maintenance and repair for community infrastructure and services (upgrading providing a one-off improvement with public agencies needing to take over maintenance – which they often fail to do).

There are also many government initiatives that upgrade informal settlements that were not formally labelled as upgrading. In many Latin American cities, provision of piped water, sewers and storm drains and electricity have been expanding to reach almost all residents, including those in informal settlements. Some cities have improved bus services that also bring benefits to informal settlement dwellers. These are components of upgrading that are not labelled upgrading – including some that bring city-wide benefits – see for instance the experience in Rosario, Argentina (Almansi 2009) and Porto Alegre in Brazil (Abers 1998).

There seems to be an acceptance by local governments in much of Latin America that upgrading or provision of services to informal settlements is the conventional policy response; so different to the conventional policy responses in the 1960s and 1970s of bulldozing or ignoring them (Portes 1979, Hardoy and Satterthwaite 1989) One factor behind this was the political changes brought in many nations with the return to democracy and the changes that strengthened the capacities and accountabilities of city governments that included elected mayors and city governments (Fernandes 2007). These were in turn often supported by land titling programmes in informal settlements (Lula da Silva et al 2003) and participatory budgeting – that gives each district of a city the right to influence priorities in public works and makes the city budget more transparent (Cabannes 2015).

The South African government has made strong commitments to upgrading and to community-led practices for upgrading. This has included many positive commitments by city governments (and ministers within national governments). But it has proved difficult to put this into practice on the ground within the formal processes of local government with its sectoral rivalries, bureaucratic inertia and range of (often inappropriate) rules and regulations (Fieuw and Hendler 2017).

There are also case studies that show upgrading schemes that have not served the local population – and indeed some that end up evicting the residents (Patel 2013, Mitra et al 2017). Some government led 'upgrading' projects displace the residents when the whole point of upgrading is not to do so - see the assessment of the government of India's Basic Services for the Urban Poor (BSUP) programme (Patel 2013). Many of the 'upgrading 'projects "…are simply public housing construction re-labelled – and often with very inadequate provision for upgrading "basic services" (Patel 2013, page 177). In many such schemes, the former residents do not get accommodation in the 'upgraded' settlement. But even where there is some success in improving conditions, it may have grave limitations. This is illustrated by the comment of a community leader in South Africa:

"If it is just physical upgrading you are doing then the project can be finished in a few days. You don't need to do much work, you can just send a contractor to do it. But the people won't be changed. Their capacities won't be changed. Their relationships won't be changed, they will still be a poor, vulnerable, marginalized and unorganized group of people who happen to live together in the same slightly improved informal settlement" (SDI 2016)

Upgrading can be seen as a challenge to conventional government 'housing for low income groups' programmes, most of which are ineffective as they are located far from labour markets and impose costs that low-income households have difficulty affording (Buckley et al 2016). Many also suffer from poor maintenance. The South African government has long had a major programme of support for new housing for low income groups but little support for upgrading. This is beginning to change – and the national development plan calls on government to "stop building houses in poorly located land and shift more resources to upgrading informal settlements provided that they are in areas close to jobs" (South African SDI Alliance 2013). Balancing the locational needs of low-income groups, and exposure to climate change-related hazards, will be one of the most critical decisions to be made when considering whether upgrading is appropriate in any particular location.

3.5 Community-led upgrading

There are many initiatives in urban areas of Asia and Africa that contribute to upgrading that are not labelled as such. For instance, the hundreds of community-designed and managed toilets and washing facilities in informal settlements in Mumbai (Burra et al 2003) would not be labelled as

upgrading. In many informal settlements, there are improvements in basic services that come from pressure from residents or their community organizations on local governments although these are usually partial and not always of good quality.

However, the last twenty years have brought many upgrading initiatives driven by community organizations formed by their residents. These include many initiatives by federations of slum or shack dwellers that are active in over 30 nations. These have been supported by Slum/Shack Dwellers International (SDI) and the Asian Coalition for Housing Rights (ACHR). These have also developed methodologies to document and map informal settlements and this can also provide the information needed for community-led upgrading and registering of land titles.

One of the main constraints on upgrading informal settlements is the lack of data on their residents and structures, on land tenure - and often a lack of street names and legal addresses. Developing an upgrading programme in high density informal settlements that residents approve of is time consuming and expensive if done by professionals. It often has to deal with conflict (for instance between tenants and landlords) and with residents' hostility to interviewers (for instance as they fear the survey is a prelude to their eviction) (Weru 2004).

But there are many examples of community-organization-led upgrading schemes that have done this successfully. This was noted in the IPCC's 5th Assessment: "In a growing number of cities, residents' organizations supported by grassroots leaders and local NGOs are mapping and enumerating their informal settlements with eventual support and recognition from city governments (Patel and Baptist, 2012). This provides the data and maps needed to plan the installation or upgrading of infrastructure and services. Some of these enumerations also collect data on risks and vulnerabilities to extreme weather and other hazards" (page 582) (see Livengood and Kunte, 2012, Karanja 2010). There is the potential to tailor mapping processes towards collecting data on climate-related hazards, such as to identify areas that flood or areas with limited access to tap water. All the data is presented back to the residents to engage them in designing the intervention.

In Epworth (Zimbabwe), the Local Board used the enumeration conducted by the Zimbabwe Homeless People's Federation to develop an *in situ* upgrading plan for an area with high levels of informal housing (Chitekwe-Biti et al 2011). The South African SDI Alliance has secured two government tenders to profile and enumerate over one hundred informal settlements to inform city-wide urban planning (SDI 2016). The Kenyan Homeless People's Federation has undertaken upgrading schemes in several informal settlements – and they are developing an upgrading scheme for the 101,000 households that live in Mukuru (Nairobi) with support from local government (Lines and Makau 2017). The Kenyan federation also showed how it was possible to get agreement between landlords and tenants in upgrading Huruma, an informal settlement in Nairobi with 2,800 household (Weru 2004).

In Pune (India), in situ upgrading in Mother Teresa Nagar managed by *Mahila Milan* (Women Together, a federation of women slum and pavement dweller savings groups) showed how upgrading was possible despite very high densities and space that had to be cleared to allow infrastructure in. Rehousing was minimized and those that had to move were rehoused in four storey buildings within the settlement (Patel 2013). In Thailand, within the CODI programme described below, where densities were high, community-directed upgrading was often in the form of two or three storey terraces as these can accommodate 200 or more households per hectare (Boonyabancha 2005). For Dharavi in Mumbai with several hundred thousand inhabitants and

thousands of enterprises in two square kilometres – upgrading is being organized in small clusters in which agreement is reached among all the residents in each cluster as to how upgrading will be implemented. All these community-driven upgrading schemes have relevance for climate change adaptation, in part because of what they achieve on the ground that contributes to resilience, in part because they have the institutional capacity to do so.

In Thailand, the *Baan Mankong* (secure tenure) programme implemented by the Community Organizations Development Institute (CODI) is a mix of government-supported upgrading led by community organisations. CODI is a national government agency that provides infrastructure subsidies and housing loans direct to community organizations formed by low-income inhabitants in informal settlements. The community organizations plan and carry out improvements to their housing or develop new housing including negotiating to purchase or lease the site or part of the site from the owner. If this is not possible, they find another site close by. Then they can work with local governments or utilities to provide or improve infrastructure and services. CODI has particular significance in three aspects: the scale; the extent of community-involvement; and the extent to which it seeks to institutionalize community-driven solutions within local governments. It is also significant in that it is funded by domestic resources – a combination of national government, local government and community-contributions. By 2017, more than 100,000 households have benefitted from this programme (Boonyabancha 2005, 2009, Shand 2017).

In all of the above examples, the upgrading has met deficits identified by local residents in terms of infrastructure and housing. This helps to address some of the climate-related and other hazards the settlements face – however, as discussed below, without access to adequate information and downscaled climate projections in an accessible form, there is a risk that future climate impacts are not taken into account when planning upgrading initiatives.

3.6 Relocation and new build

Most inhabitants of informal settlements would move to formal settlements if these better met their needs and capacities to pay. This is especially so if they currently live on sites that are particularly at risk to extreme weather, to eviction or to other shocks and stresses. The CODI programme described above focused on supporting community organizations to buy land they already occupied – but where this was not possible to support them finding and acquiring lands close by. There are some examples of urban governments successfully providing 'formal' alternatives – in Ilo, Peru through providing cheap 'formal' plot (López Follegatti, 1999), in Solo, Indonesia through providing financial support to households living in sites that got flooded regularly to find and build on safer sites (Taylor 2015), in Windhoek by making the cost of formal plots cheaper (reducing minimum plot sizes and infrastructure standards) (Mitlin and Muller 2004). There are also many examples of less success – including many nations and cities where governments have very large scale 'low-cost' housing that either never got allocated to low income groups or whose poor quality and distant location made them unsuitable (Fiew and Mitlin 2018, Buckley et al 2016, Rojas 2018). But despite these examples, many governments still favour large an expensive public housing programmes, in part supported by pressures from the private sector construction companies, in part because they are easier to administer, in part because they are politically more visible (see Patel 2013). Rojas (2018) notes that the funding for these policies would have been a lot more effective if made available to city governments to expand infrastructure and services.

