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Human Settlements: Urban Challenges and Future Development

Abstract

Human settlements are comprehensive, i.e., shaped by human ecology and the relationship between humans as a social being and biological organisms and their interaction with their environments. This chapter explores urban morphology and landscape ecology as a pretext to a wider examination of the vast scholarship of why humans settle where they settle—with the focus on cities. The movement away from rural to urban is considered in conjunction with urban energy use, agriculture and food security, and sustainability. Maladaptation to climate change is considered in the context to urban environmental pollution, human health and well-being, and quality of life. Cities have a unique opportunity to advance policies that ensure the energy supply and food production are reliable, affordable, and environmentally sustainable. In terms of energy research, direct effects on people, communities, and countries in terms of economic growth, health, safety, the environment, education, and employment are investigated. Agricultural data is presented from a global perspective with specific land use and land cover specificities. Food security, food health, and food production are interfaced with regional populations and agricultural land use. An overview of cities from the Global North versus the Global South is assessed in terms developmental parameters—including city-to-city climate action. These city variances, specific to developed and developing countries, indicate megacities in the North have relatively high affluent and stable populations while those in the South have rapid expanding and overcrowded ones. Case-specific research into the effects of the COVID-19 pandemic on informal settlements is looked at in terms of direct and indirect impacts. The complexity of these issues signposts different types of human settlements and conditions and veers toward piecing together the urban challenges and future development of the twenty-first century.

Keywords
Human ecology · Urban morphology · Green infrastructure · Urban energy · Climate change · Agriculture and food security · Cities · Informal settlements · COVID-19 support

1 Human Ecology: Urban Morphology and Landscape Ecology

Human ecology expands on the relationship between humans as social beings and biological organisms and their interaction with their environment. It has become the epicentre of international debate, revolving around the sustainable development agenda, in every corner of the world. In the field of sustainable urbanism, urban morphology and landscape ecology have become crucial in analysing perspectives of future of human settlements [1, 2]. This is because cities play a crucial role in the rise of greenhouse gas (GHG) emissions and urban pollution. Cities account for a small percentage of the earth's surface, yet they host the highest proportion of the world's population. In 2018, it was estimated that 53% of the world's population lived in urban settlements [3]. Moreover, cities consume about 75% of the world's energy and emit about 60% of the world's CO_2 [4–6]. The urban population is projected to increase above 60% by 2030 [7]. This creates an urgent need to examine sustainable energy consumption, low-carbon emission, and climate adaptation. The vast literature on urban morphology and landscape ecology enable us to understand human ecology in the urban setting, including architectural archetypes, energy systems, and inhabitant behaviour [8]. As a result, there is a growing scholarship on knowledge management perspectives in terms of urbanization and human ecology where cities have become information hubs [9–12]. As such, urban morphology is a key approach to study human ecology. It analyses the formative and transformative process of an urban area and draws from various disciplines, including urban geography, planning and archaeology, anthropology, urbanism, and architectural history [13–15]. Urban morphological concepts enable us to understand how current urban environments, as habitats, were formed and how urban phenomena such as energy use, land value, urban agriculture, urban microclimate, and mobility exist. As well, it brings together the interrelationship and complexity of various segments of urban settlements and their relationship with non-urban areas.

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Urban morphology is a method of identifying, structuring, and investigating sets of relationships of various multidimensional complexities ultimately to inform policy-makers on strategic urban planning. This is notwithstanding that urbanization is a sociopolitical act, i.e., different urban processes are driven by economic and political concerns [15, 16]. Scholars have studied urban morphology in different ways. The four broad approaches are typo-morphological, configurational, historico-geographical, and spatial analytical. Each urban form uses different tools and methods to examine human ecology. These approaches differ in explaining levels of complexity and compositional hierarchy in the structure of the urban open and built form. Typo-morphological analysis emerged from urban design analysis in Europe and North America and is mainly confined to historical urban forms. Mainly relevant to urban surveying and planning, e.g., studies showing harmonious development of European towns and cities [17], it has been used to study urban areas globally [18]. Other investigative research has used configurational urban morphology, commonly using space syntax methods (i.e., to analyse urban configurations) such as spatial categories and structures, aerial differentiation, and other urban structural sub-systems, to better understand these areas. Such an analysis is essential in understanding the relationship between urban structural configuration and social capital [19]. The historico-geographical approach is concerned with the physical forms of cities, the agents, and processes that shape those forms over time [14]. The spatial analysis of urban morphology relies on analytical cartography and visual communication tools to illustrate the formation and transformation of urban forms [20, 21]. These human ecology approaches each have their own strengths and challenges in the assembly of urban morphology research. To have a complete understanding of urbanization, scholars combine different urban morphology forms to the study of human ecology [18].

Landscape ecology is concerned with the interrelationship between spatial patterns and ecological processes. It borrows from economics, sociology, geography, earth sciences, and computer application to study urban settlements, i.e., open and built landscapes [22]. It also deals with the generation and dynamics of constellations in ecosystems and their relationship with urban structures, communities, and ecosystem processes [23, 24]. Scholars have used landscape ecology to examine the structure and composition of heterogeneity of landscapes and their effect on people, the environment, and climate change [25, 26]. The future of human ecology examines our understanding of climate change and biodiversity in urban settings—interlinked by urban morphology and landscape ecology. Some of the new concepts like urban green spaces are becoming more mainstream and are gaining traction in how cities are designed [27, 28]. Other concepts such as smart cities incorporate Internet-based development, e.g., digital infrastructure, renewable energy, data management systems, cloud computing, and the Internet of things [19, 20, 29]. In other cases, peri-urban areas in developing countries undergo physical transformations to become cities [30] in which urbanization is often linked to deforestation, flooding, and desertification [31, 32]. The future of human ecology underpins the sustainable urbanization process, including clean energy consumption and decarbonization in cities. There is a vast scholarship of climate change adaptation, where cities spearhead climate action [33, 34], where emerging threats of detrimental risks of adaptation are not met—the so-called maladaptation dilemma [35] and business- as-usual mentality [36]. In this chapter, a breakdown on why humans settle where they settle—with a focus on why people settle in cities—is examined. The movement away from rural to urban is looked at in conjunction with urban energy, agriculture, a North–South overview, and case research into the effects of the COVID-19 pandemic on informal settlements.

2 Green Cities, Urban Agriculture, and Sustainable Energy

The health and well-being of people are becoming increasingly dependent on the quality of urban settlements [28, 37, 38]. Over the last 30 years, urban settlements have experienced dramatic growth [39]. Also, food, energy, raw materials, consumer products, and economic production are all connected to global networks, and these long-distance transactions produce substantial GHG emissions [39]. Thus, having access to clean, accessible, and reliable energy has become the pillar of prosperity and economic development [40]. As a result, cities have a unique opportunity to advance policies that ensure the energy supply and food production are reliable, affordable, and environmentally sustainable [39]. Urban design and landscape architecture are some of the more important tools for creating sustainable urban settlements. There is a need to consider design approaches and strategies that would work at a city scale such as a green infrastructure-led design approach that “creates healthier more socially cohesive and biodiverse urban environments and a connected city ecosystem for people and wildlife that also builds in resilience measures against climate change in the form of storm, flood, heat, drought, and pollution protection” [41]. In particular, green infrastructure can improve cities’ adaptive capacity by preparing for and responding to shocks and systemic changes brought on by severe weather and natural disasters [42]. Ecosystem services, i.e., provided by green infrastructure, can contribute to a more energy-efficient and less carbon-intensive urban metabolism [43].

Green infrastructure can help to mitigate the negative effects of the energy sector, by (1) reducing energy consumption, (2) supplying bioenergy, and (3) capturing and storing carbon [44]. Green roofs can contribute to decreasing building energy as well as mitigating the urban heat island in cities [45]. According to Tsoka et al. [46], the shading effect of dense trees can result in energy savings of 54% in a dense urban area in Thessaloniki, Greece. A critical review for evidence-based urban greening in North America, Ko [47] found, in contrast to buildings without trees, buildings with trees used

2.3–90% less cooling energy and 1–20% less heating energy due to wind-break effects. A study conducted by Nowak et al. [48] in the USA, found that trees and forests in urban and community areas annually reduce electricity use by about 38.8 million MWh (i.e., USD 4.7 billion), heating use by 246 million MMBtus (i.e., USD 3.1 billion), and an average reduction in national residential energy use due to trees is 7.2%. If implemented throughout an urban watershed, green infrastructure strategies such as low impact development in the USA or surface water management systems and sustainable drainage systems in the UK can have significant energy cost savings to municipal water pollution control facilities [49]. Moreover, green infrastructure implementation in urban regeneration projects can have a positive impact on the economic value of target buildings as well as their larger contexts of open spaces, housing, and public facilities [50]. The ecocity of Augustenborg, Sweden, is an excellent example that incorporates blue and green infrastructure to address issues such as flooding, new renewable energy sources, sustainable construction, recycling systems, and sustainable transportation [44, 51]. Augustenborg's design had several tangible benefits, including: increased biodiversity by 50% (i.e., by creating natural habitats), reduced emissions from the neighbourhood by more than 20% (i.e., due to energy efficiency protocols), and increased renewable energy usage (i.e., accounting for 80–85% of it is used in the heating systems city-wide) [51]. Green infrastructure not only reduces energy consumption but can provide food security in cities, e.g., via edible green infrastructure (i.e., urban agriculture, allotment gardens, edible commons, and edible green roofs) [27, 28, 52, 53]. An illustrative difference between gray and green cities is shown in Fig. 1.

