

Building Resilience to Climate Change in Informal Settlements

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Approximately 1 billion people currently live in informal settlements, primarily in urban areas in low- and middle-income countries. Informal settlements are defined by poor-quality houses or shacks built outside formal laws and regulations. Most informal settlements lack piped water or adequate provision for sanitation, drainage, and public services. Many are on dangerous sites because their inhabitants have a higher chance of avoiding eviction. This paper considers how to build resilience to the impacts of climate change in informal settlements. It focuses on informal settlements in cities in low- and middle-income countries and how these concentrate at-risk populations. This paper also reviews what is being done to address climate resilience in informal settlements. In particular, community- and city-government-led measures to upgrade settlements can enhance resilience to climate-change risks and serve vulnerable groups. It also discusses how the barriers to greater scale and effectiveness can be overcome, including with synergies with the Sustainable Development Goals.

Rapid Urbanization and Growth of Informal Settlements

The current urban population is approximately 4.4 billion people globally. About 3.4 billion people currently live in urban centers in what the United Nations (UN) terms “less developed regions.”¹ UN projections suggest that urban population growth in “less developed regions” will be over 2 billion people by 2050 and that close to 90% of this increase will be in Asia and Africa. This means that another 2 billion urban dwellers will require housing, basic services, and resilience to climate-change impacts.¹

At present, approximately 1 billion urban dwellers live in what are termed informal settlements in poor-quality houses or shacks.² Informal settlements fall outside formal laws and regulations on land ownership, land use, and buildings. Their illegality makes government agencies unable or unwilling to work with them. These are settlements to which city governments have not extended what the UN Intergovernmental Panel on Climate Change (IPCC) terms risk-reducing infrastructure (paved roads, storm and surface drainage, piped water, etc.) and services relevant to resilience (including healthcare, emergency services, and rules of law).² Many informal settlements are ill prepared for climate change and face particularly high risks of floods and landslides as a result of poor-quality buildings and a lack of infrastructure to prevent flooding, withstand heavy storms, and cope with heat waves.² In the absence of more effective policies, most of the world's growth in urban population will be accommodated in informal settlements. Given

the projected rates and regions of urban population growth by 2050, there is an urgent need to build resilience to climate change in these settlements and to do so at scale. There is also an urgent need to vastly expand the supply and reduce the cost of “formal” (i.e., legal) housing that provides low-income groups with safer and more accessible alternatives to informal settlements.

The heterogeneity among informal settlements precludes agreement on a precise definition. The term “informal settlement” generally refers to urban settlements that develop outside the legal systems intended to record land ownership and tenure and enforce compliance with regulations relating to planning and land use, built structures, and public health and safety. The definition used by the Organization for Economic Co-operation and Development includes “areas where groups of housing units have been constructed on land that the occupants have no legal claim to or occupy illegally” and “unplanned settlements and areas where housing is not in compliance with current planning and building regulations (unauthorized housing).”³

Given their legal status, most governments do not collect data on informal settlements or their inhabitants. Censuses should be able to provide detailed data on informal settlements, but they would need to define informal settlements and include a field in the household census form for marking whether the household is living in an informal settlement.⁴ Official household surveys (including the Demographic and



Health Surveys Program of the US Agency for International Development) have sample sizes that are too small to be able to provide data on each urban area and each informal settlement.⁵

Despite the general lack of data, two sources of information support the estimate of approximately 1 billion people living in informal settlements. The first source is UN estimates that suggested 880 million “slum dwellers” in 2016.⁶ Most of these are likely to be in informal settlements, although informal settlements and slums are not necessarily the same. Informal settlements are defined according to contraventions of specific laws, rules, and regulations, whereas slums are usually defined on the basis of measures of housing quality, overcrowding, and the provision of urban services. The second source of information is city-level case studies that suggest that it is common for cities to have 30%–50% of their population in informal settlements,⁷ although some have a higher proportion—for instance, 60% in Nairobi,^{8,9} 65% in Cairo,¹⁰ and 70% in Dar es Salaam.¹¹ A study in Mumbai notes that “over half of the city’s population lives in informal settlements of varying infrastructure, income, economy, ethnicity and religion, squeezed into whatever space can be found from bridges and railways to pavements and shantytowns” (p. 91).¹² One billion informal-settlement dwellers would represent 29% of the total urban population of low- and middle-income nations of 3.4 billion;¹ therefore, this estimate is consistent with existing data. There are some detailed case studies of informal settlements^{13,14} and some city-wide studies,^{15,16} but it is difficult to collect data on informal settlements. There is often hostility to outsiders asking questions, and these settlements often have no street names, street maps, or registered addresses for residents. Data scarcity therefore remains a central challenge.

Although the response of many city governments to informal settlements is either to ignore them or to bulldoze them,² some city governments have worked successfully with informal-settlement inhabitants on upgrading programs to secure tenure, improve housing, install needed infrastructure, and provide public services. Such upgrading programs generally focus on addressing current risks to informal-settlement inhabitants. This paper considers the extent to which these upgrading programs can enhance the resilience of informal settlements and their inhabitants to the impacts of climate change. [Defining Climate Resilience in Informal Settlements](#) discusses how a concern for resilience can be applied to informal settlements. [Climate-Change Risks in Informal Settlements](#) describes how and why these settlements face particularly high risks related to climate change. [Building Climate Resilience in Informal Settlements](#) and [Building Resilience through Upgrading Initiatives](#) review existing approaches to upgrading informal settlements, including community- and city-government-led measures, and the extent to which these serve vulnerable groups and enhance resilience to climate-change risks. [Addressing Barriers to Upgrading](#) discusses the barriers to greater scale and effectiveness of upgrading programs and how these might be overcome. [Synergies with the Sustainable Development Goals](#) considers the relevance of the Sustainable Development Goals (SDGs) to helping build resilience in informal settlements. The final [Conclusions](#) section draws some conclusions, including the need for new funding models that support city

governments and other local actors to act upon upgrading programs that address climate-change risks.