Most urban governments find it difficult to get access to land that can be developed for housing. This encourages them to develop sites for low-income housing on the periphery of the city where land costs are lower and land acquisition easier – but this also means locations distant from labour markets and services (which is why people do not want to move there). Residents of an informal settlement on a dangerous site may not want to move (see Neto and Heller 2016) – but what limit is set on how much to invest to protect an area and justify an upgrading programme rather than relocation? But at least in two cases, relocation from dangerous sites was successful because those who were moved were organized and engaged in finding solutions that worked best for them (Patel et al 2002, Lines and Makau 2017).

3.7 NGO-led upgrading

Some of the most successful upgrading programmes have been driven by local NGOs working with residents and their organizations who then built partnerships with local governments. The Orangi Pilot Project Research and Training Institute has implemented one of the largest and most successful informal settlement upgrading programmes bringing together household and community investment and government investment – thus integrating community systems to city-wide systems. This began by supporting households in each lane in Orangi (an informal settlement in Karachi with over one million inhabitants) to plan, implement and finance the 'internal components' of high quality sanitation systems - sanitary toilets in the houses, underground sewers in the lanes and neighbourhood collector sewers. Then it showed how it was possible for local governments to plan, finance and implement the larger 'external' trunk sewers into which the neighbourhood sewers feed and 'end-of-pipe' treatment plants. In each lane, the inhabitants had to raise the funding to cover the costs of the street and neighbourhood components (the small pipes) and in over 300 locations in Pakistan, communities have financed, managed and built their own internal sanitation systems. Local governments were then able to install the external systems (the big pipes) as they no longer have to fund and manage the 'small pipes' and as the NGO helped them develop lower-cost methods for planning and building trunk sewers and supported the conversion of open drains to closed drains (Hasan 2006). Similar approaches will need to be developed that engage with protective infrastructure to reduce the effects of climate change-related hazards.

The Asian Coalition for Community Action (ACCA) developed a novel way to catalyse community-driven upgrading (Archer 2012, Papeleras et al 2012) through supporting over 1,800 small community upgrading projects and more than 100 larger housing initiatives – working in 215 cities in 19 different nations. ACCA provided community organizations with up to US$3,000 with the flexibility to choose what to do. The most popular interventions were improvements in water, sanitation, drainage, solid waste management electricity and street lights and community centres. In each city, the community organizations undertaking ACCA supported initiatives go together to present their work to city government. In most of the cities, some kind of joint working group has been established at the city level to provide a platform for community networks, city governments, civic groups, NGOs and academics to plan and to manage the upgrading; and to identify responses to land issues. In many of the cities involved in the ACCA programme, new local funds have been developed, jointly managed with local government (Boonyabancha and Mitlin 2012). As of 2014, of the 136 city funds existing across 19 Asian countries in the ACHR network totalling USD 21.6 million, communities had contributed USD 15.26 million while governments had contributed USD 2.1 million, with the rest coming from project funding and other sources (ACHR, 2017).

There is a growing recognition of the need to match the growth in the competence and capacity of community organizations in upgrading with the flexible funding they need to expand the scale and scope of what they do – and to support partnerships with local government. As described above, CODI provided this. The initiatives of the Kenyan Homeless People's Federation *Muungano wa Wanavijiji* have support from the Akiba Mashinani Trust which also raises and manages bridging finance. The Trust has provided 7,000 households with loans for shelter upgrading as well as supporting many community-led upgrading (Weru et al 2017). The National Slum Dwellers Federation in Uganda and the government of Jinja City have set up a jointly managed Community Upgrading Fund (Shand 2017). SDI manages the Urban Poor Fund International that draws support from international donors and this in turn supports many community-driven upgrading programmes (Shand 2017). These funds provide potential entry points for funding for climate-related interventions, as prioritised and implemented by local communities – including resources from climate funds.

3.8 The potential of upgrading for addressing urban risk

Upgrading has significance for climate change adaptation since good quality 'risk reducing' urban infrastructure and services and better housing quality are at the centre of reducing risks from extreme weather – and as noted earlier this is acknowledged by the IPCC. Upgrading can also support low carbon development pathways in that most upgrading takes place in dense clusters of housing with upgrading able to support high levels of walking, bicycling and use of public transport. However, this needs to come with support to local community organisations, NGOs and local governments to access and interpret climate data, so that their interventions can be sufficiently forward-looking. Gaps in downscaled data also need to be addressed, as this rarely is available at the city-scale.

There is the issue of how well upgrading serves groups that are more vulnerable to many risks (see Box 3). For instance, how well does upgrading reduce risks to which infants or children are particularly susceptible? Does it address discrimination (for instance on the basis of age, sex/gender or social group). If upgrading includes providing land tenure, this may exclude tenants (although as noted above this can be avoided). It may discriminate against women in the allocation of tenure

Thus, there is a need to consider who is excluded from or disadvantaged in accessing housing, land and land tenure and financial services. Also, who is excluded from being active politically and having leadership roles. There are important gender dimensions to these. Discriminatory inheritance and divorce practices can exclude women from owning or realising the value of land and property; gender norms can stigmatise single or divorced women from renting or living alone and make it harder for women to access credit (Chant and McIlwaine, 2016; Rakodi, 2014; Moser, 2017; Chitekwe-Biti and Mitlin, 2016). Unnpaid domestic care burdens and lower incomes limit access to good-quality shelter and infrastructure (*ibid.*). In many cities, women are disproportionately represented among renters due to these overlapping, gender-inequitable barriers to home-ownership (Rakodi 2014).

However, enhancing women's property ownership through land certification programmes (especially joint tenure of marital property) has been shown to expand women's agency and provide them with greater levels of economic independence. There are also the many examples of upgrading that had a strong engagement with community organizations (especially savings groups where most members and managers are women) that ensure that all residents benefit – including women, children, the elderly, and those with disabilities (Colenbrander and Archer, 2016).

Since any individual or group is only vulnerable when exposed to risk, they are no longer vulnerable if successful upgrading removes the risk. When vulnerability assessments are locally owned but feed into wider planning processes the act of collecting and analysing data can itself build local capacity and enable a more equal conversation between those at risk and urban planners or developers

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Box 3: Vulnerability in informal settlements

Assessments of vulnerability have particular importance for highlighting individuals or groups among informal settlement residents who are more sensitive to/impacted by risks and/or less able to cope and to adapt. They can also assess who is more at risk because of discrimination on the basis of (for instance) gender, caste, class or being a migrant – which may mean vulnerability in regard to many risks.

So vulnerable individuals or groups are:

- *Those who are more susceptible or sensitive to any of the life or health threatening risks evident in poor housing, living and working conditions* including lack of capacity to cope or beyond this to adapt
- *Those whose age, sex or health status* make them more susceptible to particular hazards and/or have limited capacities to avoid hazards, cope with them or adapt including through transformative pathways.
- *Those individuals or groups that face discrimination that decreases their capacities to cope and to adapt* and transform and may increase risk levels
- *Those with less (household and collective) capacity to cope and to adapt* (i.e. reduce exposure to hazard)

There is also the issue of whose time and effort is expended in making up for the absence of formal service provision – the time and effort needed to access and bring water and fuel (often from distant sources) to manage disposal of household toilet, liquid and solid wastes and/or access to community or public toilets, to nurse sick or injured family members…… this does not get covered adequately within the discussions of vulnerability. Responsibilities for these usually fall to women.

At present, the international funds that are meant to support climate change adaptation do not see informal settlement upgrading as a priority. They also lack the structures to engage with local governments and local civil society organization to make this happen. The potential is there for a very large expansion in upgrading, with local government and community support and with the international, national and city funds through which to channel funding in place. National governments, donor agencies, and international climate finance institutions will require clearer evidence about the role that upgrading plays in increasing climate resilience, if they are to support this more extensively.

4: Addressing development, mitigation and adaptation in informal settlements

4.1 Lack of evidence

Whilst the previous section highlighted the importance of upgrading to development and disaster risk reduction, there remains a lack of evidence on the complex interactions between these – and between climate mitigation and adaptation. We need to learn more on the effectiveness of potential synergies between these agendas and of trade-offs. Thus, there is an urgent need for research on

the preconditions and contingencies for a successful transition to low-carbon, climate and disaster-resilient, health enhancing urban development. This research needs to assess what can be learnt from participatory and negotiated processes to determine what 'success' might look like in diverse contexts and for diverse interests (Colenbrander *et al.*, 2016; Ziervogel *et al.*, 2017). Questions of equity and justice need to be at the heart of this research agenda, or low-income and other marginalised groups who have contributed the least to climate change will also bear most of the costs from direct and indirect impacts. However, it should be noted that development/poverty reduction, disaster risk reduction and climate change adaptation share a focus on identifying and acting on local risks and their root causes, even if they have different lenses through which to view risk.

4.2: Balancing development, adaptation and mitigation

For one informal settlement upgrading programme in Guatemala City, the residents felt that it was 'cementing poverty, putting a roof over its head' when what they needed most was adequately paid jobs (Diaz et al 2001). While provision of all the 'risk reducing' infrastructure and services to informal settlements brings much improved health, better possibilities of home-based work and more time (for instance cutting time lost to accessing water), it does not address their lack of income. The scale and depth of urban poverty has been under-estimated because poverty lines have not recognized the high costs that low-income city dwellers face for rent and for (often informal) service provision (Mitlin and Satterthwaite 2013). The upgrading programmes described in this paper certainly contributed to reducing urban poverty – but by themselves, they cannot remove it.