Several studies have highlighted that edible green infrastructure and urban agriculture can be very productive, bolstering environmental and social benefits over intensive farming since crops are typically grown with little chemical inputs, travel shorter distances, and are intended for local use [54]. According to Russo and Cirella [27, 28, 55], edible green infrastructure can also regenerate sounder urban settlements. Urban woody biomass, for instance, from pruning residues can be used as bioenergy [56, 57]. The direct burning of pruning residues for electricity generation can be advantageous not only because it saves fossil fuels and creates new economic opportunities, but it also results in low CO_2 power generation [58]. Winzer et al. [59] calculated that the clearance wood from fruit trees could generate an energy potential of 191,000 MJ * ha^{-1}. Clinton et al. [60] estimated urban ecosystem services provided by urban vegetation—globally—could result in annual food production of 100–180 million tons, energy savings ranging from 14 to 15 billion kilowatt-hours, nitrogen sequestration between 100,000 and 170,000 tons, and avoided stormwater runoff between 45 and 57 billion m^3 annually. It is believed that a sustainable planning and management vision that promotes integrated green space, a multimodal transportation system, sustainable food production, energy efficiency, and mixed-use growth should guide the design and planning of urban settlements [61]. Future research should investigate the implementation of futuristic algae-powered buildings for the production of bioenergy and biofuel in urban environments [62]. To explore this factor, the need to better understand human settlements in relation to energy is looked at followed by an examination of land use in terms of agriculture and food security.

Fig. 1 Gray city (e.g., fossil fuel society, no sustainable transportation, and no recycling) versus green city (e.g., green infrastructure, 10-min walk to a park, sustainable energy, urban agriculture, sustainable transportation, and recycling). Vector files designed by Macrovector and Freepik

3 Human Settlements in Relation to Energy Needs

The relationship of energy with human development is identified in many studies [63, 64] directly affecting people, communities, and countries in terms of economic growth, health, safety, the environment, education, and employment [65–67]. However, a study by Wu et al. [68] using panel data claimed that in 105 countries, this relationship is only short term. In contrast, research from Wang et al. [69] illustrated renewable energy consumption did not improve the human development process; as such, fossil fuels (i.e., oil, coal, and gas) still lead the global energy supply [70] accounting for around 500 EJ annually [71]. The global installed capacity is much less (i.e., 50% in China, Brazil, Canada, and the USA) from the total capacity potential of 3721 GW [72]. Bioenergy, which is generated from biological sources, has a large potential (i.e., 3500 EJ annually) [73]; however, the production of biofuels is comparatively low [74]. The emergence of wind as a source of energy has taken a superior lead in renewable sources [75]. Another important source of energy is direct solar energy; the World Energy Council [72] shows that the total energy from solar radiation is more than 7500 times the world's annual energy consumption.

The share of global primary renewable energy could rise from 11% in 2019 [76] to 63% in 2050 [77]. The IRENA [78] project clearly manifests that about 50% of renewable energy will need to be from wind, solar, and biofuel energy sources with 24%, 15%, and 10% share, respectively, in 2050 (Fig. 2). Estimations using energy demand models show that the amount of primary energy from biomass—if supplied cost effectively—is approximately 50–250 EJ per year while the global primary energy use is predicted to be approximately 600–1040 EJ per year by 2050 [72, 79]. This confirmation, at least in principle, indicates the biomass potential and demand could increase to one-third of the global energy demand [80]. The motivation of using renewable energy is steadily being accrued in many countries via fossil fuel price hiking [81], clean energy subsidies, technological advancements, and policy targets in-line with the United Nations Sustainable Development Goals (SDGs) [82, 83]. For instance, the European Union has recently revised its 2030 target from 27 to 32% set back in 2014 [84]. The Government of India set a renewable energy target of 175 GW by 2022, which includes 60 GW from wind and 100 GW from solar energy [85, 86]. About 11% of the total energy demand and 17% of all electricity generation in the USA are supplied from renewable energy resources according to the latest data from its Energy Information Administration [87]. Likewise, China has also set targets to reduce its carbon emissions per unit of gross domestic product (GDP) by 65% by 2030 in-line with its 2005 levels—playing a pivotal role in its energy grid. China's target for non-fossil fuel share in total energy demand is 20% by 2030 [88]. Russia, one of the largest fossil fuel resources in the world [77], has implemented energy trials of in excess of 5 GW from wind and solar energy since 2013, with projections of exceeding its 2024 target of 5.9 GW [77, 78, 89].

A transition away from fossil fuels to low-carbon solutions will play an essential role, as energy-related polluting emissions represent two-thirds of all GHGs [90, 91]; however, experience has shown that energy transitions take time, typically half a century from the first market uptake to the majority of market share [92]. Therefore, business opportunities, energy transition benefits, and self-determination of individuals will still need to be at the core of such change [93, 94]. Moreover, problems in the energy sector go beyond traditional government research and development, as it will require appropriate policy incentives and long-term perspectives—both currently lacking [78]. The potential of this energy transition is not yet fully appreciated by many policy-makers and analysts. Yet, there will be a critical threshold if many of the SDGs are to be met by 2030. From the top-down, human settlements in relation to energy must be forward- looking with the prospect of just and fair growth, that being, additional investments by 2050 should support an increase in global GDP, jobs, and environmental benefits.

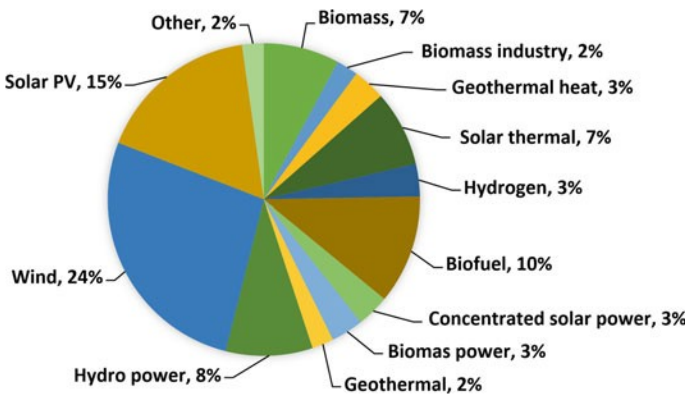

Fig. 2 Projected renewables in total world energy consumption, 2050 [72, 77–79]

4 Agriculture and Human Settlements

Over the last three hundred years, spatial patterns of land use and land cover have changed significantly [95]—specifically following the expansion of human settlements and economic development [96–101]. Croplands and pastures have increased by 279 million ha (i.e., 16.7%) between 1985 and 2013—a trend that dates back to the 1950s [102–104]. Agricultural lands establish the largest biome on the planet [105] with typological make up, including (1) a third of the global ice-free landmass [106], (2) providing food and other agricultural products for the rapidly rising human population (e.g., the increase in cereal production per capita from 0.29 to 0.39 tons per person between 1961 and 2014 [107]), (3) the major livelihood for 40% of the world's population, and (4) contributing to about 30% of GDP in low-income countries [108]. Lowder et al. [109] showed that 69% of the world's farmlands exist in Southeast Asia, South Asia, and Sub-Saharan Africa, with 30% of their produce coming from holdings less than 2 ha in size [110]. Despite all these, 800 million people remain undernourished [107] and approximately 2 billion suffer from micronutrient deficiencies [111, 112]. The main reason for the human nutrition gap is global dependency on a very few crops for energy, i.e., 84% of calories is generated from just 17 crops [113]. This is demonstrated by the dominance of white rice in the diet of Southeast Asian and South Asian regions, which experience micronutrient deficiency in prevalence of about 30% [114]. Moreover, in some regions such as in Sub-Saharan Africa, noticeable drops in micronutrient density in diets have been observed in recent decades—moving away from fruits, nuts, and pulses toward calorie-dense, but nutrient-poor foods (i.e., maize, rice, wheat, and vegetable oils) [114]. Furthermore, there is also an indication of declining trends in the nutritional quality of crops for some items detected in the USA [115]. The world produces 22% less fruit and vegetables than required to meet the World Health Organization recommendation to consume per day to achieve a healthy diet [116].

A common manifestation of climate change is the strengthening of hazardous climate events that effect agriculture such as floods, droughts, and irregular heat– cold fluctuations. "Climate change is a major issue for agricultural sustainability, and changes in farming practices will be necessary both to reduce emissions and to adapt to a changing climate and to new social expectations" [117]. Currently, agricultural lands are being degraded at an annual depletion nutrient rate of 10 million ha [118] in which clean phosphorous reserves are predicted to run out in only 20–50 years [119] (i.e., used for waterlogging and salinity control of irrigated areas [120]). Spatial diversity of cropping has also declined as large amounts of farmland grow monocultures in which the doubling and tripling of annual crops are degrading soils—globally [121]. Traditional varieties—vital for maintaining biodiversity—have been reduced due to industrial agricultural transition [122] even though farmers in traditional agro-ecosystems often maintain high varietal and species diversity on their farms as well as across communities and regions. This is much more prominent for staple rather than non-staple crops [123]. Moreover, price instability of agricultural food commodities has been escalating in the last decade [107, 124]. Farmers producing for the global market are particularly vulnerable because they are facing increasingly unpredictable market trends while the cost of agricultural inputs is increasing following the rise in the price of oil [125, 126]. Simultaneously, recent phenomena like fast urban expansion [38, 127] and land grabbing [128–130] are consuming agricultural land. In light of a continuously increasing world population, approaches and solutions to conquer these crises are immediately needed. Agricultural science and practice are asked to provide solutions to both alleviate the effects of climate change and increase adaptation of cropping and farming systems [52, 117]. According to the Millennium Ecosystem Assessment [131], the unsustainable production of food, feed, fibre, and fuel strongly degrades global ecosystems and the services those systems provided for human existence, including the provision of pure water, recycling of organic matter and nutrients, and adaptation to climate and weather events [27, 52]. Such degradation has not been hindered or overturned hitherto in spite of the fact that sustainability has become the focus of agricultural policy [118, 132]. A shift toward sustainable agricultural production demands the adoption of more system-oriented strategies that include farm-derived inputs and productivity based on ecological processes and functions [133]. However, studies show, for instance, overall yield gaps of organic farming for all crops are estimated to be 25% based on 316 comparisons [134] and 20% based on 362 comparisons [135].

