Climate change will exacerbate demographic challenges for urban planners

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Abstract—**Urban planning has to date concentrated on climate change adaptation or mitigation. It has also taken into consideration rising populations; however, growth patterns have followed a different direction which has been driven by different demographic developments: whereas Africa is confronted with rising and young populations, China and East Asian countries are facing declining and ageing societies. They will follow the trends in Europe and Latin America. Therefore, a review of current urban designs and future policies is recommended. In designing sustainable and green cities, Urban planners should accommodate the existing housing stock and urban landscapes to the needs of an ageing society; they should define different structures in urban agglomerations with growing populations in an economy. These adjusted policies will ensure continued job creation and long-term well-being for their citizens.**

Keywords—Demographics, climate change, urban planning, growth patterns, Asia, Africa

I. Introduction: climate change and demographic dynamics influence urban planning and design

This summer, the heatwave over Nanjing lasted much longer than anticipated. From her home, Weilan saw how the once mighty Yangtze River turned into a trickle. She has lived at this place for many decades. Since her childhood, the river has always been full of water, even in hot summers. She learnt from experts that the fertile lands in the river basin are likely to develop into steppe like some landscape in the Gobi Desert.

In Lagos, in the slums close to the sea, one night during a severe thunderstorm, big waves thrashed into a newly built neighborhood. Akintunde saw his newly built house dissolving into the stormy sea. Neighbors warned him not to build in this area as it had become prone to flooding. But where could he have a plot of land if no land at affordable cost had been available?

Two events in different part of the world but inextricably linked by climate change. It will make urban planning more complex to prepare cities for hotter and more fragile weather.

Demographic dynamics add more complexity to urban planning and growth patterns. The development of urban agglomerations in Africa and Asia will differ which is owed to (i) exposure of cities to climate change; (ii) direction of population growth and societal structures and (iii) resources available to finance adaptation or mitigation measures to cope with the impact of change.

Whereas Africa is confronted with rising and young populations, China and East Asian countries are facing declining and ageing societies. They will follow the trends in Europe and Latin America. Therefore, planners must accommodate the existing housing stock and urban landscapes to the needs of an ageing society or define structures which will provide housing and jobs for growing populations.

A debate among city planners, researchers and policy makers is arising whether current urban designs are sufficient to deal with demographic dynamics: can cities continue housing an expected influx of young migrants in search of work and a better future? Are cities capable of providing decent shelter with a larger share of older people?

The objective of this paper is to analyze the impact of climate change and different growth patterns because of differing demographic developments on urban planning in Africa and Asia. The findings and conclusions aim to support urban planners in the design of urban modeling by adjusting general applications to the specific context and conditions of African and Asian urban landscapes and areas.

The paper is structured in the following way: first, it describes the population growth patterns and demographic changes in Africa and Asia; second, it looks at the impact of climate change on urban planning and design; and third; it discusses examples and solutions, which have already been implemented, and could help refine urban modeling designs and algorithms.

II. Population growth and demographics developments in Africa and Asia

To date, most of the debate in emerging markets has concentrated on the impact of growing populations and an increasing urbanization. According to estimates by the United Nations, the world population is projected to grow from 7.9 billion in 2021 to about 10 to 11 billion by 2100. Additionally, the world population will grow older. According to the World Health Organization, the proportion of the world's population over 60 years will reach 22% by 2050. In 2015, this ratio was 12%. Growth and longer lives have been the result of improvements in (public) health care, better nutrition, and personal hygiene as well as higher levels of fertility.

The breakdown among regions and countries, however, is uneven: by 2050, Africa's population will have reached about 2 billion; this means every fifth person on the planet will be

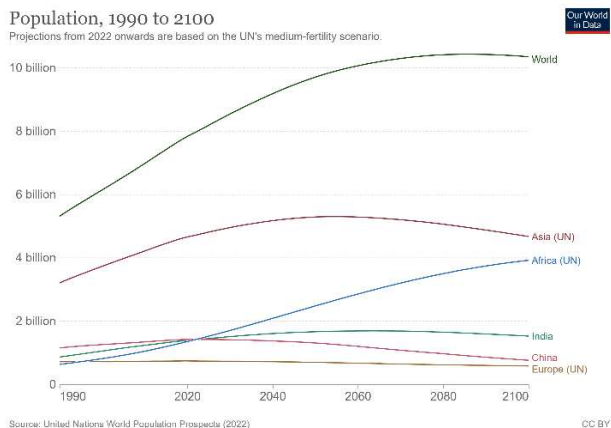from Africa. This figure is expected to rise to 4.3 billion by 2100.

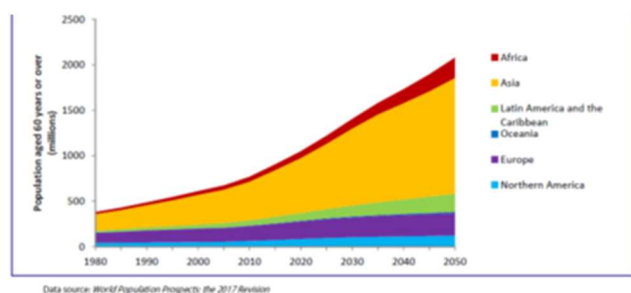Fig. 1. Example Population growth 1990 – 2010 (estimates)

Fig. 2. Population aged 60 years or over, estimated for 1980‐2017 and projected to 2050

The African population is young, says the World Economic Forum on their website. At present, 77% of the population is below the age of 35. It will be more urbanized in 2050. Africa's urban population is expected to nearly triple by 2050, to 1.34 billion, about 67% of its total population.