Defining Climate Resilience in Informal Settlements

Within broader debates around climate-change adaptation, there has been growing interest in the resilience of cities and communities to the impacts of climate change. In the broadest sense, resilience is defined as the capacity or ability of something, someone, or some group to anticipate, accommodate, cope, adapt, or transform when exposed to specified hazards. The IPCC’s definition of resilience when applied to urban centers is the ability of urban centers (and their populations, enterprises, and governments) and the systems on which they depend to anticipate, reduce, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner.²

There is much overlap between this and the 100 Resilient Cities initiative’s definition of urban resilience as the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience.¹⁷ Thus, “city resilience describes the capacity of cities to function, so that the people living and working in cities—particularly the poor and vulnerable—survive and thrive no matter what stresses or shocks they encounter” (p. 11).¹⁷

In the context of these broader definitions of urban climate resilience, [Figure 1](#) identifies specific resilience-building measures relevant to informal settlements. [Figure 1](#) highlights the ways in which informal-settlement-upgrading programs can act to reduce hazards, reduce risk by reducing exposure to hazards, and increase resilience among vulnerable populations. Anticipatory adaptation by households can avoid or reduce climate-change-related risks, for instance, by living in a safe location, having a safe, structurally sound house, and having risk-reducing infrastructure. Reducing disaster risk is also anticipatory in its focus, and accommodating and recovering from a disaster seeks to “bounce back” to the previous state.¹⁸ “Bouncing back” requires government capacity to rapidly restore key services and repair infrastructure. Bouncing forward, by contrast, is part of what the IPCC refers to as transformative adaptation, where urban centers have integrated their development, disaster-risk reduction, and climate-change-adaptation policies and investments within an understanding of the need for mitigation and sustainable ecological footprints (as discussed in the [Conclusions](#) section).

There are limits to adaptation, however. As noted in [Figure 1](#), certain hazards in informal settlements cannot be addressed by upgrading programs.¹⁹ Flood risks that require watershed management in the wider region, far beyond a settlement’s boundaries and the scope of its upgrading programs, would be one such example. There are also the residual risks that remain after all the measures to reduce hazards and risks and to address the needs of vulnerable populations.

For informal settlements, there is a need to enhance climate resilience at different scales and with a range of different measures. The different scales are individuals or households (and their homes, assets, and livelihoods), neighborhoods, settlements, settlement-city links, and settlement-city-regional links. For each of these scales, mixes of measures to anticipate,

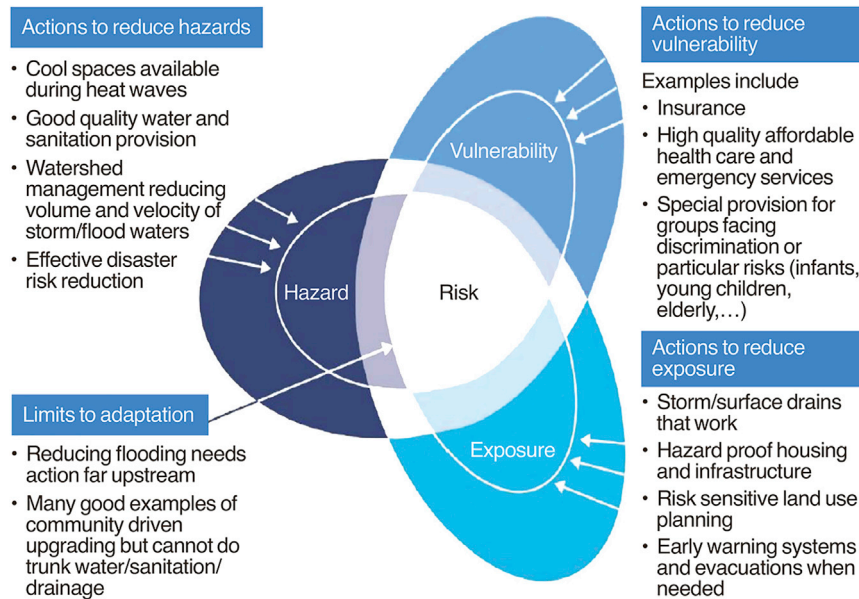


Figure 1. Addressing Hazards, Risks, and Vulnerable Populations in Informal Settlements

This figure shows the measures that can reduce risk in informal settlements through acting to reduce hazards and who is exposed to them and measures to increase resilience among vulnerable populations. This draws on an IPCC figure on the interaction between climate-related hazards and the vulnerability and exposure of human and natural systems but is modified to focus on informal settlements.¹⁹

notes how “rapid urbanization and rapid growth of large cities in low- and middle-income countries have been accompanied by the rapid growth of highly vulnerable urban communities living in informal settlements, many of which are on land at high risk from extreme weather” (p. 538).²

Urban climate-change-related risks include “... rising sea levels and storm

reduce, accommodate, and recover exist to serve vulnerable groups.

The settlement-city-region links are especially important because resilience to many climate-change impacts within informal settlements depends on city-wide infrastructure. For instance, flood control and management within a settlement can depend on infrastructure outside settlement boundaries. Land-use management in and around the city scale also has relevance to associated informal settlements.

Most of the measures needed to build city resilience to climate change are within the responsibilities of their governments. But in cities with infrastructure deficits and a substantial proportion of their population in informal settlements, risk and vulnerability are often highly concentrated in these settlements; many are on floodplains alongside rivers or on steep slopes.² These are settlements to which city governments have not extended risk-reducing infrastructure and services relevant to resilience. Here it falls to individuals, households, and community organizations to address these issues without external support.

Climate-Change Risks in Informal Settlements Informal Settlements and the IPCC

Reviewing the five IPCC Global Assessments undertaken since 1990 reveals that over time, there has been increasing attention to cities for both climate-change adaptation and mitigation. The IPCC Fifth Assessment Report (Working Group II) was notable for being the first global assessment to have a chapter focusing only on urban areas and for having more detailed coverage of cities than the previous assessments—in large part because the Fifth Assessment Report contained much more source literature on cities and climate change.²

This chapter on urban areas notes how “urban climate change risks, vulnerabilities, and impacts are increasing across the world in urban centers of all sizes, economic conditions, and site characteristics” and how “much of key and emerging global climate risks are concentrated in urban areas” (p. 538).² It also

surges, heat stress, extreme precipitation, inland and coastal flooding, landslides, drought, increased aridity, water scarcity, and air pollution with widespread negative impacts on people (and their health, livelihoods, and assets) and on local and national economies and ecosystems” (p. 538).² The report further notes that “these risks are amplified for those who live in informal settlements and in hazardous areas and either lack essential infrastructure and services or where there is inadequate provision for adaptation” (p. 538).²

These concerns were further amplified by the Summary for Urban Policymakers prepared by IPCC authors advised by city practitioners and policymakers,²⁰ drawing on the IPCC Special Report on Global Warming of 1.5°C.²¹ This summarizes the impacts of the average temperature warming: human death and illness are expected to increase in pathways with warming greater than 1.5°C as a result of risks directly attributable to climate change, such as exacerbated urban heat islands, amplification of heat waves, extreme weather volatility, floods, droughts, coastal inundation, and an increase in vector-borne diseases such as malaria and dengue fever.^{20,21}

Impacts on natural systems—including the degradation of natural systems and the loss of species with repercussions for regional and global food security, forests, and water systems—will also affect urban centers. There are also knowledge gaps on impacts at 2.0°C of warming compared with 1.5°C; these include “effects at the local level, as well as linkages between climate risks, poverty, equity, and well-being” (p. 11).²⁰