Across Africa and Asia, urban residents with lower per capita incomes use less energy and produce much lower greenhouse gas emissions than their higher-income counterparts (Marcotullio *et al.*, 2013). However, the infrastructure deficits they face also theoretically creates opportunities to 'leapfrog' to low or zero emission systems and structures. Leap frogging entails avoiding the less efficient, more expensive or more polluting development trajectories of high-income countries and moving directly to good practice options (Unruh and Carrillo-Hermosilla, 2006) - for instance low-carbon options for transport, settlement designs, home energy use, public space and waste management. Successful leapfrogging will require decision-makers to re-imagine service and infrastructure provision in informal settlements in an affordable, low-carbon way.

Climate commitments and innovations could create new incentives and opportunities for pro-poor urban planning and policy, particularly with respect to improving livelihoods, access to services and environmental health. Low-carbon considerations reinforce the importance of ensuring that walking and cycling are safe and attractive modes of transport (Cervero, 2013), and of supporting urban forestry and agriculture that can sequester carbon while enhancing livelihoods and resilience (Lwasa *et al.*, 2014, Roberts et al 2012). The modular design of many renewable energy technologies could allow incremental deployment as incomes and energy demand grow (Colenbrander *et al.*, 2015), while environmentally friendly building materials can improve the quality and reduce the cost of low-income housing (Dobson *et al.*, 2015). Emission reduction policies can deliver improvements in air quality – so much needed in the hundreds of cities with air pollution concentrations far above WHO guidelines.[4] Domestic energy programmes that support shifts from dirty to clean fuels reduce indoor and outdoor air pollution and generally lower carbon emissions – with most of the health benefits being captured by low-income groups (Slovic *et al.*, 2016). Good practice in solid waste

[4] http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/

collection and management supports resource recovery, re-use and recycling and there are many examples of municipal authorities doing this, working with and supporting the work of waste pickers. However, there are also many examples of solid waste collection being contracted out with large disadvantages in regard to waste recovery (and less waste to dispose of) and cost.[5]

However, in many cases, there are also tensions between the development, mitigation and adaptation agendas in informal settlements. For mitigation, many climate-compatible options require greater planning and technical capabilities than conventional approaches or involve paying a premium. For example, mass transit, energy-efficient buildings and renewable technologies have higher capital costs than fossil fuel generation or road networks, even where they prove more economically attractive in the longer-term (Gouldson *et al.*, 2015). Their delivery depends on strategic public sector-led investment, which has been notably absent in informal settlements.

Established development priorities and planning practices in functions like land-use management, construction, or infrastructure provision may not be aligned with the goals or practice of adaptation. Combined with the lack of accountable and transparent governance systems, local populations find themselves without government support to address their development and adaptation needs. There may be trade-offs among different temporal and geographic scales, or among economic, cultural and ecosystem functions (Chelleri *et al.*, 2015). For the many informal settlements located on sites at risk from floods and landslides, there are examples of successful relocation (see Velasquez 1998 and Valsagna, Tejedor and Botteron 2017) but also examples of residents not wanting to leave (see Neto and Heller 2014).

4.3: Urban form

Urban form and structure have significant implications for the carbon intensity of urban activities (Seto et al., 2014). With rapid urban population and economic growth in much of Asia, decisions made around spatial patterns of infrastructure investments and land-use arrangements today will strongly influence whether urban areas will be able to reach net zero emissions in the second half of the century (Creutzig *et al.*, 2015). From a mitigation perspective, global evidence suggests that decision-makers should promote compact urban form, with high average population densities, mixed land use and good connectivity through high quality bus and rail. This can reduce greenhouse gas emissions by reducing demand for intra-city transport (especially for private car use), emissions from the construction of networked infrastructure and land use management and change around the urban periphery (Seto *et al.*, 2014).

However, many cities in the global South already have very high population densities: Dhaka has 44,500 people per square kilometre, followed by Mumbai (31,700), Medellin (19,700), Manila (14,800), Casablanca (14,200) and Lagos (13,300) (UN Habitat, 2017). For these and other cities, planning or managing land use and infrastructure provision in their (often low density) peripheries is key, both to compact urban forms and to increasing the supply and reducing the cost of housing plots (see for instance Patel et al 2018).

Most informal settlements are a combination of very high density and one or two storey buildings with lack of access roads. Their high densities mean economies of agglomeration for the costs of

[5] http://www.wiego.org/informal-economy/occupational-groups/waste-pickers

upgrading. So upgrading can also retain the advantages of compact urban form. But without needed infrastructure and services (especially good quality toilets, piped water in each home and solid waste collection) high population densities bring high health burdens (premature death, illness and injury) (Ezeh *et al.*, 2017).

In addition, fierce competition for limited urban land resources and weak governance can result in exclusionary and inequitable forms of urban development (Zhu, 2012). Efforts to replace or redevelop informal settlements in pursuit of 'smart' or 'green' cities has often led to the eviction of low-income households, and their displacement to peripheral urban areas with longer commutes and poorer service provision (Revi and Rosenzweig, 2013). This contributes to urban sprawl and increases exposure to economic, social and environmental risks. It is also difficult (and expensive) to provide infrastructure to low-density peri-urban development or to retrofit it to reduce greenhouse gas emissions.

Spatial planning and strategic infrastructure investment to promote high but liveable density could improve the lives of low-income urban residents. Higher population densities reduce unit distribution costs and permit economies of scale and agglomeration, enabling cities to drive down the average per capita costs of infrastructure and service provision (Turok and McGranahan, 2013). Avoiding sprawl can preserve biodiversity and ecosystem services around the urban periphery, which can enhance resilience to climate-related shocks and stresses (Campbell-Lendrum and Corvalán, 2007; McPhearson et al., 2012). Compact urban forms can enhance access to jobs, services and amenities (Ahlfeldt and Pietrostefani, 2017), and reduce the probability that low-income residents will need to live in hazardous areas within and around the city in order to enjoy the benefits of proximity (Dodman *et al.*, 2017). However, the potential benefits of higher urban population density will only be realised through inclusive approaches to development, where aspirations for compact urban form are accompanied by *in-situ* upgrading of informal settlements. Secure tenure and investment in basic infrastructure (piped water, sewers, drains and mass transit) are particularly important to anchor urban form and to minimise the costs of density and risks of displacement.

4.4: Buildings, shelter and infrastructure

For individuals and households, living in a well-built, affordable house in a safe, legal location is one of the most critical determinants of their resilience. But for many residents of informal settlements, both the location of the dwelling and the quality of the shelter it provides are vastly inadequate in providing protection from current climate variability and future climate change. The factors shaping urban land use, and the outcomes this generates in terms of the location of low-income and informal housing are addressed elsewhere in this paper; this sub-section focuses primarily on the quality of buildings in informal settlements and approaches that can be taken to develop better shelter for their inhabitants.

The characteristics common to most informal settlements were noted already – mostly low-rise, poor quality housing, high densities, lack of urban infrastructure and services….and often on dangerous sites. We also noted earlier how the IPCC 4th and 5th Assessments identified informal settlements as being particularly at risk to the impacts of climate change. Good quality housing has an important role in linking disaster risk reduction and post-disaster recovery with climate resilience (Moench et al, 2017). Housing should also protect household assets. It is frequently the place where

household members earn a livelihood (particularly for women as home-based workers), and a site where particular vulnerable persons may live – the elderly, those with disabilities or very young.

One indicator of the relative roles of 'formal' and 'informal' housing is the proportion of city households living in formal housing – and how this is changing (Rojas 2018). What proportion of households can afford to buy, build or rent formal housing? As discussed already, government attempts to address this by financing large scale public housing programmes have long been known to be ineffective. But governments can have key roles in lowering the cost of 'formal' housing – through cutting the costs of getting land for housing, increasing serviced land (see Patel et al 2018 for how to support this through bus rapid transit), adjusting or removing inappropriate regulations (e.g. smaller minimum plot sizes), and supporting housing finance. Here, government acts as the enabler, as it supports the market to deliver quality 'formal' housing that lower-income groups can afford to rent or purchase.

Many case studies of informal settlements have made evident the ways in which households seek to cope with environmental risks including extreme weather (Stephens et al 1995, Wamsler, 2007; Adelekan, 2010; Jabeen et al 2010, 2010; Livengood and Kunte, 2012; Kiunsi, 2013). This includes modifying hazards or reducing exposure—for example, through ventilation and roof coverings to reduce high temperatures; barriers to prevent floodwater entering homes; keeping food stores on top of high furniture; having electrical systems as high as possible and moving temporarily to safer locations (Stephens et al 1995, Wamsler 2007, Douglas et al., 2008, Jabeen et al 2010, Revi et al 2014). Wamsler 2007 in particular highlights the many ways that households and communities can reduce risk through building improvements and site and other environmental improvements within the neighbourhood, and organizational, institutional and social measures including insurance – and how these measures also contribute to post-disaster recovery.

There are examples of efforts to implement climate resilient housing in an affordable manner, specifically with low-income populations in mind, though it is important to ensure that these designs are developed in such a way to ensure local input and cultural acceptability. In Gorakhpur, India, designs for flood resilient housing with raised plinths, second-storey bedrooms and screen brick-work techniques for improved ventilation, are estimated to be feasible for 18% less than the cost of standard construction, by using some low-cost materials such as bamboo (Moench et al, 2017). In Vietnam, designs for typhoon-resistant housing included thicker walls, positioning of concrete pillars, anchoring of roofing materials and establishment of safe rooms. These designs were estimated to increase construction costs by 33% compared to those who have no elements of typhoon-resistance in their housing. However, this cost would be recouped by avoiding the need for extensive post-disaster reconstruction (ibid). Retrofitting improvements to build resilience is possible – though in most cases, householders will want to ensure some measure of security of tenure before investing in their housing, and therefore this underlying issue must be addressed in order to enable the development of climate-resilient housing.