The world's population is projected to be approximately 10 billion by 2050 [136] with greater per capita consumption of meat, refined fats, refined sugars, alcohols, and oils [137]. One of the two future projections of crop production for 2050 is a 60% growth in aggregate production (i.e., USD-weighted) from a 2005 to 2007 baseline and 100–110% increase in caloric demand. These studies have resulted in a doubling of food production requirement by 2050 [137, 138]. Research by Tomlinson [139], however, challenges this by utilizing the initial Food and Agriculture Organization of the United Nations (FAO) estimate of a 70% increase by 2050 as not a normative estimate but rather a projection of the most likely future. Moreover, the indicated FAO estimate is not of production or caloric input but of the USD-weighted aggregate production—exclusive of fruit and vegetables. Another recent study also commented on the doubling narrative by ignoring baselines [126], indicating only a 25–70% increase is needed between 2014 and 2050. Until recently, the prime focus of agricultural science was on supply-side solutions meeting the sustainable food security challenge. However, recent research has indicated the essential and massive advantage of demand-side solutions [137, 138, 140]. For example, Erb et al. [141] explored 500 different future scenarios for feeding the world in 2050 including the exclusion of further deforestation and found feasible biophysical options in nearly two-thirds of their scenarios—all requiring cropland intensification. Cassidy et al. [140] estimated that shifting the current combination of crops away from biofuels and animal feed would itself increase global caloric inputs by 70%. This study also calculated the approximate equivalent of all yield gains met in maize, wheat, and rice during the period 1965–2009. Notably, less-extreme shifts toward decreasing meat consumption, waste, and the demand for non-food agricultural products could greatly decrease the environmental impacts of the food system [138]. Generally speaking, increasing population, market infrastructure, and climate change are major driving forces that are transforming the agricultural industry. New management options and methods of production are required for sustainable agriculture [142]. Discovering best management options in terms of climate degradation is a key factor under consideration in agronomic research to sustain future crop productivity [143]. The use of crop simulation, i.e., as a decision-making tool, could make up an important and viable research alternative to the betterment of sustainable agriculture, the relation- ship between human settlements and arable land, and the future of agriculture relative to food projections [144]. This type of focused approach is paramount to the different ways human settlements are built and dictate, to large extent, the way people live. In terms of the urban construct, an elucidative look at cities in the north and the south will help piece together some perspective on the geography of feeding the world as well as pinpointing varying reasons for their urban morphology.

5 Cities: The North Versus the South

In the twenty-first century, cities have become the loci of the future for human settlement. An emerging primacy of cities, as places of international action, plays key parts of society's structure in the era of globalization [145–149]. They are also key agents of sustainable development [150, 151]; however, some cities are located in the Global North while others are in the South. Due to differences in the country's level of development and urban morphological processes, cities in the two worlds have generalizable characteristics—either differences or similarities—which to some extent define their relations. There are different ways to look at cities in the North and the South, including the analysis of land area (i.e., open and built environment) and demography, energy consumption, pollution, urban settlement (i.e., structure density of cities), and physical characteristics such as urban spatial structure which define the state of urbanization. The country's development level is critical, such that cities in the Global North and the Global South could have the same size but be defined by different socioeconomic rationales [152] (Fig. 3). Demographic transition in cities has shifted the locus of urban population from the Global North to the Global South [148, 153]. In this regard, the urban demographic transition is defined as "the historical period in which the population growth in cities structurally changes the settlement of territories" [154]. Also, cities in the Global South have a higher density than those in the North. Urban density is measured by determining the level of compactness, i.e., land use diversity, natural environment preservation, and efficient public transport facilities. The peripheral squatter settlement (i.e., city slums) in developing countries has the highest compactness [155]. Even though cities in the Global North and the Global South experience relatively similar inequalities in urban green spaces [155], cities' compactness in the South is generated by less strict land use planning rather than an absolute lack of it. However, some phenomena such as water and air pollution are not directly attributed to higher densities but rather because of weak environmental regulation and enforcement.

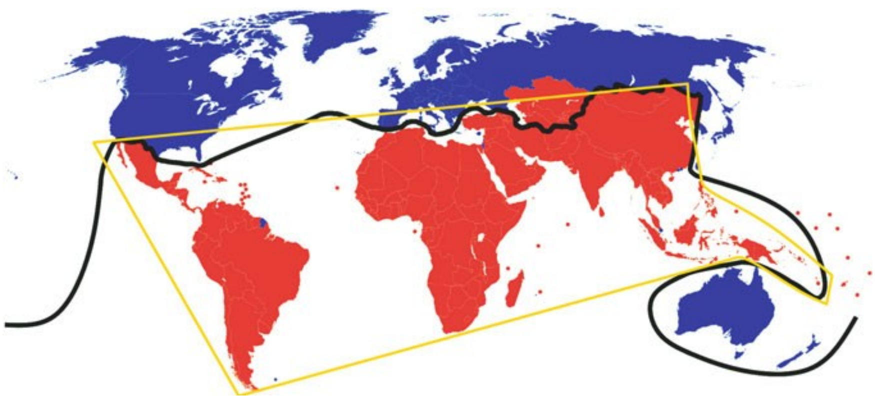

Fig. 3 World map of the Global North (blue) and Global South (red) overlaid on the Brandt Line (black line) [156] that divides developed and developing countries from forty years ago, and Ganguly and Mobley's South outline (yellow line) [157], adapted from Wikipedia Commons [158]

Most megacities are located in the Global North, while large cities in the Global South follow the Global North's spatial development trajectory. But again, megacities in the North have relatively high affluent and stable populations while those in the South are expanding more rapidly and become overcrowded. The urban landscape between the Global North and Global South is different. In developed countries, cities are built more outwardly (i.e., extensive) and up (i.e., have tall buildings) than in developing countries [152, 153]. The former has more developed transport systems compared to the South. For instance, special group-friendly features in cities are some characteristics of modern cities. Special groups like the disabled or the elderly require extra care within cities [159]. Age-friendly features are extensive within cities in developed countries than in developing ones. These urban structures correlate with the higher older population and urbanization designs in the North [160]. As such, smart city technologies are common and increasingly becoming a norm in most cities in the North. The technology is recently diffusing to the South, though, there are still inadequate studies on smart cities initiatives in developing countries [161]. Even before making an effort to become smart cities, most urban policies in the South aim to make cities functional by maintaining the provision of essential public goods such as public transport and sewerage. In addition, urban governance aims to regulate migration from rural to already the crowded urban centres [162].

Contemporarily, cities have become a major source of pollution through increased GHG emissions. As a response, and in-line with SDGs, cities are engaged in climate adaptation planning, which include a combination of social, structural, institutional, and technological measures to adapt [163–165]. While cities in the South are less industrialized and generate far lower levels of emissions than those in the North, climate adaptation planning is a top priority agenda in both. In the North, adaptation planning is well established [166, 167], especially where cities share sustainability-oriented knowledge and experience through city-to-city networks [168–172]. However, cities in the South are in their early stages of adaptation planning and tend to learn best practices from their North counterparts [167]. Owing to the advanced city networks in the North and the homogeneity of city features and urban challenges, climate adaptation planning diffuses easily between cities and countries. Still, there lacks established South-to-South city networks as well as between the North and the South. There is a need for more research into the relationship between cities in the North and the South and whether climate adaptation and mitigation planning in cities in the South are diffused from the North or are locally generated. Researchers have also noted the risks of maladaptation in climate action, where policies and practices by some actors might either fail to meet their objectives or might increase the vulnerability of other groups or sectors in the future needs to be considered [173–176]. Maladaptation is defined as "an action taken ostensibly to avoid or reduce vulnerability to climate change that impacts adversely on, or increases the vulnerability of other systems, sectors, or social groups" [177]. One of the inadequately researched areas in the role of cities in climate action is how common forms of maladaptation in the North differ from those in the South. It remains unclear whether maladaptation in the North has a real or potential impact on the South and vice versa.

In the North, cities play a crucial role in climate action [33] with emerging roles of city diplomacy [178–180] and foreign policy of cities [150]. There are few studies on the differentiated role of cities in foreign policy and city diplomacy in climate action, first in the South and between the North and the South. As well, there is a need for more examination of relations between cities in the North and the South and how they promote climate adaptation and mitigation while addressing the already known maladaptation. The concept of the sustainable city underpins economic, environmental, and social sustainability. As such, a sustainable city should not be a goal but rather a principle of efficient provision of livelihoods based on social equity and justice [181]. Most city dwellers in some of the fastest-growing cities in the Global South do not have access to basic amenities such as clean and reliable energy. The challenge of urban energy access is rampant to the low-income population, especially in Africa and Asia. Hence, the old carbon-intensive development model used in the Global North is not reasonable in the Global South [181]. The goal-based sustainable city discourse popular in the North does not adequately capture problems of cities in the South and, therefore, might be inappropriate and misleading in the development of urban cities in the South [182, 183]. Based on the differential impact of climate action in cities between the North and the South, the idea of justice in climate adaptation has increasingly become popular [184–187]. By integrating environmental regulations in the urban development–climate adaptation nexus, researchers and policy-makers are able to generate a balanced (i.e., beyond neoliberal) comparison of sustainable cities in the two worlds [148]. Anguelovski et al. [164] recommend the need for a win-win climate adaptation solution with balanced costs and benefits for both the North and the South. In the South, a key concern is whether the efforts toward climate adaptation adequately prioritize the needs of the most vulnerable and marginalized cohorts or leave them in a worsened state. Notwithstanding this marginalization, the world—united—faces the COVID-19 pandemic in which human settlements, i.e., from the Global North and the Global South, must work to alleviate the outbreak that is central to cities (i.e., as hubs of transmission). Informal settlements, outside of the mainstream, are a distressing example of how urban centres have fallen short, especially during the pandemic, and where the North and the South can come to terms with bettering the human condition and our relationship with one another.