The IPCC’s Fifth Assessment Report emphasized the large spectrum in the capacity of urban centers to address resilience issues,² as summarized in Figure 2. In high-income nations, almost all of the urban population is in homes that include the IPCC’s list of risk-reducing infrastructure and services. Most housing meets building regulations, which contributes to resilience and provides a base on which it can be increased. By contrast, much of the urban population in low- and many middle-income nations lives in informal settlements in homes that

	← Low capacity			→ Radical adaptation	
Indicator	Very little adaptive capacity	Some adaptive capacity	Adequate capacity for adaptation	Climate resilience	Radical or transformative adaptation
Proportion of population served with risk-reducing infrastructure, basic services and institutions, and living in legal housing	0–30% of population served	30–80% of population served	80–100% of population served	Most/all population served; active adaption policy and current/future risk identification; institutional structure encourages actions by all sectors	Most/all population served, with integrated development and adaptation policies; efforts towards mitigation and sustainable ecological footprint
Total population in cities at each capacity level	1 billion people	1.5 billion people	1 billion people	Very few people	Very few people
Distribution of cities at each capacity level	Most urban centres in low-income and many middle-income countries	Many urban centres in many low-income countries and most urban centres in most middle-income countries	Nearly all urban centres in high-income countries, many in middle-income countries	Small proportion of cities in high- and upper-middle-income countries	Some innovative city governments taking some initial steps
Local government investment capacity	Very little or no local investment capacity				Substantial local investment capacity
Frequency of disasters from extreme weather	Very common				Uncommon

SOURCE: IPCC Fifth Assessment

Figure 2. The Spectrum of Urban Adaptive Capacity

This IPCC figure shows the large spectrum in the capacity of urban centers to address resilience issues.² It suggests that 1 billion urban dwellers live in urban areas with very little capacity to adapt to climate change and another 1.5 billion live in urban centers with only some capacity. Few live in urban centers with climate resilience.

are not structurally sound and neighborhoods with little or no risk-reducing infrastructure or services.

Figure 2 indicates that some cities have sufficient climate resilience and a capacity to “bounce forward” to greater resilience after a hazardous event.² But cities need to aspire to transformative adaptation where they have integrated their development, disaster-risk reduction, climate-change adaptation and mitigation policies, and investments.

Variation among Informal Settlements

Informal settlements include squatter settlements where the occupation of the land is illegal and often contested. They also include “illegal subdivisions”—housing developments that are carried out without official permission but that are not on illegally occupied land. For example, agricultural land that is purchased from the owner and used for residential development in contravention of zoning regulations would be an illegal subdivision. These often have conventional site layouts with room for access roads. It is both easier and less controversial for governments to provide illegal subdivisions with infrastructure and services. Informal settlements are part of a larger “informal” land market where there are often powerful well-connected real-estate interests.²²

The extent of the deficiencies in infrastructure in informal settlements also varies greatly. For instance, the proportion of informal-settlement residents with government-provided water piped into each house or plot and a connection to a sewer can vary from 0% to 100%.²³ Deficiencies in infrastructure vary not

just between cities but also within them.²⁴ Consideration of informal settlements also needs to include their role in housing temporary migrants, including internally displaced people and refugees. But there are few data on this other than a recognition that many live in urban areas, including informal settlements, rather than in camps.²⁵ Discussions of informal settlements can include “formal” housing that has been subdivided or derelict housing.²⁶ Within informal settlements, there is a large spectrum of “informality” and different forms of exclusion and (il)legitimacy.²⁷

Informal settlements have housed large sections of the population of many cities for over 50 years, so they cannot be seen as being a temporary transitional phase.²⁸ Although informal settlements can be defined through contraventions of rules, norms, and standards, they have to be understood and analyzed in political terms as well given that their populations are so often embedded in adverse and unequal relations.^{12,29}

Informal Settlements and the Informal Economy

Although city and community case studies show the importance of informal settlements to housing informal workers and most of the informal economy,^{30–32} there is little literature on the overlaps and interactions between them. The scale of informal employment within urban areas has to be inferred from statistics on the scale in non-agricultural employment—given that most such employment is in urban areas. Half of the total non-agricultural employment globally was in informal employment in 2016—and particularly high in Africa (71.9%), the Arab

states (63.9%), and Asia and the Pacific (59.2%).³² So, a very large proportion of the workforce works in the informal economy that operates outside laws and regulations. The informal economy in urban areas includes construction workers, domestic workers, home-based producers, street vendors, transport workers, and waste pickers, plus many low-end service occupations.³⁰ Women are over-represented in the more poorly remunerated sections of the informal economy.³¹ In many informal settlements, most housing is for rent, so landlords figure as among the most common informal enterprises.

Labor markets influence where informal settlements develop. Informal settlements often develop close to ports, markets, industrial areas, airports, and bus and rail terminals because many of their inhabitants provide the labor these depend on.³³ Many informal settlements develop large and varied economies of their own by serving their population, fabricating goods at home, or providing services to external markets.³⁴

The deficiencies in provision of essential services in most informal settlements also constrain home-based enterprises.³⁵ In the absence of “formal” provision of water, sanitation, electricity, healthcare, schools, and solid-waste collection, alternative (often informal) providers develop to serve informal-settlement dwellers and enterprises.

Inherent Risks and Vulnerabilities

It has already been noted that risk and vulnerability in cities are often highly concentrated in informal settlements.² Many informal settlements are also located on sites that are at a high risk of floods or landslides. Many are in close proximity to unstable waste dumps, railway tracks, or highways. Many are in low-lying coastal areas at risk of sea-level rise and storm surges or alongside rivers that frequently overflow. Informal settlements develop on dangerous sites because their inhabitants have a higher chance of avoiding eviction given that such sites are unattractive to developers. Many informal settlements, including unregulated multi-story buildings, are densifying; some are expanding onto unsuitable sites.^{36–38} Many have poor-quality housing that is less able to withstand high winds and flooding.^{2,39}

Many informal settlements are also very dense with little open or public space and often with uninsulated corrugated iron roofs and poor ventilation, all of which contribute to higher indoor temperatures. So, their inhabitants—especially infants and young children, the elderly, expectant mothers, and those with certain chronic diseases—are at a higher risk of high temperatures and heat waves.^{2,36,38} Home workers and outdoor workers in informal settlements often have high exposures to extreme heat and curtailed worktime.