There are also opportunities for housing designs and technologies to produce mitigation co-benefits, for example with designs that maximise natural ventilation and reduce the need for cooling systems, or growing vines over roofs for cooling (Jabeen et al 2010, Haque, Dodman and Hossain, 2014). Affordable housing materials can also have environmental co-benefits, such as the interlocking soil-stabilised bricks developed by the National Slum Dwellers Federation of Uganda, which do not require firing and hence help reduce deforestation and are cheaper per metre than regular fired bricks (Dobson, Nyamweru and Dodman, 2015). However, these cheaper materials are sometimes available only in specific locations and therefore insufficient to meet the scale of need.

But there are many constraints on action for low-income households. They cannot provide the trunk infrastructure systems into which their settlement must integrate (paved roads and paths, piped water mains, sewer and storm drainage system, street lighting…). or manage land use in watersheds to reduce flood risk.

There are also the constraints on disaster response. Do warnings get issued in cities in anticipation of storms, high rainfall or heat waves? Do they reach the inhabitants of informal settlements? And if they do, can these inhabitants act on these warnings – for instance, is transport to safe sites provided? The inhabitants of informal settlements are often reluctant to leave their homes because of risks of looting or fears of not being allowed back – or from fears for personal safety in the areas to which they are meant to move (Jabeen et al., 2010; Hardoy et al., 2011).

In most cities and neighborhoods, where infrastructure coverage is incomplete and household incomes limited, community- based adaptation can contribute to adaptation and prepare for future risk – and support household adaptation. A range of studies document the depth of knowledge and capacities held by local populations around reducing exposure and vulnerability (Stephens et al 1996, Wamsler 2007, Anguelovski and Carmin, 2011; Dodman and Mitlin, 2011; Livengood and Kunte, 2012). For a high proportion of the households that live in informal urban settlements, household and community-based adaptation is their only means of responding to risk. But it too needs the trunk infrastructure and the land-use management for the wider city into which to integrate.

IFRC (2010) identifies three broad requirements for successful urban community-based disaster risk reduction that can be extended to assess coping and adaptive capacity: the motivation and partnership of stakeholders; community ownership, with flexibility in project design; and sufficient time, funding, and management capacity. The effectiveness of community-based action also depends on how representative and inclusive the community leaders and organizations are (Appadurai, 2001; Wamsler, 2007; Banks, 2008; Houtzager and Acharya, 2011; Mitlin, 2012). This includes their capacity to generate pressure for larger changes within government that also depends on the quality of the relations between community organizations and different levels and sectors of government (Boonyabancha and Mitlin, 2012, Arputham 2016).

But considering again city-wide problems, upgrading informal settlements needs to be complemented by growth in the housing stock including housing that is affordable to households currently living in informal settlements. Well located informal settlements are densifying (see Hasan 2010). Accommodation there may be becoming increasingly expensive, especially if the settlement is upgraded. Low-income households may be forced to move by rising rents. Large scale upgrading can help limit this. But as importantly, most city governments need to greatly increase the supply and reduce the cost of serviced land plots that low income groups can afford and that are well located in relation to income earning opportunities. So a larger supply of well-located serviced land for housing widens choices for low-income households. Communities that are engaged in upgrading may choose to develop community-ownership of their land that can limit informal settlement ‘gentrification’ (Boonyabancha 2005).

4.5 Knowledge and capacity

Municipal plans need to draw in all key actors, so they come to understand different urban pressures and get agreement on the needed trade-offs (Hardoy et al 2017). Participatory decision making is essential where uncertainty and complexity characterize scientific understanding of policy problems (Funtowicz and Ravetz, 1993; Liberatore and Funtowicz, 2003). It will need to take into account

uncertainty about future climates and extremes (Revi et al 2014) and the complexity and dynamics of evolving socio-ecological systems (Ibid, Kennedy et al., 2011). A lack of understanding of how the different services and infrastructure connect to reduce risks can mean priorities/demands focus on the most visible everyday problems or the most frequent disasters, not necessarily those that generate the greatest risks. For instance, the main causes of infant and child deaths in informal settlements – typically diarrhoeal diseases, acute respiratory infections and often malaria – often get left out of discussions of risk (Mitlin and Satterthwaite 2013). But drawing from recent dialogues with city governments in Latin America, Hardoy et al 2017 stress the importance of cities not delaying action or embarking on developing complicated scientific information systems; the issue in many cities is more about integrating existing information (that is also in similar formats – e.g. geo-referenced what is possible), common language, easily accessible to all/ and up dated easily, and co – built with all local actors/owned locally.

To avoid maladaptation in housing design and ensure most effective use of resources, climate science and models should be accessible to those agents making decisions about housing investments – including home-owners. Expert input by architects or engineers may be necessary, but their designs need to be developed in a responsive and consultative manner to ensure that local needs are incorporated, in order to maximise take-up. The architects and engineers themselves should also be aware of climate projections to incorporate these in their designs. Community architects are particularly skilled in working on participatory, affordable designs in response to community needs, making use of local materials where appropriate. Community architects can play a role in bridging the physical and social aspects of housing and neighbourhood design (Archer, Luansang and Boonmahathanakorn, 2012) – and there is an opportunity here to insert consideration of local climate risks into this process. For this they may require training to raise their own understanding of local climate risks and projections and how to communicate this effectively, and ensure these considerations get discussed with residents in inclusive ways and are then integrated into housing designs and site layouts.

The government can play a role in facilitating the take-up of such technologies and designs through targeted financial mechanisms such as micro-credit or subsidies, expert support in housing design, and improvements to other integrated urban systems such as water supply, drainage and power supply which will affect the resilience of housing (Moench et al, 2017). Whilst building regulations may also be used to this effect, in many instances regulations help make housing unaffordable –so putting in place by-laws to take into account the particular needs of low-income populations, and building regulations supporting incremental constructions, would be more responsive to local needs and capacities.

Local organisations can also facilitate take up – for example, as part of the ACCCRN initiative[6], the Women's Union in Da Nang, Vietnam, made available low-interest finance for members to reinforce their homes against storms through a pilot program for 400 households. The Women's Union staff also received training on climate change and disaster risk reduction, whilst local builders were trained in building and design of resilient low-income housing (Reed, 2013). Another project in Da Nang saw seed funding from GIZ in partnership with the city government and the Association of Vietnamese Cities (ACVN) for a community-level climate fund in Hoa Hiep Bac Ward. This fund was managed by the community for upgrading and strengthening housing, adaptation of income-generating activities, planting trees and purchasing shared back-up generators.

[6] The Asian Cities Climate Change Network https://www.acccrn.net/

4.6: Industry / livelihoods

We noted earlier how in almost all nations in the Global South, more than half the non-agricultural workforce work in informal employment; the proportion exceeds 80% in some countries (Chen 2014). Also, how 'informal' employment covers many categories including those employed in informal enterprises and those in informal employment within formal (public or private) enterprises. How the informal economy also represents an important part of the national economy. And the particular importance of the informal economy for women, including home-based workers.

As with land use, buildings and infrastructure, an adaptation and mitigation lens can be brought to livelihoods and to the new employment possibilities generated by good management of eco-system services and of waste (Roberts, Boon, Diederichs et al 2011). Below, we give an example of how waste collection and management can contribute much to livelihoods while also keeping down greenhouse gas emissions.

Most cities in the Global South have large and important informal 'waste' economies that grow where formal systems do not operate – for instance in the collection and disposal of households' solid, liquid and toilet wastes. It is also common for large concentrations of waste pickers to work on formal and informal solid waste dumps and for there to be high levels of resource recovery. Informal settlements often develop next to waste dumps and contain many enterprises cleaning and sorting waste and organizing its sale.

How the 'waste' economy is managed has importance for development, for climate change mitigation and often for disaster risk reduction and climate change adaptation. Regarding development, informal settlements usually lack a regular household waste collection service which means households use nearby informal dumps (or just open spaces or drains) or they seek to bury or burn it. Local authorities generally lack the means to act (the trucks and equipment they have with a capacity far below what is needed) or to provide accessible and well-managed disposal sites. Or as an alternative, they contract out collection services.

The 'waste economy' in cities in low- and middle-income nations is important to the green economy, providing livelihoods and contributing to waste reduction and GHG emission reduction (Ayers and Huq, 2009). But local governments generally ignore the large informal system for waste collection, waste-picking, sorting and re-use/recycling. They do not see the contribution of informal waste collectors and pickers to serving households, cleaning streets and reclaiming waste, saving city governments large amounts of would-be expenditures as well as reducing carbon emissions (Scheinberg *et al*, 2010).

The ways city governments choose to work with (or ignore) those in this waste economy have obvious implications for employment and for resource use. Rather than ignoring it (or considering it as illegal), city governments can incorporate the informal waste economy into a more effective city-wide waste collection and management systems. Organizations of waste pickers in India, Argentina, Brazil and Colombia, have fought legal cases to secure the right to bid for solid waste management contracts, with some success (Chen, Roever and Skinner 2016).

Chen, Roever and Skinner (2016) suggest three needed lines of action for informal workers: "reduce the negatives" - for instance stopping the harassment and evictions by local authorities; "increase the positives" – that includes establishing informal workers' legal identity as workers and pushing for regulatory reforms that recognize their work and contribution to the economy; and access to

infrastructure and basic services for informal workers at their workplaces, whether in public space or in their homes. They also point to many positive examples of change driven by grassroots organizations formed by those working in the informal economy. These include examples of legal cases and campaigns to persuade municipal officials and urban planners to take home-based producers and street-based vendors into account when they develop local economic, housing, land use and zoning plans.