6 Informal Settlements: Impact of the COVID-19 Pandemic

The COVID-19 pandemic has changed the way people and societies function, globally and across sectors. Some circumstances have been replicated in informal settlements, advocating a type of renewal-to-revitalization concept. This idea encompasses three main value systems: human-cantered, planetary health, and transdisciplinary (i.e., where the general act of human settlements exactly recognizes the relationship between people and nature alongside urban systems) [188]. Informal settlements have turned into epicentres for the pandemic [189, 190]. For an estimated one billion people, who represent the majority of the urban population in many low-and middle-income countries, these settlements are their neighbourhoods. As such, informal settlements are facing considerable challenges and limitations due to the COVID-19 crisis [191]. A direct impact on communities living in informal settlements that impose city lockdowns—intended to prevent the spread of the disease—further creates impoverishment [191]. Two key measures to prevent the disease's spread are social distancing and increased hygiene. However, von Seidlein et al. [192] elucidate that both the lack of access to basic needs and overcrowding in slum areas, especially throughout cities in the Global South, have worsened. Regardless of the well-known fact that demographic groups with specific age or health conditions are more vulnerable to the virus, there is significantly less recognition of effect of inequality in access to measurements on a population's exposure to COVID-19 or its capacity to respond, which could augment existing vulnerabilities and create new ones [193]. Undoubtedly, public health officials recognize that most assailable groups are people living in informal habitats and contingent to informal livelihoods [194]. COVID-19 has seriously affected informal communities by virtue of the poor medical care services and undeveloped infrastructure; in addition, there is the lack of resources to develop appropriate living conditions by local governments that has further compounded the problem. As such, there are several issues on how COVID-19 affects informal settlements in terms of state intervention. To date, restrictions have made income harder to generate (i.e., by laying off employees or closing down) as well as rendering low-income households more vulnerable to infection, food short- ages, and lack of digital services (e.g., limitations to online education and Internet access). One of the main goals to understanding the impact of the pandemic on these settlements is to uncover the appropriate strategies and tactics that should be used to minimize negative influences. Utilizing an exploratory qualitative stance, one may ask how such communities are affected in the near(est) future and what might be the impeding results caused by the pandemic? To answer these questions, global human settlement patterns and processes alongside social needs and health concerns would be where to start.

Almost every corner of the world has been influenced by the pandemic. From its outset with no pharmaceutical solution, governments were forced to implement special rules—i.e., regulations—and public policies in order to prevent the spread of the virus and control social behaviour. COVID-19 has a significant direct and indirect impact on people in poverty, living in informal settlements—i.e., slums, shanty towns, and favela communities [195]. Many studies address the dramatic evidence of social and economic effects of government regulations as well as their huge negative effect on informal settlements. Such communities often develop strong social networks to share social and economic resources and fight for the access to private and public facilities; however, research indicates that possibilities for collaboration and social interaction have been significantly reduced since the pandemic [196]. Hence, those living in slum areas are at a structural disadvantage to overcome challenges and deal with the health crisis since governments are often not capable of implementing needed health targets. For instance, households in informal settlements have been affected by lack of space (i.e., to practice social distancing), overburdened infrastructure, lack of savings, loss of income, shortage of food, hunger and diseases, anxiety and depression, and poor access to education. Moreover, many people in informal settlements are not formally employed and depend on the informal sector to support their families. As such, informal sectors hardly generate extra income during hard times like the COVID-19 lockdowns [197]. These groups are paying a high toll since their employment loss is significantly larger than the loss reported in the general public. Data shows that labour participation has decreased by 30% which represents around a 50% drop in comparison with pre-pandemic levels as well as a drop in more than 40% in labour force participation [198]. Special financial support plans and unemployment insurance programs (UIP) were implemented by a number of governments. The participation of informal communities in UIP increased to 17% in September last year. Similar to that, to date, participation in financial pro bono support programs has increased from 33 to 37% during the pandemic [196]. However, more than half of the people who applied for support have not received any help. Regrettably, one of the limitations to apply for government support is usually central to the informally employed, leaving a large group of informal dwellers ineligible. The lack of any regular employment places positions informal dwellers in a very peculiar and unfortunate circumstance. In particular, large unemployment hikes have affected migrating populations, (i.e., people who travel from slum areas to urban centres for work), since more than 40% have now been fired during the pandemic and, as a result, have returned home wage less and stressed. These informal communities struggle to progress beyond a dead-end situation and are often limited to a life of crime and violence [199]. Moreover, an increase in domestic abuse places women and girls at much higher risk with obstruct access to protective services where medical care services are already limited. Shortage of food among an already underprivileged people has escalated the various infections and deficiency diseases (i.e., especially in children), notwithstanding the risks these populations face going out in the community and returning home infected—infecting their household. Economic stress has led to depression with shame among many informal communities when one loses their employment since security is a major health challenge [200, 201].

The absence of governmental attention is confirmed by the creation, location, and operation of quarantine centres. Quarantine and care centres are in part an acknowledgment of the compressed conditions of life in slums. Unfortunately, these are usually centres allocated quite far from the settlements themselves. Some quarantine hubs are initiated in high pollution zones and in unused slum buildings with inappropriate living conditions and infrastructure. For informal dwellers, environmental costs can originate from inadequate or no provision for piped water, paved roads, sanitation, and high levels of street garbage [202]. Accordingly, around 25% of the world's population live in informal settlements, with 213 million residents added since 1990 [197]. Such an increase places a heavy demand on land and natural resources which lead to harmful effects on the environment. As a result, the possibility of contracting new infections in an overburdened slum area could easily enable accompanying illnesses among the community [197]. In terms of access to information, guidelines given by police services, health authorities, and the government regarding the pandemic are limited due to the fact that majority of informal settlements cannot afford either a television or Internet access. Respectfully, a number of non-governmental organizations (NGOs) have started to provide brochures written in the local language to raise awareness; however, more than half of informal residents around the world are illiterate [197]. Even though informal settlements are considered to be temporary, central governments should consider placing a high priority in strengthening the infrastructure in these areas as a strategy to curtail the impact of pandemics like COVID-19 [190]. In doing so, there is a need for both governments and all types of human settlements to form partnerships as that can ensure that the virus will be countered effectively.

The COVID-19 pandemic is a wake-up call for city authorities to rethink their engagement with the people living in informal settlements [203]. The impact of COVID-19 will be most devastating in poor and densely populated urban areas, especially for the people living in slums worldwide as well as for refugees, internally displaced people, and migrants. For the one billion people who live in informal settlements, they face extremely tough conditions—even at the best of times—where many residents do not have access to sanitation or on-site water and face the constant threat of forced eviction and overcrowding. Along with that, vulnerable populations are also experiencing excess all-causing mortality related to disruptions in healthcare services [194], critical to aiding and preventing the spread of COVID-19 via disinfecting, physical distancing, and quarantine for the infected. However, these essentials are almost impossible to follow unless governments assist these communities in resolving their problems by establishing immediate measures. NGOs together with the authorities have to react quickly and provide economic support and social protection for those living in this state [204]. There is a need for central governments to establish strong working policies to support vulnerable communities living in informal settlements, such that policies could act as guarantors of care for these communities during pandemics [205]. It is necessary to prioritize the building of permanent households, communication initiatives, and pandemic awareness programs to mitigate impact in informal communities. Mobile medical centres to support testing, diagnostics, and early treatment need to be deployed. It is obvious that in most slums health clinics are not able to provide needed care for a large number of people; hence, distance, cost, and mistreatment by medics in those areas must be prioritized [194]. Moreover, organized food banks should be set in order to provide food with nutritional value to these communities. Hunger crises, especially during the lockdown of informal settlements, make it imperative that NGOs and central authorities create food provision services for these vulnerable communities [197]. There are grounds for an interdisciplinary approach in helping human settlements overcome these challenges caused by the global health crisis. Public health authorities have to be compelled to roll out strategic communication campaigns that focus on pandemic awareness to alleviate struggles caused by COVID-19. As such, the complexity of differing human settlements amounts to a broad vision of human ecology. As this chapter has pointed out, urban morphology in relation to the different typologies of infrastructure, energy usage, and agriculture—compounded by geographic location—sets the stage for urban challenges and future development in the twenty-first century.