Higher minimum temperatures could extend the range and activity of some disease vectors that could disproportionately affect informal-settlement residents who lack both public-health measures to control disease vectors and healthcare systems to provide needed responses.^{2,20} Infants and young children are particularly at risk.^{2,36}

Storms with high wind speeds can bring devastation to cities, especially to areas where many buildings and infrastructure are poor quality (as in most informal settlements). This inherent vulnerability was evident in the devastation caused by high winds in Ibadan in 2008.⁴⁰

For cities facing decreased quantity and quality of water resources, informal-settlement residents and enterprises usually face more water constraints and are more vulnerable to increases in food and water prices. Informal-settlement residents are also typically the least able to afford alternative sources of water, which is particularly serious for home workers with water-intensive livelihoods.

The environmental risks faced by informal-settlement dwellers intersect with social drivers of vulnerability, such as low-income and gender discrimination.⁴¹ Informal-settlement residents usually have difficulties engaging with the local governments whose support they need. They are often trapped in clientelist relationships.⁴²

Many city governments still see informal settlements (and their interconnections with the informal economy) as a “state of exception” from the formal order and view them normatively as separate from, and inferior to, those of the formal city.²⁷ Informality could be seen as “the unregulated, uncontrolled, messy and inefficient settlement and use of land” and “positioned as fundamentally different from the ordered, regulated, efficient notions of planned land use and settlement” (p. 116).²⁸

Informal-settlement dwellers can also face the consequences of a lack of a registered address. This denies them access to goods and services that are important for household resilience. Having no registered address often means no access to government services such as public schools, healthcare, and social protection or in some cities getting on the voter register. Without a registered address, households might be denied connection to plot-based piped water, sanitation, and electricity or access to a bank account or to insurance for homes and possessions. This status also increases the risks of eviction.⁴²

Building Climate Resilience in Informal Settlements Government Responses

The urgent need for action to build climate resilience in cities and in the wider economic and ecological systems that serve them is obvious. It is also clear that this needs to include a focus on informal settlements because of the needs of the 1 billion people living in them, because of their importance to the city economy, and because of their vulnerability to current and future climate-change impacts.

It was noted earlier how and why many informal settlements develop on dangerous sites primarily because they best meet other needs (especially regarding access to jobs and services) and financial constraints. The inhabitants of informal settlements might not consider moving to formal homes and settlements that are better served with risk-reducing infrastructure and services unless these compare favorably with their current accommodation on issues such as price and location, as well as quality and tenure.

The conventional government response to the need to build resilience in informal settlements is to demand that homeowners and landlords invest in bringing their existing and new buildings up to official standards and that they help pay for the cost of connecting these buildings to infrastructure and services. To avoid excluding those unable to afford to buy or rent formal housing, this approach would need to be supplemented by an effective “affordable housing” policy and by

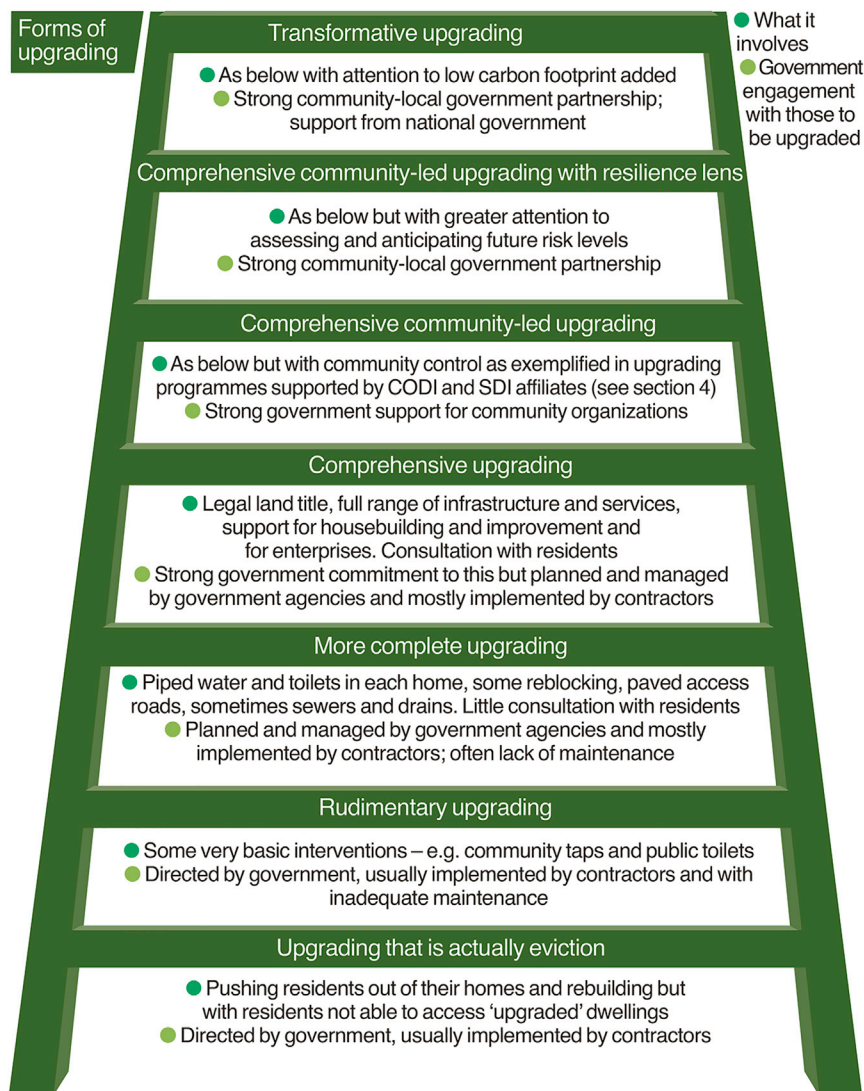


Figure 3. From Eviction to Transformation: The Ladder of Different Forms of Informal Settlement Upgrading

This figure shows the different forms of upgrading and what each implies for the role of government and for the roles of residents. At the bottom of the ladder is upgrading that is actually eviction; at the top is upgrading that has been implemented by a strong community-local government partnership with attention paid to climate-change adaptation and mitigation. Its use of a ladder to illustrate characteristics of different approaches is drawn from Arnstein.⁴³

quality and safety of housing structures and other buildings and provide infrastructure (such as piped water, sewers, storm drains, electricity, and all-weather roads) and public services (including healthcare, emergency services, and public transport).

Informal-settlement upgrading developed well before the recognition of climate-change-related risks, but most of what upgrading provides also reduces climate-change-related risks (and disaster risks). Upgrading is also anticipatory in that it builds resilience to future disasters. What needs to be added to upgrading schemes is a resilience lens that accounts for likely current and future climate-change impacts.

Although informal-settlement upgrading has become commonplace in some regions (in much of Latin America, upgrading is regarded as a conventional part of local government policy), there are still many examples of governments bulldozing informal settlements. In some instances, the evictees avoided forced eviction and, with government support,

city-wide infrastructure and services. But this is far beyond the capacity of most city governments and is unrealistic in relation to the very large gap between the cost of the cheapest formal house and what low-income groups can afford.