4.7: Drainage, sanitation, waste and water

The IPCC's 5th Assessment (WGII) highlighted the very large deficits in provision for water, sanitation, wastewater management and drainage among urban centres in low-income and many middle-income nations. Most of the deficits are in informal settlements, although provision for these is so inadequate in many cities that it impacts on middle income groups and 'formal' housing. "Reducing basic service deficits and building resilient infrastructure systems (water supply, sanitation, storm and waste water drains, electricity, transport and telecommunications, health care, education, and emergency response) can significantly reduce hazard exposure and vulnerability to climate change, especially for those who are most at risk or vulnerable" (Revi et al, 2014, page 539)

Upgrading informal settlements should be the means by which deficits in provision for these are cut – and in many cities in Latin America, conventional systems have been extended to many informal settlements. But a large proportion of the urban population lack good provision for water and sanitation (WHO and UNICEF 2017), especially in sub-Saharan Africa and Asia and it is likely that much of this population are living in informal settlements. We noted earlier that households and community organizations can contribute to resilience within their settlements, but they cannot make the investments needed in district and city-wide storm and surface drains and watershed management to reduce the volume and velocity of flood waters. Wastewater and sanitation systems will be increasingly overburdened during extreme precipitation events if attention is not paid to maintenance, the limited capacity of drainage systems in old cities, or lack of provision for drainage in most unplanned settlements and in many urban centres (see Douglas et al 2008).

Managing water, waste water management and storm drainage usually needs a city-region perspective – for instance for protecting watersheds (important for water supply and often for disaster risk reduction) and coping with storm and surface run off. This often means a need for agreement between city government and different local government jurisdictions around the city – for instance on watershed management to reduce the volume and slow the speed of flood waters for the city

4.8: Public space

The informal processes by which cities develop and expand outside the control of a functioning public land use management framework usually means very little land is allocated to public space. Or there are no controls over encroachments onto public space. At the city scale, spaces on streets, sidewalks and traffic intersections are the place of work for many fixed-site and mobile traders, who provide goods and services to consumers at all times of day. Other commonly used public places are parks and municipal markets. But access to use of these spaces by traders and vendors is often contested and they may be prevented from being there – or fined or arrested or their goods confiscated (Chen, Roever and Skinner 2016).

Public space limitations are even greater in most informal settlements that have very little public space and trees - especially in the better located settlements that have high land values. What public spaces exist are usually not well managed – and often sites with uncollected domestic wastes.

There are no 'cooler' public spaces to help moderate extreme temperatures and where residents can go to get some relief from the very high temperatures within their dwelling (see Scott *et al.*, 2017).

But it is common for informal settlements to have indoor and outdoor community spaces that residents helped create. Many of the slum/shack dweller federations have built community or resource centres which is where the federation savings groups meet and keep their records. These are also used for training and hired out for weddings and parties. Many meeting rooms have been built on top of community toilets (see Burra, Patel and Kerr 2003) – so they avoid the difficulties and costs in getting land (d'Cruz with Patel and Mazvi 2014). Formal schools located within informal settlements often have some outdoor space such as playgrounds that can be used by residents - and schools may provide indoor spaces for community meetings outside teaching hours.

Community-driven reblocking in informal settlements can enlarge open spaces, as in the secure tenure programme of the Community Organizations Development Institute that was described in section 3.4 (see Boonyabancha 2005, Shand 2017). Community planning in Cape Town made use of lost space between communities to create more useful space. By realigning their internal spaces and pathways, communities were able to create open space within their settlements for women children and young people to have safe spaces to socialize (d'Cruz with Patel and Mazvi 2014).

The lack of open space in any settlement usually means intense use of paths and streets. For instance, in Kisenyi, one of the largest informal settlements in Kampala, groups gather around porches, courtyard verandas and other open spaces to cook dinner, chat, wash clothes and play (ibid).

Given the intense competition for land in cities (in both formal and informal markets), it is difficult to see how to better meet needs for public and open space both within informal settlements and within the larger city. At city level, there are examples of elected city governments that have substantially increased parks and other public spaces. In Rosario (Argentina), this was achieved through the city government working with private landowners to restore the riverbank area and create many new neighbourhood parks, pedestrian zones, public beaches and themed educational parks for children (Almansi 2009). Attention to climate change issues have been added onto this (Hardoy and Ruete 2013). The city of Manizales in Colombia greatly increased public space by a relocation programme for the inhabitants of informal settlements on sites at high risk of landslides – but then using this land for eco-parks managed by community organizations (Velasquez 1998). The city of Santa Fe in Argentina is combining a relocation programme for those who settled in flood risk areas with the creation of a nature reserve (combining education, environmental protection and flood risk reduction) and the creation of a city park on a former landfill with green and blue infrastructure initiatives (Valsagna, Tejedor and Botteron 2017). The city of Durban has recognized the importance of land use management in and around the city that protects the globally significant biodiversity and the eco-system services on which the city depends while also supporting new 'ecopreneur' employment opportunities as foundations for ecosystem-based community and city climate change adaptation (Roberts and O'Donoghue 2012, Roberts, Boon, Diederichs et al 2013).

4.9: Urban ecology

Green and blue infrastructure provide a wide range of ecosystem services for urban areas that are significant for human wellbeing, climate mitigation and adaptation and can be significant for disaster risk reduction. These are commonly categorised as provisioning services (such as food and water supplies), regulating services (such as temperature control), cultural services (such as recreational space) and supporting services (such as nutrient cycling). The functioning of cities, including informal

settlements, is dependent on ecosystem services produced far beyond municipal boundaries. Urban residents depend on the hinterland for both consumption and waste absorption (Gómez-Baggethun *et al.*, 2013), and the movement of people, goods and capital between rural and urban areas is important for both individual livelihoods and city-scale processes of development (Tacoli, 2006). While the quality of the regional environment has significant implications for the wellbeing of all urban dwellers, this section focuses particularly on ecological conditions and impacts within informal settlements.

Green and blue infrastructure within informal settlements is often degraded. This is partially because many informal settlements are located in areas that are ecologically fragile and/or valuable, where formal development is prohibited (Benítez *et al.*, 2012). Many cities have informal settlements that developed in watersheds or around reservoirs and along river or canal banks and into which their wastes get disposed of.

Even small increases in pollution or changes in land use can negatively affect biodiversity and ecological processes in these areas (Roberts et al 2012) – and rapid urban expansion into these ecosystems constitutes a major disruption. Local ecosystem services are also likely to be degraded in informal settlements because of the absence of effective planning or infrastructure to safeguard natural environments. The absence of sewers or waste collection services, for example, means that residents of informal settlements often depend on rivers or lakes for disposing of their toilet wastes and/or household wastes (Vollmer and Grêt-Regamey, 2013; Corburn and Hildebrand, 2015). It is important to note that, even if inhabitants of informal settlements are more likely to live in degraded environments, they typically have small ecological footprints - much smaller than middle or upper income groups. It is also important not to confuse environmental health risks with environmental degradation.

Low-income and other marginalised urban residents are typically more dependent on ecosystem services than higher-income groups. Even in large cities, low-income groups are more likely to obtain food, water, fuelwood, medicines or other resources from urban wetlands, lakes and forests (Ward and Shackleton, 2016; Mundoli *et al.*, 2017). They are also more likely to use gardens for productive rather than ornamental purposes (Cilliers *et al.*, 2013). This dependence means that the wellbeing, livelihoods and resilience of low-income groups are more sensitive to decreases in the extent, quality or accessibility of green and blue infrastructure, including loss and damage attributable to climate change. For example, where lakes have been privatised, polluted or converted into recreational parks, the supply of provisioning ecosystem services can be affected. This particularly affects urban residents without reliable or sufficient incomes, who cannot afford to pay for these goods and services, and those without secure land tenure, who lack the option of establishing a private garden to produce them (Hettiarachchi *et al*. 2014; Derkzen *et al.*, 2017).

As noted above, informal settlements are often located in hazardous parts of the city, such as floodplains, low-lying coastal areas or steep slopes. These environmental risks intersect with social drivers of vulnerability such as low-income and gender discrimination, so that the most marginalised urban residents are most at risk (Porio, 2014). However, there is evidence that green and blue infrastructure can mitigate environmental risks in informal settlements. For example, it can contribute to floodwater retention and temperature regulation through evapotranspiration and shading (da Silva *et al.*, 2012). The extent and configuration of urban environmental spaces determine how effectively they can mitigate environmental risks. For example, evidence from Addis Ababa suggests informal settlements have higher proportions and better composition of green

space, so these areas have the lowest land surface temperatures in the city (Cavan *et al.*, 2014). By contrast, temperatures in informal settlements in Nairobi are several degrees higher than in many formal residential areas, which can be attributed to the lack of vegetation, high density and the high albedo of metal housing (Scott *et al.*, 2017).