References

1. Chokhachian A, Perini K, Giulini S, Auer T (2020) Urban performance and density: generative study on interdependencies of urban form and environmental measures. Sustain Cities Soc 53:101952. https://doi.org/10.1016/j.scs.2019.101952
2. D'Acci L (2019) On urban morphology and mathematics. In: Modeling and simulation in science, engineering and technology. Springer, Zurich, pp 1–18
3. World Bank (2021) Urban population (% of total population). https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS. Accessed 14 Mar 2021
4. UN-Habitat (2014) Energy: the challenge. In: United Nations humanities settlements program. https://unhabitat.org/topic/energy. Accessed 15 Mar 2021
5. Privitera R, Palermo V, Martinico F et al (2018) Towards lower carbon cities: urban morphology contribution in climate change adaptation strategies. Eur Plan Stud 26:812–837. https://doi.org/10.1080/09654313.2018.1426735
6. Shi Z, Fonseca JA, Schlueter A (2017) A review of simulation-based urban form generation and optimization for energy-

driven urban design. Build Environ 121:119–129. https://doi.org/ 10.1016/j.buildenv.2017.05.006
7. United Nations (2017) The World's cities in 2018: data booklet. In: United Nations department of economics and social affairs. https://www.un.org/en/events/citiesday/assets/pdf/the_worlds_cities_in_2018_data_booklet.pdf. Accessed 15 Mar 2021
8. Salat S (2009) Energy loads, CO2 emissions and building stocks: Morphologies, typologies, energy systems and behaviour. Build Res Inf 37:598–609. https://doi.org/10.1080/09613210903162126
9. Evans G (2009) Creative cities, creative spaces and urban policy. Urban Stud 46:1003–1040. https://doi.org/10.1177/ 0042098009103853
10. Yigitcanlar T, O'Connor K, Westerman C (2008) The making of knowledge cities: Melbourne's knowledge-based urban development experience. Cities 25:63–72. https://doi. org/10.1016/j.cities.2008.01.001
11. Yigitcanlar T, Velibeyoglu K, Martinez-Fernandez C (2008) Rising knowledge cities: the role of urban knowledge precincts. J Knowl Manag 12:8–20. https://doi.org/10.1108/136732708 10902902
12. Israilidis J, Odusanya K, Mazhar MU (2021) Exploring knowledge management perspectives in smart city research: a review and future research agenda. Int J Inf Manage 56:101989. https://doi.org/10.1016/j.ijinfomgt.2019.07.015
13. Hall T, Barrett H (2018) Urban Geography, 5th edn. Routledge, New York
14. Oliveira V (2019) An historico-geographical theory of urban form. J Urban Int Res Placemaking Urban Sustain 12:412–432. https://doi.org/10.1080/17549175.2019.1626266
15. Kropf K (2018) The handbook of urban morphology. Wiley, West Sussex
16. Kropf K (2013) Urbanism, politics and language: the role of urban morphology. Riv Geogr Ital 69:117–132
17. Trache H (2001) Promoting urban design in development plans: Typo-morphological approaches in Montreuil, France. Urban Des Int 6:157–172. https://doi.org/10.1057/palgrave.udi.9000052
18. Zhang Y, Li X (2020) What new insights can the combination of the historico-geographical and configurational approaches to urban morphology offer? Dublin Hist Rec 88:84–96
19. Rashid M (2019) Space syntax: a network-based configurational approach to studying urban morphology. In: Modeling and simulation in science, engineering and technology. Springer, Zurich, pp 199–251
20. Boeing G (2021) Spatial information and the legibility of urban form: Big data in urban morphology. Int J Inf Manage 56:102013. https://doi.org/10.1016/j.ijinfomgt.2019.09.009f
21. Zaki SA, Azid NS, Shahidan MF et al (2020) Analysis of urban morphological effect on the microclimate of the urban residential area of Kampung Baru in Kuala Lumpur using a geospatial approach. Sustainability 12:7301. https://doi.org/10.3390/ su12187301
22. Gergel SE, Turner MG (2017) Learning landscape ecology. Springer, New York
23. Ingegnoli V (2013) Landscape ecology: a widening foundation. Springer, Berlin
24. Naveh Z, Lieberman AS (2013) Landscape ecology: theory and application. Springer, New York
25. Forman RT (2014) Urban ecology: science of cities. Cambridge University Press, Cambridge
26. Azhdari A, Soltani A, Alidadi M (2018) Urban morphology and landscape structure effect on land surface temperature: evidence from Shiraz, a semi-arid city. Sustain Cities Soc 41:853– 864. https://doi.org/10.1016/j.scs.2018.06.034
27. Russo A, Cirella GT (2019) Edible urbanism 5.0. Palgrave Commun 5:1–9. https://doi.org/ 10.1057/s41599-019-0377-8
28. Russo A, Cirella GT (2018) Modern compact cities: how much greenery do we need? Int J Environ Res Public Health 15:2180. https://doi.org/10.3390/ijerph15102180
29. Deakin M, Reid A (2018) Smart cities: under-gridding the sustainability of city-districts as energy efficient-low carbon zones. J Clean Prod 173:39–48. https://doi.org/10.1016/j.jclepro. 2016.12.054
30. Cobbinah PB, Gaisie E, Owusu-Amponsah L (2015) Peri-urban morphology and indigenous livelihoods in Ghana. Habitat Int 50:120–129. https://doi.org/10.1016/j.habitatint.2015. 08.002
31. Cirella GT, Iyalomhe F, Jensen A, Akiyode O (2018) Exploring community of practice in Uganda's public sector: environmental impact assessment case study. Sustainability 10:2502. https://doi.org/10.3390/su10072502
32. Cirella GT, Iyalomhe FO (2018) Flooding conceptual review: sustainability-focalized best practices in Nigeria. Appl Sci 8:1558. https://doi.org/10.3390/app8091558
33. Watts M (2017) Commentary: cities spearhead climate action. Nat Clim Chang 7:537–538. https://doi.org/10.1038/ nclimate3358
34. Araos M, Berrang L, Ford JD et al (2016) Climate change adaptation planning in large cities: a systematic global assessment. Environ Sci Policy 66:375–382. https://doi.org/10.1016/j.env sci.2016.06.009
35. Magnan AK, Schipper ELF, Burkett M et al (2016) Addressing the risk of maladaptation to climate change. Wiley Interdiscip Rev Clim Chang 7:646–665. https://doi.org/10.1002/wcc.409
36. Pozzer A, Zimmermann P, Doering UM et al (2012) Effects of business-as-usual anthropogenic emissions on air quality. Atmos Chem Phys 12:6915–6937. https://doi.org/10.5194/acp-12-6915-2012
37. Vujcic M, Tomicevic-Dubljevic J, Zivojinovic I, Toskovic O (2019) Connection between urban green areas and visitors' physical and mental well-being. Urban For Urban Green 40:299–307. https://doi.org/10.1016/j.ufug.2018.01.028
38. Russo A, Cirella GT (2020) Urban sustainability: integrating ecology in city design and planning. In: Cirella GT (ed) Sustainable human-nature relations: environmental scholarship, economic evaluation, urban strategies. Springer, Singapore, pp 187–204
39. UN-Habitat (2009) Sustainable urban energy planning: a handbook for cities and towns in developing countries. UN-Habitat and UNEP, Geneva
40. Chu S, Majumdar A (2012) Opportunities and challenges for a sustainable energy future. Nature 488:294–303. https://doi.org/10.1038/nature11475
41. ARUP (2014) Cities alive: rethinking green infrastructure. Work Pap 161
42. Carter JG, Cavan G, Connelly A et al (2015) Climate change and the city: building capacity for urban adaptation. Prog