Although such conventional government responses are often not realistic, there are effective actions governments can take readily. City governments can improve access to “formal” housing by increasing the supply and reducing the cost of the key components, including land and permits, building materials, connection to infrastructure (water, sanitation, drainage, and electricity), and services.⁷ Governments can develop policies or programs to reduce the cost of land with legal tenure, encourage firms to build cheaper “formal” housing, and encourage banks to develop affordable loan programs.

For most informal settlements, the cheapest and most effective way to build resilience to climate-change impacts is to support residents and their community organizations to work with local governments to implement “upgrading” programs (Figure 3).⁴³ Upgrading programs can potentially improve the

engaged in organizing and managing their move and choosing the resettlement location.^{9,44,45} But more governments—and the planning professionals that support them—have recognized that evicting informal-settlement residents is neither acceptable nor effective because these residents crowd into other settlements that are already overcrowded.

Differences in the Scope and Effectiveness of Upgrading

A review of documented experiences with upgrading reveals that there are very large differences in what upgrading provides, what it costs per house served, who implements it, who pays for it, and the extent to which it engages the population and serves its needs. Figure 3 highlights the range of responses to informal-settlement upgrading, ranging from eviction to transformation.⁴³ Upgrading ranges from rudimentary provision of infrastructure (for instance, public water points and a storm drain) to a full range of infrastructure and services (often community facilities and sometimes income generation or support for housing improvement or extension) and land tenure granted to the occupiers.^{46,47}

Rudimentary upgrading does little to build resilience, but comprehensive upgrading that does contribute significantly to resilience can cost several thousand dollars per house.⁴⁷ The legal costs of sorting out tenure for the occupiers can be particularly high as a result of landowners' demand for compensation (if the land that has been occupied is privately owned) and the costs of preparing a cadaster to define and register ownership of plots and their boundaries. Land-titling programs are beyond the capacity of many urban governments.⁴⁸

The costs of upgrading are usually covered by the public agency supporting the initiative, although as discussed below, it can include a household or community contribution both in terms of labor for infrastructure installation and in terms of loan repayments. There are also public schemes described as upgrading where the inhabitants get displaced while dwellings are bulldozed and new apartment blocks are built and where there is no guarantee that the original inhabitants will get one of the new apartments.^{49–51}

Upgrading might not ensure that all buildings meet all official regulations, but upgrading can produce government acceptance of more appropriate standards—for instance, smaller plot sizes.⁵² Or it might catalyze changes in official regulations to lower the cost of “formal” housing.⁵³

Where government-supported upgrading works well, it greatly improves housing conditions, infrastructure (including links to city-wide systems for paved roads, water, wastewater, and storm drainage, all of which 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 of the associated costs, including disruptions to social networks and almost always less favorable locations).

There are also many government initiatives that upgrade informal settlements but that are not termed as upgrading. In many Latin American cities, provision of piped water, sewers and storm drains, and electricity has been expanding to reach almost all residents, including those in informal settlements.²³ These are often part of city-wide initiatives; see, for instance, the experiences in Rosario⁴⁷ and Porto Alegre.^{54,55} One factor behind this was the political changes brought in many nations with the return to democracy and strengthened capacities and accountabilities of city governments that included elected mayors.^{55,56} These often led to land-titling programs in informal settlements⁵⁷ and participatory budgeting—which gives each city district the right to influence priorities in public works and makes the city budget more transparent.⁵⁸

In South Africa, the national development plan calls on government to stop building houses on poorly located land and shift more resources to upgrading informal settlements provided that they are in areas close to jobs.⁵⁹ The government has also made a strong commitment to community-led practices for upgrading. However, it has proved difficult to put these into practice within the formal processes of local government given its sectoral rivalries, bureaucratic inertia, and range of (often inappropriate) rules and regulations.⁶⁰ Although civil society has made many efforts to engage government and has succeeded in securing innovative policies, scaling these up has proved difficult.^{51,61}

Household and Community Responses

If there is no government support for upgrading, households and community organizations could take on upgrading initiatives that contribute to resilience to extreme weather.^{11,39,62–64} For their homes and settlements, this could include barriers to prevent the entrance of floodwater into homes and house designs that keep down high temperatures. They often include food stores on top of high furniture or shelves and electrical wiring as high as possible.^{2,62,64–66} But there is less scope for housing modifications to keep down extreme heat.⁶⁷

Local funds can enhance low-income households' resilience by supporting them to upgrade or to get or build better housing. One example of this is the Akiba Mashinani Trust (AMT), which provides funding and financial services to the Kenyan Homeless People's Federation (Muungano wa Wanavijiji), a federation of autonomous savings groups with over 60,000 members from informal settlements across Kenya. The AMT provides a range of financial services: support for savings groups; livelihoods loans that can be used to finance group enterprise or individual projects, such as selling groceries, clothes, and food or opening a hotel or motorcycle taxis (bodaboda); consumption loans to cover expenses such as school fees, medical costs, and home improvements; and community project loans for Muungano's social housing, sanitation, and basic-infrastructure projects. These loans finance *in situ* upgrading and housing improvements, land acquisition for housing development, and greenfield housing development. As of December 2016, 6,822 Muungano members had received financing from the AMT for land and housing, and 6,174 members had benefitted from livelihood loans.⁶⁸

Households and communities can reduce risk through upgrading buildings and site and neighborhood improvements.⁶³ But, household- and neighborhood-level investments cannot provide the trunk infrastructure systems required (paved roads, piped water mains, sewer and storm drainage systems, and street lighting). Nor can they act outside their locality—for instance, for “upstream” watershed management to reduce the volume and velocity of flood waters passing through their settlement.³⁹ The effectiveness of community-based action also depends on how representative and inclusive the community leaders and organizations are^{63,69–72} and on their capacity to generate pressure for more substantive changes in government policy and programming. This also depends on the quality of their relationships with different levels and sectors of government.^{73–75}

Building Resilience through Upgrading Initiatives

The last 20 years have brought many upgrading initiatives driven by community organizations formed by their residents and supported by local governments. These include many initiatives by national federations of slum or shack dwellers in over 30 nations.⁴² These have been supported by Slum/Shack Dwellers International (SDI) and the Asian Coalition for Housing Rights.⁷⁶