Recognising and reconciling tensions between different development and environmental agendas is a major challenge. By definition, the informal nature of urban growth makes it difficult to safeguard ecologically significant sites, especially if these are well-located in relation to labour markets. Yet the loss of ecosystem function and services can compound poverty and increase vulnerability to climate-related risks. There are many documented examples of these conflicts and, too often, residents of informal settlements are excluded from the relevant decision-making forums (Harper *et al.*, 2011; Mehta and Karpouzoglou, 2015). However, there is a growing body of evidence on participatory approaches to urban environmental governance that can mediate these conflicts: for example, see van Horen 2001, Menegat 2002, Douglas 2016, Mguni *et al.* 2015, Seeliger and Turok 2014 and Sundaresan *et al.* 2016.

These studies underscore the importance of community-based strategies that seek to simultaneously improve opportunity, security and living standards, and that obtain support from municipal authorities and other formal actors. If environmental strategies do not address the priorities of residents of informal settlements, there is little prospect of establishing green and blue infrastructure in these areas at a scale sufficient to reduce climate-related risks or significantly contribute to other development goals.

5: Governance for urban adaptation

5.1 The role of effective urban governance

The IPCC's Fifth Assessment emphasized how urban governments are uniquely situated to understand local contexts, raise local awareness, respond to citizens' and civil society pressures (including face to face meetings), and work to build an inclusive policy space (Revi et al 2014, citing Grindle and Thomas, 1991; Brunner, 1996; Cash and Moser, 2000; Brunner et al., 2005; Healey, 2006). As the key components of climate change adaptation have become apparent, so too has the recognition that much of what has to be done falls within local government responsibilities.

Revi et al 2014 recognized two key governance issues for adaptation: the competence, capacity and accountability of urban (municipal, city, metropolitan) governments, and the measures taken at higher level (e.g. state and national governments) to support urban governments through cooperative multilevel governance. So, there is an interest in urban government capacity that at one extreme includes cities with relatively well-resourced local government institutions that can ensure provision of infrastructure and services and adherence to relevant codes and standards. But at the other extreme there are poorly resourced local governments unable to provide these or to put in place the framework ensuring provision by private, NGO or community enterprises. There is also an interest in how acting on climate change is influenced by the quality of local government and governance that ranges from cities with democratic and accountable local government structures to undemocratic, unaccountable and often clientelist local government. The examples given in the section on learning from upgrading initiatives highlighted the importance of this.

An IPCC assessment of adaptation capacity among urban governments showed that most had very little capacity or some capacity but as yet no willingness to act (Revi et al 2014). While there are many city governments taking steps to address adaptation and mitigation, they represent a very

small proportion of the world's urban population and are dominated by larger and wealthier cities, mostly from high-income nations. Meanwhile, the urban centres with least adaptive capacity are generally in low- and middle-income nations and these are also the urban centres with the largest deficits in infrastructure and service provision. These urban centres also house almost all the urban population living in informal settlements.

Climate change adaptation in urban areas (and its development underpinnings) are not possible if urban governments refuse to engage with their population living in informal settlements and working in the informal economy. This also needs a shift in how urban governments view and understand informality - to recognizing informal settlements and the informal economy as critical parts of the urban fabric and urban economy. Examples were given earlier of where this has happened. But many national and urban governments do not recognize this shift – and claim that the growth of informal settlements and of deficits in provision for infrastructure and services are caused by rapid urbanization or, for a particular city, rapid population growth.

But informal settlements can also be viewed as a failure of governance – as (mostly local) governments fail to meet their responsibilities for infrastructure and service provision and land-use management. There are also fast-growing cities where their governments did meet these responsibilities and have much smaller proportions of their populations in informal settlements. Adverse impacts in urban areas from natural disasters can also be seen as "a failure of urban management" (UN 2009) because of deficits in the infrastructure and services that should have anticipated and reduced disaster risk.

Both low-carbon and climate-resilient urban development are likely to be inhibited by the same constraints that have hindered more conventional forms of development: weak government and governance structures, scarce resources (including little investment capacity), constrained local powers, limited delivery capacities, vested interests, political disinterest in the urban poor and the presence of multiple competing priorities (Berrisford, Cirolia and Palmer 2018, UCLG 2014, Chelleri et al 2016).

5.2 Inclusive urban governance

As described already, most urban centres in Africa and Asia and many in Latin America have a substantial proportion of their residents living in informal settlements and engaged in informal livelihood activities. What local changes can address their needs while contributing to resilience and what roles for local government and local civil society? What aspects of this involve both the formal and the informal private sector, especially in relation to access to land and service provision?

So one important governance issue for informal settlements is the nature of their residents' relationship with (mostly local) government bodies and politicians and with utilities. How is their settlement viewed by local civil servants and politicians, and how is upgrading in them constrained (or prohibited) by their contravention of laws, rules or regulations?

How residents of informal settlements choose to organize, act, and interface with (mostly local) government has importance for what can be done (Herrle, Ley and Fokdal, 2015). So too has their learning of how to be more effective – both in the organizations they form and in how these interact with local government (Arputham 2008). Residents of informal settlements may favour a direct engagement – for instance as they lobby for particular changes such as upgrading or avoiding eviction or develop relations with particular civil servants or politicians. They may engage through a well-connected individual within a clientelist relationship. Or they may engage through

representative democracy - influencing government through voting for elected representatives (although as noted earlier, informal settlement residents may lack the documentation needed to get on the voter register).

For low-income groups living in informal settlements, the following political factors can facilitate or constrain their access to safe shelter and risk reducing infrastructure and services:

Politics of getting 'formal' infrastructure and services in informal settlements – which has to overcome hostility to 'illegal' settlements and often needs changes in law. Or they face particular difficulties extending formal provision – for instance, for water supplies, operating a billing system in settlements with no maps, street names and official addresses.

How politics influences the setting and applying of terms and conditions for informal settlements' access to formal infrastructure, including the costs of connections to infrastructure (e.g. piped water supplies, sewer connections, electricity grids) and the cost of services once connected

Politics of avoiding eviction: Informal settlements by definition have aspects of illegality (for land occupation, land use or structures) that governments can use as the justification for evicting their inhabitants. Residents of informal settlements facing eviction threats may undertake settlement-wide surveys to demonstrate to city governments their importance to the city economy and avoid displacement (Arputham 2008, Karanja 2010, Farouk and Owusu 2012).In Surabaya, the residents of informal settlements along a main river were being blamed for exacerbating flooding (claiming that they were disposing of their wastes into the river). When they were threatened with eviction, one response was to show how they should be seen as the guardians of the river, preventing waste disposal into it (Some et al 2009). Also important in many contexts, urban poor organizations use the law and courts to question the legality of evictions; however, the courts can act to legitimize evictions and to serve middle and upper income group interests (Bhan 2009). One important strategy of the slum dweller federations is for all households to collect documentation that shows and can legitimate their occupation (Arputham 2008, 2012).

Politics of relations with city, district and ward-level governments. Those living in informal settlements lack the protection of the law and are often impacted by exclusionary policies and practices of government at different levels. This may disadvantage particular groups such as recent migrants or particular ethnic groups or, (for many cities) refugees or internally displaced persons. The many slum/shack dweller federations and their support NGOs whose work was described in Section 3 have long recognized that the most powerful resource of any poor community is being organized - bringing its own ideas, resources and strategies to the table (Patel 2014). Federations actively seek good relations with politicians and civil servants at different levels. They can use this to present their plans (supported by detailed maps and surveys) and negotiate for support and co-production (see for instance Lines and Makau 2017). The foundation of these federations are community managed savings groups with most savers and savings group managers being women, so their needs and priorities are fully included.

Politics of space for informal livelihoods: This includes city authorities' provision for fixed spaces on streets, in public spaces or within markets and on what terms. Also, government attitudes to vendors and other informal labourers, and the politics of regulating or controlling informality (Roever and Skinner 2016, Chen et al. 2016). Can local authorities promote and encourage *hybrid economies* in which micro- businesses can co-exist alongside small, medium, and large businesses and in which street vendors can co-exist alongside the kiosks, retail shops, and large malls (see Bhatt quoted in Chen 2014).

Politics of getting land tenure for residents in informal settlements and legal addresses (which may be complicated by opposition by politically-powerful absentee landlords – see Weru 2004, Lines and Makau 2017). However, many upgrading schemes have included provision of tenure or support for the residents to buy or lease the land they occupy (ibid, Boonyabancha 2005).

Politics of land access - getting legal land sites that low-income groups can afford that are realistic alternatives to informal settlements. There are the difficulties of getting land for housing in formal or informal markets due to competing formal/informal actors, such as local politicians, brokers and private developers, and rights and roles of traditional authorities.

Section 3 on upgrading described where community organizations have taken the lead – and in how they used this to engage with local governments and often to get local government-community organization partnerships. In many cases, the settlement improvements implemented by community organizations contribute to their climate resilience – such as functioning drainage systems, paved roads and upgraded houses. Sometimes the act of upgrading by local citizens can incentivise local authorities to step in and complete or supplement the improvements. Where local governments are willing to contribute financially to the initiatives of community organisations, and participate in decision-making about the allocation of funds, this signifies a shift in relationships. Previously marginalised residents of low-income settlements are regarded as legitimate citizens of the city with a voice in local decision-making and the power to take action. This creates more accountability in decision-making, with mechanisms for meaningful citizen participation to ensure decisions are taking local needs into account.

But for these community-led processes to also address underlying issues of social and political exclusion, there is a need to consider rights and justice in approaches to urban governance. Building resilience will require a long-term approach which equips all urban residents, including those in informal settlements, with the capacity to prepare for and adapt to climate change, not just physically but also socially, politically and economically.