Plann 95:1–66. https://doi.org/10.1016/j.progress.2013.08.001
43. Perrotti D, Stremke S (2020) Can urban metabolism models advance green infrastructure planning? Insights from ecosystem services research. Environ Plan B Urban Anal City Sci 47:678–694. https://doi.org/10.1177/2399808318797131
44. European Commission (2014) Green Infrastructure in the energy sector
45. Susca T (2019) Green roofs to reduce building energy use? A review on key structural factors of green roofs and their effects on urban climate. Build Environ 162:106273. https://doi.org/ 10.1016/j.buildenv.2019.106273
46. Tsoka S, Leduc T, Rodler A (2021) Assessing the effects of urban street trees on building cooling energy needs: the role of foliage density and planting pattern. Sustain Cities Soc 65:102633. https://doi.org/10.1016/j.scs.2020.102633
47. Ko Y (2018) Trees and vegetation for residential energy conservation: a critical review for evidence-based urban greening in North America. Urban For Urban Green 34:318–335. https://doi.org/10.1016/j.ufug.2018.07.021
48. Nowak DJ, Appleton N, Ellis A, Greenfield E (2017) Residential building energy conservation and avoided power plant emissions by urban and community trees in the United States. Urban For Urban Green 21:158–165. https://doi.org/10.1016/j.ufug. 2016.12.004
49. Spatari S, Yu Z, Montalto FA (2011) Life cycle implications of urban green infrastructure. Environ Pollut 159:2174–2179. https://doi.org/10.1016/j.envpol.2011.01.015
50. Hsu K-W, Chao J-C (2020) Economic valuation of green infrastructure investments in urban renewal: the case of the Station District in Taichung Taiwan. Environments 7:56. https://doi. org/10.3390/environments7080056
51. BSHF (2014) Eco-city Augustenborg. Winner, World Habitat Award. Work Pap, Sweden, pp 1–43
52. Russo A, Escobedo FJ, Cirella GT, Zerbe S (2017) Edible green infrastructure: an approach and review of provisioning ecosystem services and disservices in urban environments. Agric Ecosyst Environ 242:53–66. https://doi.org/10.1016/ j.agee.2017.03.026
53. Sardeshpande M, Rupprecht C, Russo A (2021) Edible urban commons for resilient neighbourhoods in light of the pandemic. Cities 109:103031. https://doi.org/10.1016/j.cities.2020. 103031
54. Nicholls E, Ely A, Birkin L et al (2020) The contribution of small-scale food production in urban areas to the sustainable development goals: a review and case study. Sustain Sci 15:1585–1599. https://doi.org/10.1007/s11625-020-00792-z
55. Russo A, Cirella GT (2020) Edible green infrastructure for urban regeneration and food security: case studies from the Campania region. Agriculture 10:358. https://doi.org/10.3390/ agriculture10080358
56. Nowak DJ, Greenfield EJ, Ash RM (2019) Annual biomass loss and potential value of urban tree waste in the United States. Urban For Urban Green 46:126469. https://doi.org/10.1016/j.ufug.2019.126469
57. Russo A, Escobedo FJ, Timilsina N et al (2014) Assessing urban tree carbon storage and sequestration in Bolzano, Italy. Int J Biodivers Sci Ecosyst Serv Manag 10:54–70. https://doi.org/10.1080/21513732.2013.873822
58. Sagani A, Hagidimitriou M, Dedoussis V (2019) Perennial tree pruning biomass waste exploitation for electricity generation: the perspective of Greece. Sustain Energy Technol Assessments 31:77–85. https://doi.org/10.1016/j.seta.2018.11.001
59. Winzer F, Kraska T, Elsenberger C et al (2017) Biomass from fruit trees for combined energy and food production. Biomass Bioenerg 107:279–286. https://doi.org/10.1016/j.biombioe. 2017.10.027
60. Clinton N, Stuhlmacher M, Miles A et al (2018) A global geospatial ecosystem services estimate of urban agriculture. Earth's Futur 6:40–60. https://doi.org/10.1002/2017EF000536
61. ASLA (2021) Sustainable urban development. American Society of Landscape Architects. https://www.asla.org/sustainable urbandevelopment.aspx
62. Chew KW, Khoo KS, Foo HT et al (2021) Algae utilization and its role in the development of green cities. Chemosphere 268:129322. https://doi.org/10.1016/j.chemosphere.2020.129322
63. Hendry DF, Juselius K, Hendry D, Juselius K (2000) Explaining cointegration analysis: part 1.Energy J 21:1–42
64. Sanchez-Loor DA, Zambrano-Monserrate MA (2015) International journal of energy economics and policy causality analysis between electricity consumption, real gross domestic product, foreign direct investment, human development and remittances in Colombia, Ecuador and Mexico. Int J Energy Econ Policy 5:746–753
65. UNDP (2018) Statistical update 2018, human development reports. United Nations Development Program. http://hdr.undp.org/en/content/human-development-indices-indicators-2018- statistical-update. Accessed 23 July 2020
66. UNDP (2018) Industrialization with a human face. United Nations Development Programme, Addis Ababa, Ethiopia
67. UNDP (2019) Human development index. United Nations Development Programme. http://www.hdr.undp.org/en/2019-report. Accessed 17 July 2019
68. Wu Q, Maslyuk S, Clulow V (2010) Energy consumption transition and human development. Monash University, Melbourne
69. Wang Z, Danish ZB, Wang B (2018) Renewable energy consumption, economic growth and human development index in Pakistan: evidence form simultaneous equation model. J Clean Prod 184:1081–1090. https://doi.org/10.1016/j.jclepro. 2018.02.260
70. Owusu PA, Asumadu-Sarkodie S (2016) A review of renewable energy sources, sustainability issues and climate change mitigation. Cogent Eng 3:1167990. https://doi.org/10.1080/233 11916.2016.1167990
71. IEA (2008) Key world energy statistics 2020—analysis. In: IEA OECD. https://www.iea.org/reports/key-world-energy-statistics-2020. Accessed 15 Mar 2021
72. World Energy Council (2013) World energy resources 2013 survey: summary. World Energy Council, London
73. Hoogwijk M, Faaij A, Eickhout B et al (2005) Potential of biomass energy out to 2100, for four IPCC SRES land-use scenarios. Biomass Bioenergy 29:225–257. https://doi.org/10.1016/j.biombioe.2005.05.002
74. Ajanovic A (2011) Biofuels versus food production: does biofuels production increase food prices? Energy 36:2070–2076. https://doi.org/10.1016/j.energy.2010.05.019
75. Manwell JF, McGowan JG, Rogeres AL (2010) Wind energy explained: theory, design and application, 2nd edn. Wiley, West Sussex
76. Ritchie H, Roser M (2020) Renewable energy. In: Our world data. https://ourworldindata.org/renewable-energy. Accessed 17

Mar 2021
77. IRENA (2017) Renewable energy prospects for the Russian Federation. IRENA, Abu Dhabi
78. IRENA (2019) Innovation landscape for a renewable-powered future. IRENA, Abu Dhabi
79. World Energy Council (2001) Living in one world. In: Chapter 5. Concerns about sustainable history sustain. http://www.worldenergy.org/wec-geis/publications/reports/liow/the_concerns/sustainability.asp. Accessed 13 Dec 2017
80. UNEP (2007) Global environment outlook 4. United Nations Environment Programme, Nairobi
81. Abbasi T, Premalatha M, Abbasi SA (2011) The return to renewables: will it help in global warming control? Renew Sustain Energy Rev 15:891–894. https://doi.org/10.1016/j.rser. 2010.09.048
82. Allen C, Metternicht G, Wiedmann T (2016) National pathways to the sustainable development goals (SDGs): a comparative review of scenario modelling tools. Environ Sci Policy 66:199–207. https://doi.org/10.1016/j.envsci.2016.09.008
83. Nilsson M, Griggs D, Visbeck M (2016) Policy: map the interactions between sustainable development goals. Nature 534:320–322. https://doi.org/10.1038/534320a
84. European Commission (2020) Renewable energy. In: Energy. https://ec.europa.eu/energy/topics/renewable-energy_en. Accessed 15 Mar 2021
85. MNRE (2015) Tentative state-wise break-up of renewable power target to be achieved by the year 2022. Ministry of New Renewable Energy, Government of India. https://policy.asiapacificenergy.org/node/3652. Accessed 15 Mar 2021
86. Kota S, Bayne SB, Nimmagadda S (2015) Offshore wind energy: a comparative analysis of UK, USA and India. Renew Sustain Energy Rev 41:685–694. https://doi.org/10.1016/j.rser.2014.08.080
87. EIA (2018) Renewable energy explained. U.S. Energy Information Administration. https:// www.eia.gov/energyexplained/renewable-sources/. Accessed 15 Mar 2021
88. NDRC (2016) China's national climate change program. National assessment report on climate change. http://www.china.org.cn/english/environment/213624.htm
89. Power Technology (2018) Is Russia finally ready to embrace renewable energy? In: Power technology. https://www.power-technology.com/features/russia-renewable-energy/. Accessed 15 Mar 2021
90. IPCC (2013) AR5 climate change 2013: the physical science basis—IPCC. Working Group I of the Intergovernmental Panel on Climate Change, Geneva
91. IPCC (2017) AR6 climate change 2021: the physical science basis—IPCC. Intergovernmental Panel on Climate Change, Geneva
92. Sovacool BK (2016) How long will it take? Conceptualizing the temporal dynamics of energy transitions. Energy Res Soc Sci 13:202–215. https://doi.org/10.1016/j.erss.2015.12.020
93. Grayson M (2017) Energy transitions. Nature 551:S133. https://doi.org/10.1038/d41586-017- 07507-y
94. Mey F, Diesendorf M (2018) Who owns an energy transition? Strategic action fields and community wind energy in Denmark. Energy Res Soc Sci 35:108–117. https://doi.org/10.1016/j.erss.2017.10.044
95. Turner BL, Clark WC, Kates RW et al (1990) The earth as transformed by human action: global and regional changes in the biosphere over the past 300 years edited by. Cambridge University Press, New York
96. Grigg DB (1987) The industrial revolution and land transformation. In: Wolman MG, Fournier FGA (eds) Land transformation in agriculture. Wiley, Chichester
97. Lewis MW, McNeill JR (2000) Something new under the Sun: an environmental history of the twentieth-century world. Geogr Rev 90:149. https://doi.org/10.2307/216186
98. Richards JF (1990) Land transformation. In: Turner BL, Clark WC, Kates RW et al (eds) The earth as transformed by human action: global and regional changes in the biosphere over the past 300 years. Cambridge University Press, New York
99. Kaereem MA (2021) Strategic planning for agricultural development. National Institute of Agricultural Extention Management
100. Griskevicius V, Cantú SM, Van Vugt M (2012) The evolutionary bases for sustainable behavior: Implications for marketing, policy, and social entrepreneurship. J Public Policy Mark 31:115–128
101. Testa F, Russo MV, Cornwell TB et al (2018) Social sustainability as buying local: effects of soft policy, meso-level actors, and social influences on purchase intentions. J Public Policy Mark 37:152–166. https://doi.org/10.1509/jppm.16.215
102. Bennett AJ, Bending GD, Chandler D et al (2012) Meeting the demand for crop production:the challenge of yield decline in crops grown in short rotations. Biol Rev 87:52–71. https:// doi.org/10.1111/j.1469-185X.2011 .00184.x
103. Capper JL, Cady RA, Bauman DE (2009) The environmental impact of dairy production: 1944 compared with 2007. J Anim Sci 87:2160–2167. https://doi.org/10.2527/jas.2009-1781
104. Carlson KM, Gerber JS, Mueller ND et al (2017) Greenhouse gas emissions intensity of global croplands. Nat Clim Chang 7:63–68. https://doi.org/10.1038/nclimate3158
105. Ellis EC, Ramankutty N (2008) Putting people in the map: anthropogenic biomes of the world. Front Ecol Environ 6:439–447. https://doi.org/10.1890/070062
106. Ramankutty N, Evan AT, Monfreda C, Foley JA (2008) Farming the planet: 1. Geographic distribution of global agricultural lands in the year 2000. Global Biogeochem Cycles 22:GB1003. https://doi.org/10.1029/2007GB002952
107. FAO (2015) The state of food insecurity 2015. The Food and Agricultural Organisation of United Nations. http://www.fao.org/publications/sofi/2015/en/. Accessed 15 Mar 2021
108. World Bank (2019) World Bank open data. In: World Bank. https://data.worldbank.org/. Accessed 27 July 2019
109. Lowder SK, Skoet J, Raney T (2016) The number, size, and distribution of farms, smallholder farms, and family farms worldwide. World Dev 87:16–29. https://doi.org/10.1016/j.worlddev. 2015.10.041
110. Herrero M, Thornton PK, Power B et al (2017) Farming and the geography of nutrient production for human use: a transdisciplinary analysis. Lancet Planet Heal 1:e33–e42. https://doi. org/10.1016/S2542-5196(17)30007-4
111. Tulchinsky TH (2010) Micronutrient deficiency conditions: global health issues. Public Health Rev 32:243–255. https://doi.org/10.1007/BF03391600