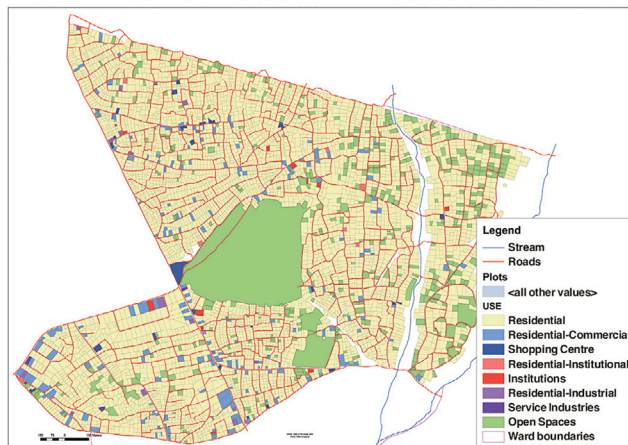
The foundation of these federations is community-managed savings groups; most savers and savings-group managers are women, so their needs and priorities are fully included. The many slum- and shack-dweller federations and their supporting



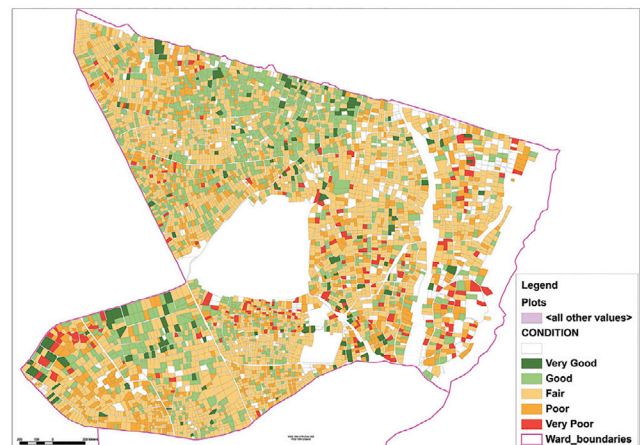
Map 1: A satellite image of Epworth, showing the location of Ward 7.



Map 2: The digitized map of Ward 7.



Map 3: Current land use and use of buildings in Ward 7.



Map 4: Conditions of buildings in Ward 7.

Figure 4. Maps from a Community-Led Enumeration of an Informal Settlement in Epworth, Zimbabwe

These four maps illustrate different stages in the community-driven enumeration of Ward 7.⁷⁸ Map 1, a satellite image of the urban center of Epworth, shows the location of Ward 7. Map 2 is a digitized map of Ward 7. Maps 3 and 4 show the kinds of very detailed maps that this digitized map makes possible; map 3 shows current land use and the use of buildings in Ward 7, and map 4 shows the conditions of buildings in Ward 7.

nongovernmental organizations (NGOs) 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.⁷⁷ Federations actively seek good relations with politicians and civil servants at different levels—from the ward up to and beyond the city.⁷⁴ They can use this to negotiate for support and co-production in upgrading initiatives.

These federations have developed methodologies for community-led documentation of informal settlements⁷⁷ to provide the data and detailed maps needed for planning and implementing upgrading programs. This includes preparing profiles of all informal settlements in a city and maps showing their location and boundaries (recorded on geographic information systems),^{15,16} which in turn helps develop better relations with government bodies that lack these data. If a city government agrees to support an upgrading program, a more detailed enumeration is carried out in the settlement to be upgraded—which is in effect a census given that data are collected from each household.^{15,77}

Figure 4 shows four of the many maps generated by a community-driven enumeration in Magada (Ward 7), an informal settlement in Epworth, just outside Harare, the capital of Zimbabwe.⁷⁸ This settlement had over 35,000 inhabitants and very inadequate provision for water and sanitation. It had also long been at risk of eviction.

The enumeration and maps drawn from its data were developed after agreement was reached between the residents and their community organizations and local and national governments for upgrading. The enumeration was done by residents, supported by the Zimbabwe Homeless People's Federation, Dialogue on Shelter Trust, and planning students. It set a precedent in that it was the first time that a city government in Zimbabwe supported upgrading and such wide-ranging participation.

Map 1, a satellite image of Epworth, shows the location of the area to be enumerated. Map 2 shows the digitized map where the data collected were superimposed onto the satellite image. Maps 3 and 4, examples of maps developed from the

enumeration, show the current land use, the use of buildings, and the conditions of buildings. Other maps provide the basis for re-blocking to allow access roads to be brought in.

Enumerations such as this provide the data and maps needed for planning the installation or upgrading of infrastructure and services. Enumerations also collect data on residents' past experience in coping with extreme weather and residents' perceptions of the most serious risks that they face—and so provide a foundation for assessments of climate-change risk.

Many federations work in partnership with government in upgrading. The Kenyan Homeless People's Federation is developing an upgrading plan for the 101,000 households that live in Mukuru, one of Nairobi's largest informal settlements.⁹ In Pune, the federation formed by female savings groups (Mahila Milan) is upgrading a very high-density informal settlement without displacing anyone.^{49,50} The Community Organizations Development Institute (CODI) in Thailand has implemented a secure tenure program that supports residents of informal settlements to design and implement their own upgrading programs. More than 100,000 households have benefitted from this program.⁷⁹

Many forms of direct citizen participation have included upgrading through processes of co-production, whereby local communities and local government join forces.⁸⁰ One of the best known is the work of the Orangi Pilot Project Research and Training Institute in Pakistan, which has implemented one of the largest and most successful informal-settlement upgrading programs. This brought household and community investment together with government investment to integrate community- and city-wide systems for water mains and sewers.⁸¹

For informal settlements on dangerous sites, relocation might be needed, and there are examples of practices where those who were moved were organized and engaged in finding solutions that worked best for them.^{9,45,82,83} There are also examples where urban governments successfully provided "formal" alternatives to informal settlements: cheap "formal" plots were provided in Ilo,⁸⁴ households living on flood-prone sites in Solo were provided financial support to find and build on safer sites,⁸⁵ and the cost of formal plots was made cheaper (reducing minimum plot sizes and infrastructure standards) in Windhoek.⁵³ But there are many examples of less successful programs: large-scale public-housing programs whose housing never got allocated to low-income groups or whose poor-quality and distant location made them unsuitable.^{7,86}

There is the issue of how well upgrading serves groups that are more vulnerable to climate-change impacts—more sensitive to or affected by risks and/or less able to cope and adapt. For instance, how well does upgrading reduce risks to which infants or children are particularly susceptible? Does upgrading address the needs of those facing discrimination (for instance, on the basis of age, sex or gender, or social group)? If upgrading includes providing land tenure, this could exclude tenants.

We still know too little about the gendered dynamics of climate-change adaptation in informal settlements.⁸⁷ In many cities, women are disproportionately represented among renters as a result of gender-based barriers to homeownership.⁸⁸ Upgrading programs that include land titles could

discriminate against women. Discriminatory inheritance and divorce practices can exclude women from owning or realizing the value of land and property. Gender norms can stigmatize single or divorced women, preventing them from getting rental accommodation and making it harder to access credit.^{88–91} Community savings groups where most savers and savings-group managers are women are the foundation of the slum- and shack-dweller federations mentioned above and among the means of ensuring greater gender equality.