Many aspects of adaptation are implemented not only through what urban governments do and control but also what they encourage, allow and support among other stakeholders. Public engagement, openness, and transparency can help ensure democratic debate to balance public interests and longer-term goals against the short-term benefits of unconstrained development. The IPCC's Fifth Assessment (Working Group II) noted the experience in some cities of engaging a wide number and range of stakeholders in early stages in a risk assessment and how it creates political support and momentum for follow-up research and adaptation planning (Revi et al 2014; see also Rosenzweig and Solecki, 2010; Anguelovski and Carmin, 2011; Hunt and Watkiss, 2011). In informal settlements with little or no formal infrastructure and services, stakeholder engagement is a means for participatory community risk assessment, where local adaptive capacity is built in part through local knowledge (Livengood and Kunte, 2012; Kiunsi 2013). Box 4 gives an example of a participatory planning process that catalysed local government interest in climate resilience in three Latin American cities.

Box 4: Catalyzing local government interest in climate resilience

A study of decision-making in regard to climate resilience in three cities, Dosquebradas (Colombia), Santa Ana (El Salvador) and Santo Tomé (Argentina), used a participatory planning process, to analyse different problems and propose a portfolio of actions that could contribute to climate resilience and improve decision-making processes. During workshops, local actors jointly evaluated problems and options and trade-offs between the

options proposed. This participatory process helped to produce a clearer idea of the WHAT (kind of options and actions necessary), WHAT FOR (context and justification), WHERE (place), WHEN (timing), WHO WITH (who are part of this process, who must get involved, who are "winners and losers"), WITH WHAT RESOURCES, and HOW (technical and financial support, different knowledge bases and experiences). These are all aspects that need to be addressed during the construction of a portfolio of action options.

Participants highlighted the need to work across different topics: establish a common vulnerability and risk base line, develop comprehensive plans of land management (e.g. to curb developments in fragile ecosystems, define protection zones, assess urban expansion trends with its positive and negative impacts, etc), define green and grey infrastructure needs that reduce risks (stream recovery and sustainable management of watersheds; water and sewage network expansion), and strengthen a communication strategy (within government areas and between government and civil society – community organizations. From this came project proposals for city portfolios that included reforestation with native vegetation and recovery of creeks and streams within urban and peri urban areas. They also included the development of community-government organizational mechanisms to monitor environmental conditions, plans and follow up on green and grey infrastructure works, measures to develop disaster risk and resilience action plans, and the strengthening both of internal measures (working within the city) and external capacities (connecting with the "outside - other cities, regions, donors, etc).

Source: Hardoy et al, 2017

Representative democracy has worked in urban centres in high-income and some upper middle-income nations in that almost all their population (including most households with low-incomes) live in secure, permanent (formal) housing with (formal) infrastructure and services. They do not have a significant proportion of their population in informal settlements. Residents do not have to actively lobby for piped water, connection to sewers and storm drains or participate in their planning, construction and management. There are political or bureaucratic channels for complaints for anyone who feels they have been poorly served or cheated by any public service and safety nets if they are unable to work or they lose their source of income. Local governments may have limitations and may fail to adequately serve a proportion of the population (typically the poorest) but they do not have large and growing proportions of their populations in informal settlements

Representative democracy has not worked for residents of most informal settlements. This helps explain why new forms of (mostly local) governance have emerged in informal settlements. As described in Section 3, this includes grassroots organizations and federations that organized to address their own needs (mostly in informal settlements) and to offer partnerships to local government. It includes participatory budgeting although here citizen and civil society engagement focused on getting their priorities accepted and holding local government to account (Cabannes 2015). The IPCC's Fifth Assessment noted how participatory processes figured prominently in cities that have been leaders in urban adaptation (Revi et al 2014, citing Rosenzweig and Solecki, 2010; Brown et al., 2012; Carmin et al., 2012;). Many forms of direct citizen participation in government have included upgrading as this improved provision of infrastructure and services – including through processes of co-production, whereby local communities and local government have joined forces in the provision of services and shelter.

This 'co-production' (Mitlin, 2008, Ostrom, 1996] of services and infrastructure by community organisations and local governments can reduce development deficits and build resilience. It also creates an entry-point for climate finance to be localised to the community level, where structures of accountability and financial management are already in place (see for instance Weru et al 2017). If

community organisations can be further resourced with national or international climate adaptation finance, it 'carves out the political space for them to use adaptation as a means to pursue justice across multiple dimensions of urban development' by further addressing underlying causes of risk and vulnerability (Colenbrander, Dodman and Mitlin, forthcoming). Furthermore, this can create incentives for state and national governments to support and resource local governments – the governance of climate change adaptation requires action from multiple spheres and types of actors: public, private and civil society.

Section 3 included clear evidence of the potential of organisations formed by residents of informal settlements to negotiate with local governments for more inclusive urban development, through processes that give more voice to population groups that are traditionally marginalised. Community-based adaptation to climate change, and community-driven development more generally, can be viewed as responses to failures in top-down climate change adaptation or development approaches (Boyd et al. 2009). Community-driven approaches open up opportunities for partnership and co-production (Papeleras, Bagotlo and Boonyabancha, 2012; Mitlin, 2008), which can begin to address some of the underlying structural inequalities and lack of resources that drive vulnerability. Where citizens are empowered and engaged, they can foster a culture of inclusion, responsiveness and collaboration between different urban actors, whether state or non-state – that builds resilience to the shocks and stresses generated by climate variability and change.

There are examples of good practice that illustrate mechanisms for meaningful participation, accountability and transparency. There are also examples of political and financial decentralisation that have enabled different actors within cities, both state and non-state, to address development and adaptation deficits (Bahadur and Thornton 2015). Section 3 also outlined the many examples of organised low-income communities in the SDI and ACHR networks building their own capital base through savings groups and revolving loan systems. This creates city-wide funds shared across several community groups, to address housing and infrastructure needs, as well as livelihoods, education and welfare (Archer, 2012). The citywide funds managed by the community organisations can include contributions from other sources, including local government (Lines and Makau 2017) There are also instances of disaster insurance funds being created, filling a gap where many informal dwellers cannot access insurance services. But in many nations, there are political and institutional constraints on these kinds of processes.

Governance challenges may arise if there are "mismatched priorities between different government spheres" related to climate change efforts. So the 'relational dynamics' between different levels of government and between government and non-government actors are central to urban climate governance (Leck and Simon 2012: 1221).

There is increasing acceptance that the governance of urban climate change 'implies a recognition of the multiple actors who intervene' (Castan Broto, 2017:1) through multiple forms of governance – a shift away from the top-down, state-led approach. There is also growing agreement of the need for 'pro-poor forms of adaptation that support the urban poor's assets' (Castan Broto, 2017:3) The involvement of a variety of stakeholders is needed for effective and inclusive decision-making on planning and resource allocations which takes into account the needs of diverse urban actors including those in informal settlements and those working within the informal economy. And while local community organisations may increasingly be playing a role in this, this should not absolve local and national governments of their responsibilities towards all citizens.

Section 3 described how community-led surveys, maps and enumerations of informal settlements in many countries had generated the data needed for planning and managing upgrading – and how

these had also led to better relations with local authorities as they served as a valuable negotiating tool, as this information is vital for planning effective and targeted infrastructure and housing improvements. These also contain data on residents' past experience in coping with extreme weather and residents' perceptions of the most serious risks that they face – and so a good foundation for climate change risk assessments.

City governments need information systems about climate change that inform their decisions. In many cities, this is mostly about bringing together and integrating already available information (geo referenced where possible), ensuring this is builds on the knowledge of local actors, is available to and accessible to all within a process that constantly updates it (Hardoy et al 2017).

A study of decision making in regard to climate resilience in Dosquebradas (Colombia), Santa Ana (El Salvador) and Santo Tomé (Argentina) found that there was usually sufficient information to guide actions. The problem was that needed information was held by different government offices, universities, research centres and private sector bodies and not shared. In many instances, key actors did not know of others' information base. The information was often in different formats and not geo-referenced. So the problem was not so much the lack of relevant information as the impossibility to access it and use it to initiate a dialogue between actors and support better-informed decisions.

On the other hand, certain types of information may be unavailable or inaccessible to particular population groups. Where it is available, it may be difficult to interpret – such as climate models and predictions. This may lead to climate adaptation plans and activities that benefit certain areas or population groups – often those with most negotiating power, such as industrial lobbies – whilst increasing impacts are faced by more marginalised groups. There is therefore a need to develop a culture of learning and openness around such data to facilitate inclusive adaptation planning. This also needs a recognition that climate change adaptation cannot consist solely of technological solutions imposed by experts from above, but requires fostering an informed, inclusive and empowered society engaged in decision-making processes.

6. Conclusions

SCALE OF PROBLEM: Around one in four of the world's urban population lives in informal settlements in low and middle-income nations. It is in these settlements that most of the urban deficit in infrastructure and services (including water, sanitation and drainage) and the worst quality housing are concentrated. This also means their inhabitants face high risks from most climate change impacts, yet their contribution to climate change is likely to be minimal. Most of their livelihoods and housing is 'informal' as are most of the services they use in the absence of government provision. Most are also in urban centres where local government lacks the funding and capacity to address this.

CITIES IN WEALTHY NATIONS: In high-income and some upper-middle income nations, almost all cities have functioning governments. They have what the IPCC terms 'risk-reducing' infrastructure and services in place covering almost all their populations, such as reliable, safe water piped to homes, good provision within the household for sanitation, paved roads and paths, storm and surface drains and connection to electricity grids. Almost all housing conforms to official standards which protects inhabitants from extreme weather. Almost all building owners have insurance while almost all households have insurance covering possessions.