112. FAO, IFAD, UNICEF et al (2018) The state of food security and nutrition in the world 2018. Building climate resilience for food security and nutrition. Rome
113. West PC, Gerber JS, Engstrom PM et al (2014) Leverage points for improving global food security and the environment. Science (80-) 345:325–328. https://doi.org/10.1126/science. 1246067
114. Beal T, Massiot E, Arsenault JE et al (2017) Global trends in dietary micronutrient supplies and estimated prevalence of inadequate intakes. PLoS One 12:e0175554. https://doi.org/10.1371/journal.pone.0175554
115. Davis DR, Epp MD, Riordan HD, Davis DR (2004) Changes in USDA food composition data for 43 garden crops, 1950 to 1999. J Am Coll Nutr 23:669–682. https://doi.org/10.1080/07315724.2004.10719409
116. Siegel KR, Ali MK, Srinivasiah A et al (2014) Do we produce enough fruits and vegetables to meet global health need? PLoS One 9:e104059. https://doi.org/10.1371/journal.pone.010 4059
117. Fleming A, Vanclay F (2010) Farmer responses to climate change and sustainable agriculture. A review. Agron Sustain Dev 30:11–19. https://doi.org/10.1051/agro/2009028
118. Pimentel D (2006) Soil erosion: a food and environmental threat. Environ Dev Sustain 8:119–137. https://doi.org/10.1007/s10668-005-1262-8
119. Figueres C, Schellnhuber HJ, Whiteman G et al (2017) Three years to safeguard our climate. Nature 546:593–595. https://doi.org/10.1038/546593a
120. Lal R (2009) Soils and world food security. Soil Tillage Res 102:1–4. https://doi.org/10.1016/ j.still.2008.08.001
121. Cassman KG, Dobermann A, Walters DT, Yang H (2003) Meeting cereal demand while protecting natural resources and improving environmental quality. Annu Rev Environ Resour 28:315–358. https://doi.org/10.1146/annurev.energy.28.040202.122858
122. Pereira HM, Navarro LM, Martins IS (2012) Global biodiversity change: the bad, the good, and the unknown. Annu Rev Environ Resour 37:25–50. https://doi.org/10.1146/annurev-environ-042911-093511
123. Jarvis DI, Brown AHD, Pham HC et al (2008) A global perspective of the richness and evenness of traditional crop-variety diversity maintained by farming communities. Proc Natl Acad Sci USA 105:5326–5331. https://doi.org/10.1073/pnas.0800607105
124. Akram QF (2009) Commodity prices, interest rates and the dollar. Energy Econ 31:838–851. https://doi.org/10.1016/j.eneco.2009.05.016
125. Mitchel D (2008) A note on rising food prices. World Bank, Washington, DC
126. Hunter MC, Smith RG, Schipanski ME et al (2017) Agriculture in 2050: recalibrating targets for sustainable intensification. Bioscience 67:386–391. https://doi.org/10.1093/biosci/bix010
127. Cohen B, Muñoz P (2016) Sharing cities and sustainable consumption and production: towards an integrated framework. J Clean Prod 134:87–97. https://doi.org/10.1016/j.jclepro.2015. 07.133
128. Gemeda BS, Abebe BG, Paczoski A et al (2019) What motivates speculators to speculate? Entropy 22:59. https://doi.org/10.3390/e22010059
129. de Schutter O (2011) How not to think of land-grabbing: three critiques of large-scale investments in farmland. J Peasant Stud 38:249–279. https://doi.org/10.1080/03066150.2011. 559008
130. Gemeda BS, Abebe BG, Cirella GT (2020) How efficient is urban land speculation? In: Cirella GT (ed) Advances in 21st century human settlements. Springer, Singapore, pp 101–121
131. MEA (2005) Ecosystems and human well-being: wetlands and water synthesis. Millennium Ecosystem Assessment, Washington, DC
132. Pimentel D, Harvey C, Resosudarmo P et al (1995) Environmental and economic costs of soil erosion and conservation benefits. Science (80-)267:1117–1123. https://doi.org/10.1126/sci ence.267.5201.1117
133. Garnett T, Godfray CJ (2012) Sustainable intensification in agriculture. Navigating a course through competing food system priorities. Food Climate Research Network and the Oxford Martin, Oxford
134. Seufert V, Ramankutty N, Foley JA (2012) Comparing the yields of organic and conventional agriculture. Nature 485:229–232. https://doi.org/10.1038/nature11069
135. De Ponti T, Rijk B, Van Ittersum MK (2012) The crop yield gap between organic and conventional agriculture. Agric Syst 108:1–9. https://doi.org/10.1016/j.agsy.2011.12.004
136. United Nations (2017) World population prospects: the 2017 revision. United Nations Department of Economics and Social Affairs. https://www.un.org/development/desa/publications/ world-population-prospects-the-2017-revision.html. Accessed 15 Mar 2021
137. Tilman D, Clark M (2014) Global diets link environmental sustainability and human health. Nature 515:518–522. https://doi.org/10.1038/nature13959
138. Foley JA, Ramankutty N, Brauman KA et al (2011) Solutions for a cultivated planet. Nature 478:337–342. https://doi.org/10.1038/nature10452
139. Tomlinson I (2013) Doubling food production to feed the 9 billion: a critical perspective on a key discourse of food security in the UK. J Rural Stud 29:81–90. https://doi.org/10.1016/j. jrurstud.2011.09.001
140. Cassidy ES, West PC, Gerber JS, Foley JA (2013) Redefining agricultural yields: from tonnes to people nourished per hectare. Environ Res Lett 8:034015. https://doi.org/10.1088/1748- 9326/8/3/034015
141. Erb KH, Lauk C, Kastner T et al (2016) Exploring the biophysical option space for feeding the world without deforestation. Nat Commun 7:1–9. https://doi.org/10.1038/ncomms11382
142. Doré T, Clermont-Dauphin C, Crozat Y et al (2008) Methodological progress in on-farm regional agronomic diagnosis. A review. Agron Sustain Dev 28:151–161. https://doi.org/10. 1051/agro:2007031
143. Xiong W, Holman I, Conway D et al (2008) A crop model cross calibration for use in regional climate impacts studies. Ecol Modell 213:365–380. https://doi.org/10.1016/j.ecolmodel.2008. 01.005
144. Amanullah M, Kailasam C, Safiullah A et al (2009) Crop simulation growth model in Cassava. Res J Agri Biol Sci 31:838–851