Addressing Barriers to Upgrading

Addressing Climate-Change Adaptation and Mitigation

Upgrading informal settlements is not generally seen as part of climate-change adaptation or of building resilience to climate-change impacts. Yet as described earlier, there is a long and varied experience with upgrading. If upgrading works well, it can greatly increase the resilience of low-income households, buildings, infrastructure, and services to extreme weather. It is an approach that is now widely accepted by government. Upgrading can adjust to local needs, capacities, and contexts. As this section describes, upgrading can integrate many measures to contribute to climate-change adaptation and some to mitigation too.

The IPCC's Fifth Assessment Report emphasized that urban governments are uniquely situated to reconcile development with climate-change adaptation because they "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" (p. 577).² It also recognized the importance of local government-community partnerships working to upgrade informal settlements.

Upgrading can include support for new employment possibilities generated by the management of ecosystem services and waste.⁹² Most cities in the Global South have large informal waste economies where formal systems do not operate—for instance, in the informal collection and disposal of households' solid, liquid, and toilet wastes. Most informal-settlement dwellers—who receive no formal services—rely on such informal waste economies, which also support high rates of resource reuse or recycling. Informal waste economies are also important for flood prevention; uncollected wastes often end up in drains or clogging local rivers and streams, which exacerbates flooding and contaminates flood waters (especially from toilet waste). Local governments might not recognize or support the contributions that informal waste collectors and pickers make to serving both formal and informal households, cleaning streets, reclaiming (and thus reducing) waste, and reducing carbon emissions.^{31,93–95}

Integrating resilience into government programs, including support for upgrading, requires agreements between different government departments or ministries at different levels over priorities and resource allocations. To be effective, it needs informal-settlement dwellers and their organizations to engage.^{96,97} Some city case studies have demonstrated how development, disaster-risk reduction, and climate-change adaptation can be combined in and around the city. Examples include the flood-protection initiatives in Santa Fe⁸³ and the land-use management in and around Durban to protect biodiversity and the ecosystem services on which the city

depends while also supporting new livelihoods.⁹⁸ There are also examples where the use of green and blue infrastructure has contributed to floodwater retention and temperature regulation.⁹⁹

Governments might blame informal settlements for some environmental problems, but informal-settlement dwellers have demonstrated how they can be guardians of the environment (for example, in Surabaya and Bangkok) by preventing waste disposal into rivers and canals.^{100,101} In Manizales, those living on unsafe steep slopes were resettled, and the land was then converted into community parks managed by residents.⁸²

Greening Upgrading

Upgraded settlements would also benefit from good connectivity through high-quality bus and rail.¹⁰² Upgrading can contribute to low-carbon mobility to ensure that walking, cycling, and public transport are safe and attractive¹⁰³ and to housing designs that reduce energy consumption. The modular design of many renewable energy technologies allows incremental deployment to informal settlements.³⁷

The lack of open space in dense informal settlements usually means few cooler public spaces within or beside the settlement where residents can get some relief from very high temperatures within their dwelling.¹⁰⁴ Community-driven re-blocking in informal settlements can enlarge open spaces, as in many previously described upgrading initiatives supported by CODI. Several city governments have also expanded parks and playgrounds to low-income areas, as in Rosario^{47,105} and Manizales.^{82,106}

Informal settlements can also be located on sites that are ecologically sensitive or critical for biodiversity, water supplies, or flood protection.^{92,107} But when well-managed, informal settlements can accommodate space for housing (and plots that low-income households can afford) while also protecting ecosystem services,¹⁰⁸ this can enhance resilience to climate-related shocks and stresses.^{109,110}

Local Funds

One of the most effective approaches to addressing resilience issues in informal settlements is grassroots organizations working with committed government officials and politicians to develop local funds. These are capitalized from multiple sources, including community savings, grant and loan assistance from governments and international agencies, and state subsidies. Hundreds of examples of local funds supported by local government and shared across community groups can address housing and infrastructure needs for resilience, as well as livelihoods, education, and welfare.^{42,111} But as of yet, this has not led to international or global funds able to work with and support city governments and community-led policies, practices, and local funds.

One example of funding that is reaching grassroots organizations and stimulating local government to work with them is funding from the Asian Coalition for Community Action, which has catalyzed community-driven upgrading in over 1,800 small communities and more than 100 larger housing initiatives in 215 cities across 19 different nations.¹¹² In each city, the community organizations present their work to city government. This often leads to a joint working group at the city level to provide a platform for community networks, city governments, civic groups, NGOs, and academics to plan and manage the

upgrading. In many of the cities involved, new local funds have been developed and jointly managed with local government.⁷⁶

Generating Relevant Data

Governments usually have a range of data sources, including household surveys and censuses, to draw on when planning upgrading. But as noted in [Rapid Urbanization and Growth of Informal Settlements](#), these often have severe limitations. Household surveys have sample sizes that are too small to be able to provide data for each informal settlement.⁵ Censuses should provide detailed data for each city and each informal settlement down to each street. But local governments rarely get these data. In addition, many nations do not have regular censuses.¹

City governments need information systems that provide relevant data for upgrading and for building resilience to climate change. In many cities, this is mostly about bringing together and integrating already available information (geo-referenced where possible) to ensure that it builds on the knowledge of local actors and that it is available and accessible to all within a process that constantly updates it.¹¹³ A study of decision making with regard to climate resilience in Dosquebradas, Santa Ana, and Santo Tomé found that there was usually sufficient information to guide actions but that the needed information was held by different government offices, universities, research centers, and private sector bodies and not shared.¹¹³

In the Asset Planning for Climate Change Adaptation initiative in Tegucigalpa, residents from poor urban communities worked with municipal authorities and other actors to identify, negotiate, and agree on climate-change-adaptation solutions that were both legally and technically feasible and financially and socially acceptable.¹¹⁴ Ward-level community resilience planning in Gorakhpur showed how low-income households, a local NGO, and the local private sector could produce the information needed to address resilience issues, but it was difficult to get support from the city government to expand this to other wards.¹¹⁵

In recent years, many tools and methods have been developed for measuring or profiling urban resilience,^{116,117} including UNISDR's City Resilience Scorecard,¹¹⁸ the City Resilience Index developed by ARUP and Rockefeller,¹⁷ and the UN-Habitat City Resilience Profiling Tool.¹¹⁹ A review of these and other methods for identifying risks (including impact-and-loss studies and urban resilience frameworks) noted how these have helped fill data gaps and support consultations with local government and other stakeholders.¹¹⁷