Here, addressing climate change adaptation is seen as a responsibility of government, mostly city government with support from national government. Building resilience to climate change is seen as what any good and accountable city government should do. The foundations are there for building a city's resilience to climate change – the infrastructure and services, the local governance systems, the needed laws, rules and regulations. City-wide infrastructure systems are in place so their resilience can be enhanced – while recognizing their interconnectedness and as Box 1 notes, the need for responsiveness, redundancy and 'safe failure.'

For city governments that have taken climate change adaptation seriously, they have moved from a political commitment to act to developing new policies and technical responses. Thus, the needed move to greater resilience to climate change happens within the 'formal' world of policies, budgets, rules and regulations overseen by elected city governments.

CITIES IN THE GLOBAL SOUTH: But what can be done in a city where city government has little technical and no investment capacity and much of the population live in informal settlements that lack almost all the 'risk reducing infrastructure and services mentioned above. Many cities and countries are failing to deliver even basic infrastructure and services to urban residents, so how are they going to find ways to ensure that these are compatible with low-carbon and climate-resilient urban development? These will be inhibited by the same constraints that have hindered more conventional forms of development: weak government and governance structures, scarce resources (including little investment capacity), constrained local powers, limited delivery capacities, vested interests, political disinterest in the urban poor and the presence of multiple competing priorities The difficulties in getting needed action can be seen in the contrast between city governments with the capacity and willingness to manage land use and land use changes in the public interest (including needs for adaptation and mitigation) and where there is none with urban sprawl, large speculative profits within legal and informal land markets and the exclusion of low-income groups.

It is difficult to imagine how the much-needed changes in development and in climate change policies will happen without more committed, competent and resourced urban governments that work well with those in informal settlements. Building climate resilience in these settings requires local governments' flexibility and a willingness to go outside conventional 'formal' responses copied from high-income nations. This includes a willingness to innovate and a commitment to co-produce solutions with informal settlement residents.

ANOTHER PATH: But there is another way for governments to view this issue; to recognize the many positive aspects of informal settlements and to work with the inhabitants and their community organizations in providing needed infrastructure and services and improving housing quality. This paper has given examples of how in particular informal settlements, upgrading has expanded and improved provision of infrastructure and services, supported housing improvements and sometimes supported legal tenure being provided to the occupiers. This 'upgrading' of informal settlements has become common practice in many nations. Some are driven by local governments responding to democratic pressures - for instance, in many Latin American cities, upgrading informal settlements and extending trunk infrastructure to them (roads, water mains, sewers, storm drains, electricity…) has become an accepted part of what a city government does. The work of the Community Organizations Development Institute in Thailand was also described earlier – and how it catalyzes and supports community-driven upgrading with upgraded settlements being incorporated into the formal systems for water, sanitation and waste collection. Previous sections also described now the last twenty years have also brought many upgrading initiatives in informal settlements driven by community organizations formed by their residents. These include many initiatives by national

federations of slum or shack dwellers that are active in over 30 nations. There are also many examples of co-production of services and infrastructure by community organisations working with local governments to reduce development deficits and build resilience. Although few of these case studies mention climate change, they are describing processes that are perhaps the most important means by which low-income urban dwellers unable to afford formal housing can get more resilience to climate change impacts – as well as reducing risks they face from everyday hazards and disasters.

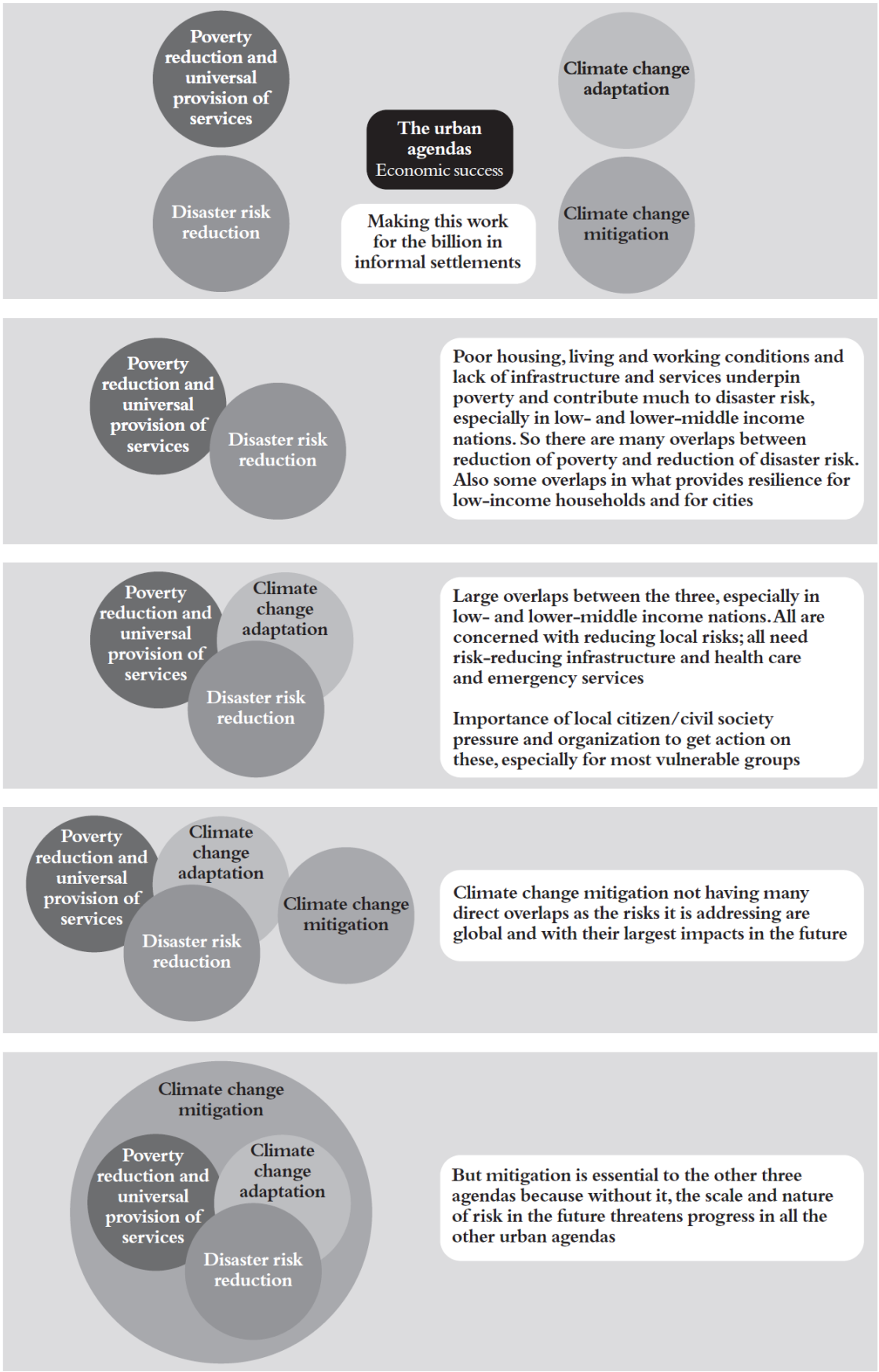
NATIONAL GOVERNMENT: The crucial role of urban governments and urban civil society in adaptation (and development) is being ignored. There are important issues that are beyond the scope of this paper that need highlighting. One is the very low priority given by most international development assistance agencies to urban issues – including informal settlement upgrading and city-wide water and sanitation systems. Another is the lack of connection between global United Nations agreements and agendas (such as the New Urban Agenda, the Sustainable Development Goals and the Paris Agreement) and what is needed to build resilience in urban areas that engages low income groups. Urban governments can be drawn into these UN agendas but always in a subsidiary role. The global agendas focus so heavily on national government commitments – and so little on the two most important actors for climate change adaptation in urban areas - urban government and urban civil society.

KNOWLEDGE GAPS: In terms of knowledge gaps, we need to build the evidence base on the interactions between urban development, disaster risk reduction, climate mitigation and climate adaptation, and identify potential synergies and trade-offs between these agendas. There is also an urgent need for research on the preconditions and contingencies for a successful transition to low-carbon, climate-resilient urban development – and this needs to include cities with limited government capacities and large infrastructure backlogs. Questions of equity and justice need to be at the heart of this research agenda, including who is excluded from accessing housing, land and land tenure and financial services. Or who faces discrimination in this, on the basis of (for instance) gender, age or ethnic group?

TRANSFORMATION: The issues raised by the 5th IPCC Assessment on the needed shift from resilience to transformation also need emphasis. Here, transformation is understood as where urban centres have integrated their development, disaster risk reduction, and adaptation policies and investments within an understanding of the need to contribute to mitigation and sustainable ecological footprints (Revi et al 2014 – see Table 8.2, page 546; see also Satterthwaite, Bartlett, Roberts et al 2016). Figure 1 illustrates this.

NEW FUNDING CHANNELS: How can the number of positive examples of local government led and community-led adaptation be multiplied? One of the sternest tests for global climate finance is to develop the institutional channels through which to encourage and support hundreds of locally-driven upgrading initiatives within which resilience enhancement is embedded. This means that global funds for adaptation will have to work out how to work with local governments and with the grassroots organizations and federations formed by the inhabitants of informal settlements.

Figure 1: The four agendas and their overlaps



SOURCE: Satterthwaite, Bartlett, Roberts et al 2016

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