145. Csomós G (2017) Cities as command and control centres of the world economy: an empirical analysis, 2006–2015. Bull Geogr 38:7–26. https://doi.org/10.1515/bog-2017-0031
146. Herrschel T, Newman P (2017) Cities as international actors: urban and regional governance beyond the nation state. Palgrave Macmillan, London
147. Malasenkova AA, Lavrov IR (2020) Global cities: Sydney. J Gov Polit 1:1–11
148. Parnell S, Robinson J (2012) (Re)theorizing cities from the global south: looking beyond neoliberalism. Urban Geogr 33:593–617. https://doi.org/10.2747/0272-3638.33.4.593
149. Toly NJ (2008) Transnational municipal networks in climate politics: from global governance to global politics. Globalizations 5:341–356. https://doi.org/10.1080/14747730802252479
150. Kosovac A, Acuto M, Jones TL (2020) Acknowledging urbanization: a survey of the role of cities in UN frameworks. Glob Policy 11:293–304. https://doi.org/10.1111/1758-5899.12783
151. De Guimarães JCF, Severo EA, Felix Júnior LA et al (2020) Governance and quality of life in smart cities: towards sustainable development goals. J Clean Prod 253:119926. https://doi.org/10.1016/j.jclepro.2019.119926
152. Jedwab R, Loungani P, Yezer A (2021) Comparing cities in developed and developing countries: population, land area, building height and crowding. Reg Sci Urban Econ 86:103609. https://doi.org/10.1016/j.regsciurbeco.2020.103609
153. Jedwab R, Loungani MP, Yezer A (2019) How should we measure city size theory and evidence within and across rich and poor countries. IMF, Geneva
154. Dumont G-F (2018) Urban demographic transition. Urban Dev Issues 56:13–25. https://doi.org/10.2478/udi-2018-0009
155. Rigolon A, Browning M, Lee K, Shin S (2018) Access to urban green space in cities of the global south: a systematic literature review. Urban Sci 2:67. https://doi.org/10.3390/urbans ci2030067
156. Brandt W (1980) North-south: a programme for survival: report of the independent commission on international development issues. Independent Commission on International Development Issues, London
157. Ganguly D, Mobley C (2021) Global south humanities lab. Academy of Global Humanities and Critical Theory. https://aghct.org/research-and-opportunities/611. Accessed 24 Mar 2021
158. RGS (2021) A 60 second guide to … the global north/south divide. Global Learning Program. moz-extension://b25df011-8780-4be7-9be7-6714e4992816/enhanced-reader.html?openApp&pdf=https%3A%2F%2Fwww.rgs.org%2FCMSPages %2FGetFile.as px%3Fnodeguid%3D9c1ce781-9117-4741-af0a-a6a8b75f32b4%26lang%3Den-GB. Accessed 23 Mar 2021
159. Cirella GT, Bąk M, Kozlak A et al (2019) Transport innovations for elderly people. Res Transp Bus Manag 30:100381. https://doi.org/10.1016/j.rtbm.2019.100381
160. Plouffe L, Kalache A (2010) Towards global age-friendly cities: determining urban features that promote active aging. J Urban Heal 87:733–739. https://doi.org/10.1007/s11524-010- 9466-0
161. Vu K, Hartley K (2018) Promoting smart cities in developing countries: policy insights from Vietnam. Telecomm Policy 42:845–859. https://doi.org/10.1016/j.telpol.2017.10.005
162. Duranton G (2008) Viewpoint: from cities to productivity and growth in developing countries. Can J Econ Can d'économique 41:689–736. https://doi.org/10.1111/j.1540-5982.2008.004 82.x
163. Ford JD, Berrang-Ford L, Biesbroek R et al (2015) Adaptation tracking for a post-2015 climate agreement. Nat Clim Chang 5:967–969. https://doi.org/10.1038/nclimate2744
164. Anguelovski I, Shi L, Chu E et al (2016) Equity impacts of urban land use planning for climate adaptation. J Plan Educ Res 36:333–348. https://doi.org/10.1177/0739456X16645166
165. Ford JD, Berrang-Ford L (2016) The 4Cs of adaptation tracking: consistency, comparability, comprehensiveness, coherency. Mitig Adapt Strateg Glob Chang 21:839–859. https://doi.org/10.1007/s11027-014-9627-7
166. Olazabal M, Ruiz De Gopegui M, Tompkins EL et al (2019) A cross-scale worldwide analysis of coastal adaptation planning. Environ Res Lett 14:124056. https://doi.org/10.1088/1748-9326/ab5532
167. Le TDN (2020) Climate change adaptation in coastal cities of developing countries: characterizing types of vulnerability and adaptation options. Mitig Adapt Strateg Glob Chang 25:739–761. https://doi.org/10.1007/s11027-019-09888-z
168. Campbell T (2013) Beyond smart cities: how cities network, learn and innovate. Taylor and Francis, New York
169. Keiner M, Kim A (2007) Transnational city networks for sustainability. Eur Plan Stud 15:1369–1395. https://doi.org/10.1080/09654310701550843
170. Mocca E (2017) City networks for sustainability in Europe: an urban-level analysis. J Urban Aff 39:691–710. https://doi.org/10.1080/07352166.2017.1282769
171. Tosun J, Leopold L (2019) Aligning climate governance with urban water management: insights from transnational city networks. Water 11:701. https://doi.org/10.3390/w11040701
172. Haupt W, Chelleri L, van Herk S, Zevenbergen C (2020) City-to-city learning within climate city networks: definition, significance, and challenges from a global perspective. Int J Urban Sustain Dev 12:143–159. https://doi.org/10.1080/19463138.2019.1691007
173. Bicknell J, Dodman D, Satterthwaite D (2009) Adapting cities to climate change: understanding and addressing the development challenges. Routledge, London
174. Guodaar L, Asante F, Eshun G et al (2020) How do climate change adaptation strategies result in unintended maladaptive outcomes? Perspectives of tomato farmers. Int J Veg Sci 26:15–31. https://doi.org/10.1080/19315260.2019.1573393
175. Juhola S, Glaas E, Linnér BO, Neset TS (2016) Redefining maladaptation. Environ Sci Policy 55:135–140. https://doi.org/10.1016/j.envsci.2015.09.014
176. Chung Y, Noh H, Honda Y et al (2017) Temporal changes in mortality related to extreme temperatures for 15 cities in northeast Asia: adaptation to heat and maladaptation to cold. Am J Epidemiol 185:907–913. https://doi.org/10.1093/aje/kww199
177. Barnett J, O'Neill S (2010) Maladaptation. Glob Environ Chang 20:211–213. https://doi.org/10.1016/j.gloenvcha.2009.11.004
178. Burksiene V, Dvorak J, Burbulytė-Tsiskarishvili G (2020) City diplomacy in young democracies: the case of the baltics. In:

Amiri S, Sevin E (eds) City diplomacy. Springer International Publishing, Cham, pp 305–330
179. Chan DK, Hong (2016) City diplomacy and “glocal” governance: Revitalizing cosmopolitan democracy. Innovation 29:134–160. https://doi.org/10.1080/13511610.2016.1157684
180. Kus¸ku-Sönmez E (2014) Regional cooperation in the black sea basin: what role for city diplomacy? Southeast Eur Black Sea Stud 14:489–507. https://doi.org/10.1080/14683857.2014.967944
181. Westphal MI, Martin S, Zhou L, Satterthwaite D (2017) Powering cities in the global south: how energy access for all benefits the economy and the environment. World Resource Institute. www.citiesforall.org. Accessed 15 Mar 2021
182. Rana MMP (2009) Sustainable city in the global north and south: goal or principle? Manag Environ Qual An Int J 20:506–521. https://doi.org/10.1108/14777830910981195
183. Rana MMP (2011) Urbanization and sustainability: challenges and strategies for sustainable urban development in Bangladesh. Environ Dev Sustain 13:237–256. https://doi.org/10.1007/ s10668-010-9258-4
184. Chu E, Anguelovski I, Roberts D (2017) Climate adaptation as strategic urbanism: assessing opportunities and uncertainties for equity and inclusive development in cities. Cities 60:378–387. https://doi.org/10.1016/j.cities.2016.10.016
185. Chu E, Michael K (2019) Recognition in urban climate justice: marginality and exclusion of migrants in Indian cities. Environ Urban 31:139–156. https://doi.org/10.1177/095624781881 4449
186. Porter L, Rickards L, Verlie B et al (2020) Climate justice in a climate changed world. Plan Theory Pract 21:293–321. https://doi.org/10.1080/14649357.2020.1748959
187. Jenkins K (2018) Setting energy justice apart from the crowd: lessons from environmental and climate justice. Energy Res Soc Sci 39:117–121. https://doi.org/10.1016/j.erss.2017.11.015
188. French M, Ramirez-Lovering D, Sinharoy SS et al (2020) Informal settlements in a COVID-19 world: moving beyond upgrading and envisioning revitalisation. Cities Heal 1–4. https://doi.org/10.1080/23748834.2020.1812331
189. Hakovirta M, Denuwara N (2020) How COVID-19 redefines the concept of sustainability. Sustainability 12:3727. https://doi.org/10.3390/su12093727
190. Bhide A (2020) Informal settlements, the emerging response to COVID and the imperative of transforming the narrative. J Soc Econ Dev 1–10. https://doi.org/10.1007/s40847-020-001 19-9
191. Lau LS, Samari G, Moresky RT et al (2020) COVID-19 in humanitarian settings and lessons learned from past epidemics. Nat Med 26:647–648. https://doi.org/10.1038/s41591-020-0851-2
192. von Seidlein L, Alabaster G, Deen J, Knudsen J (2021) Crowding has consequences: prevention and management of COVID-19 in informal urban settlements. Build Environ 188:107472. https://doi.org/10.1016/j.buildenv.2020.107472
193. Gupte J, Mitlin D (2020) COVID-19: what is not being addressed. Environ Urban 095624782096396. https://doi.org/10.1177/0956247820963961
194. Corburn J, Vlahov D, Mberu B et al (2020) Slum health: arresting COVID-19 and improving well-being in urban informal settlements. J Urban Heal 97:348–357. https://doi.org/10.1007/s11524-020-00438-6
195. Gupta S, Nguyen TD, Rojas FL et al (2020) Tracking public and private responses to the COVID-19 epidemic: evidence from state and local government actions. NBER Working Paper
196. Gil D, Domínguez P, Undurraga EA, Valenzuela E (2021) The socioeconomic impact of COVID-19 in urban informal settlements. medRxiv 2021.01.16.21249935. https://doi.org/10.1101/2021.01.16.21249935
197. Nyashanu M, Simbanegavi P, Gibson L (2020) Exploring the impact of COVID-19 pandemic lockdown on informal settlements in Tshwane Gauteng Province, South Africa. Glob Public Health 15:1443–1453. https://doi.org/10.1080/17441692.2020.1805787
198. Zhang W, Wang K, Yin L et al (2020) Mental health and psychosocial problems of medical health workers during the COVID-19 epidemic in China. Psychother Psychosom 89:242–250. https://doi.org/10.1159/000507639
199. Winter SC, Obara LM, McMahon S (2020) Intimate partner violence: a key correlate of women’s physical and mental health in informal settlements in Nairobi, Kenya. PLoS One 15:e0230894. https://doi.org/10.1371/journal.pone.0230894
200. Harris J, Cook T, Gibbs L, et al (2018) Searching for the impact of participation in health and health research: challenges and methods. Biomed Res Int 9427452. https://doi.org/10.1155/2018/9427452
201. Jennings Mabery M, Gibbs-Scharf L, Bara D (2013) Communities of practice foster collabo- ration across public health. J Knowl Manag 17:226–236. https://doi.org/10.1108/136732713 11315187
202. Adekola PO, Iyalomhe FO, Paczoski A et al (2021) Public perception and awareness of waste management from Benin City. Sci Rep 11:306. https://doi.org/10.1038/s41598-020-79688-y
203. Van Belle S, Affun-Adegbulu C, Soors W et al (2020) COVID-19 and informal settlements: an urgent call to rethink urban governance. Int J Equity Health 19:81. https://doi.org/10.1186/ s12939-020-01198-0
204. Buckley RM (2020) Targeting the world’s slums as fat tails in the distribution of COVID-19 cases. J Urban Heal 97:358–364. https://doi.org/10.1007/s11524-020-00450-w
205. Leach M, Scoones I, Stirling A (2010) Governing epidemics in an age of complexity: narratives, politics and pathways to sustainability. Glob Environ Chang 20:369–377. https://doi.org/10.1016/j.gloenvcha.2009.11.008