But these tools and methods do not appreciate the importance of community- and local-government-led upgrading for reducing the risks that they identify. They have limited capacities to fill data gaps in relation to informal settlements' upgrading. They also have difficulties in giving voice and influence to informal-settlement residents and their organizations.¹¹⁷ Community-generated data-collection methods work well for informal settlements and can generate detailed data about every household but less so for city-wide perspectives (with some notable exceptions).^{15,112}

Synergies with the Sustainable Development Goals

Before any conclusions are drawn, it is worth considering the extent to which the UN SDGs¹²⁰ address the need for resilience

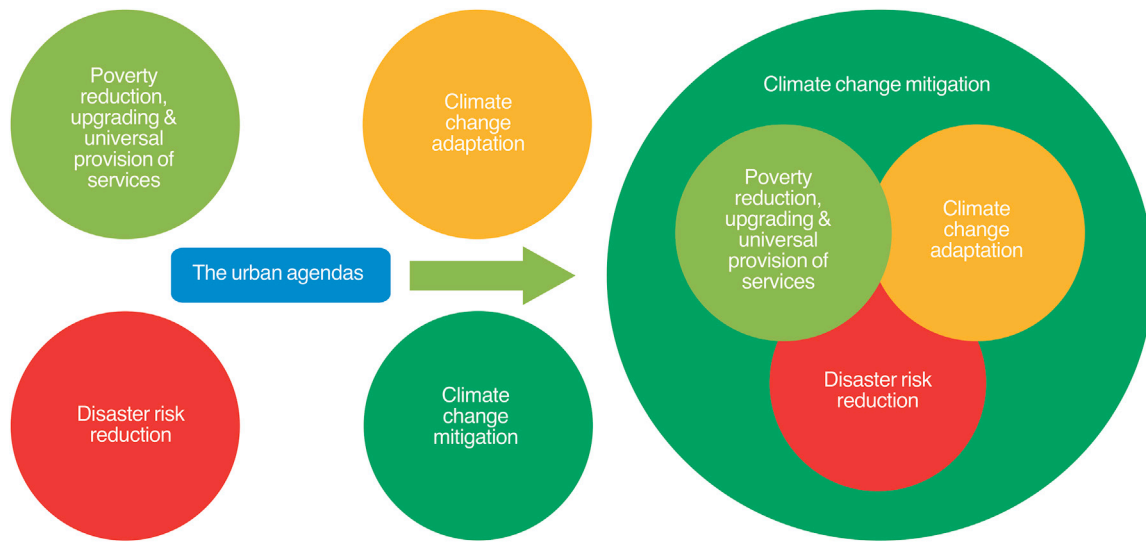


Figure 5. From Competing Agendas to Integrated Responses to Climate Change

This figure shows the need to move to an urban agenda that encompasses development, poverty reduction, disaster-risk reduction, climate-change adaptation, and climate-change mitigation.¹²¹

to climate change in informal settlements. Almost all of the SDGs will contribute to resilience if they are met. Most have relevance to building resilience in informal settlements (including ending poverty and hunger and ensuring healthy lives), but this gets obscured by having key resilience-building measures relevant to informal settlements scattered through the SDGs or subsumed under other issues judged to be more important.

SDG 11 is the only SDG that mentions housing or slums: “Make cities and human settlements inclusive, safe, resilient and sustainable” and “by 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums” (p. 21).¹²⁰ There is no mention of informal settlements here or in any other SDG.

The importance for resilience of good-quality housing served with risk-reducing infrastructure is lost within other SDGs. It is through and in their housing that people get access to piped water, sanitation, and modern energy and electricity, but these have their own SDGs (6 and 7). SDG 9 is about building resilient infrastructure but focuses on industrialization and does not mention the infrastructure needs of informal settlements.

Upgrading informal settlements can contribute to many of the SDGs, such as ensuring healthy lives (e.g., reducing indoor air pollution [SDG 3]) and achieving gender equality (e.g., in access to land [SDG 5]). SDG 16 is not about informal settlements, but in some aspects it is the most relevant SDG for informal settlements. SDG 16 commits countries to “... provide access to justice for all and build effective, accountable and inclusive institutions at all levels” (p. 25).¹²⁰ It mentions the importance of a registered address and citizenship recognition, which is central to upgrading informal settlements. SDG 16’s targets also address participation in decision making, access to information, and promotion of the rule of law. SDG 16 gets less attention than other SDGs with more focused goals and international institutions that promote them, but it is difficult to imagine how most such goals (for instance, for water, sanita-

tion, electricity, infrastructure, and healthcare) will get met without the “good” governance that SDG 16 demands.

Overall, the SDGs are very explicit about what has to be achieved but far less so about how, by whom, and with what resources. If grassroots organizations working with local governments in upgrading informal settlements are a key part of building household, settlement, and city resilience, then they need international funds on which they can draw. At present, few international funds are capable of listening to, working with, and supporting these local processes and the local funds they need.

Conclusions

Rapid urbanization in low- and middle-income countries has been accompanied by the rapid growth of highly vulnerable urban communities living in informal settlements, many of which are on land at a high risk of climate change. The IPCC has emphasized the urgent need to build resilience to climate change in informal settlements. It has also emphasized the need to learn how best to do so. These settlements house more than a fifth of the world’s urban population and represent one of the groups most at risk of climate change. Without more effective policies, much of the rapid growth in the world’s urban population is likely to be housed in informal settlements.

Community- and city-government-led measures to upgrade settlements can enhance resilience to climate-change risks and serve vulnerable groups. Most upgrading programs were not designed as responses to climate change, but they can provide the foundation into which climate-change resilience and disaster-risk reduction can be fully integrated. There is much overlap and complementarity between what informal-settlement upgrading needs and what builds their resilience to climate change; both focus on local risks. Both upgrading and resilience building usually need actions to reduce disaster risk in the wider region. But integrated action is a challenge because

responsibility for upgrading and for resilience usually falls under different sectoral agencies.

There is a wealth of experience with upgrading informal settlements on which we can draw. What can we learn from the examples given in this paper on how to increase the scale and efficacy of community-driven approaches? Informal-settlement residents are being organized within representative structures, want to work with government, and are bringing their plans and showing their capacities. And this is seen by senior civil servants and mayors and other local politicians not as a threat but as providing partners with resources and capacities to act on upgrading at a city scale.

New funding models that account for climate change are needed to support city governments and other local actors to act on upgrading. Figure 5 shows the shift from what are often seen as four competing agendas to the collaboration possible with so many overlaps and complementarities between upgrading, disaster-risk reduction, and climate-change adaptation.¹²¹ All have a focus on reducing local risk and on resilience, even if they bring different lenses to identifying and acting on them. There is less direct overlap with mitigation, but without mitigation and the avoidance of dangerous climate change, the other agendas will become increasingly ineffective. The new funding sources need the capacity to support local governments and civil society and to ensure that they move toward transformative adaptation where all four agendas in Figure 5 are addressed.²

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