On the contrary, the UN estimates that the populations of Eastern and South-Eastern Asia are likely to peak at 2.4 billion people around 2040. In comparison to Africa, East Asia is already more urbanized and older; more than 50% of the population lives in urban areas. 33.7% of Eastern Asia's population is projected to be age 65 and older by 2060.

III. EXPOSURE OF CITIES TO CLIMATE CHANGE

Urbanization will continue in all emerging markets. Therefore, the importance of cities as places of production and income generation is likely to stay. Cities will remain vital to a country's capacity to generate revenues which are needed to cover the cost to deal with the impact of climate change.

As Weilan and Akintunde are experiencing, climate change has made living in cities more challenging. To date, cities have attracted migrants from rural areas in search of jobs. But bigger cities mean more industries, more roads, more cars, and fewer trees. As a result, we experience increased pollution, and emissions of greenhouse gases, which contribute to global warming.

In addition, cities are getting warmer. Robert Wilby from King's College in London emphasizes that temperature differences of up to 7 degrees Celsius between large cities and their surrounding rural areas are possible. By 2050, many cities around the world are likely to face more recurrent and intense heatwaves during days and nights. Especially, older people are suffering more from heat waves. In France, for example, two-thirds of the excess deaths among the elderly in 2003 took place in retirement homes and care facilities. Some research shows that older people in poorer neighborhoods tends to be affected more quickly by increased heat. One reason may be the fear of crime which may discourage inhabitants to open windows for ventilation, particularly at nighttime.

Heat is not the only consequence of global warming for cities. Next to droughts, city dwellers will have more floods and cyclones or hurricanes in the next years. In East Asia, cities most at risk are in China, Japan, the Philippines, Vietnam, and Indonesia; in Africa, coastal cities like Lagos, Accra, Dar es Salaam or Mombasa are exposed to rising sea levels and more flooding. Inhabitants of inland cities like Ouagadougou, Nairobi, Johannesburg, or Cairo will experience more intense heatwaves.

Hotter summers and more flooding in coastal cities will happen more often. The earth's capacity to naturally absorb greenhouse gas emissions is declining while emissions are still going to increase. Most researchers seem to agree that the goal of the Paris Agreement to remain below a 1.5-to-2-degree Celsius temperature increase is likely to be missed. Gala Vince, a renowned researcher on climate change, even works with an up to 4-degree Celsius rise by the beginning of 2100. Other research seems to confirm this hypothesis as a distinct possibility.

Therefore, cities will become a major area of attention to deal with the impact of climate change. As the Cancun Adaptation Framework outlines, there is some consensus that policies to combat climate change must include actions to reduce greenhouse gas emissions on the one hand; on the other hand, they also must entail measures to adjust life in cities. This framework is part of the overall United Nations Framework Convention on Climate Change.

The inclusion of cities in this Framework is due to continued urbanization and the higher exposure of cities to the effects of climate change. Most cities are dense and crowded places sealed with concrete and few green areas. High density and sealed surfaces exacerbate any climate related risk as well as intensify the so-called heat island effect. According to the United States Environmental Protection Agency, these "are urbanized areas that experience higher temperatures than outlying areas. Structures such as buildings, roads, and other infrastructure absorb and re-emit the sun's heat more than natural landscapes such as forests and water bodies. Urban areas, where these structures are highly concentrated and greenery is limited, become "islands" of higher temperatures relative to outlying areas."

IV. POTENTIAL SOLUTIONS

To cope with climate change, municipalities need to invest in better data generation on migration trends, environmental hazards as well as preventive and adaptive measures. Additionally, a better coordination on the municipal, regional, and country level is required. A big stumbling block in most municipalities of emerging markets are distorted land zoning policies and unclear titling regimes. They lead to increased cost for urban planning and design and prevent developers from building climate friendly (or green) solutions in a more systemic manner.

Several building designs and some recent examples of individual buildings provide guidance how to continuously make cities livable places. Building designs include specific cooling techniques ranging from the use of alternative or specifically selected building materials to district cooling mechanisms. Another important aspect is the structure of urban surfaces with enough green spaces within cities and fresh air corridors, the reduction of urban sprawl as well as the prioritization of public transport solutions.

In Singapore, urban planners can find good examples of green urban designs. In 2008, the Government outlined in the National Climate Change Strategy an approach of how to adapt and mitigate greenhouse gas emissions and transit to low carbon economy (i.e., city state). According to Belinda Yuen from the Lee Kuan Yew Centre for Innovative Cities in Singapore, policy makers and researchers in Singapore have already concentrated on the impact of ageing societies and climate changes on urban structures and the adjustments necessary since the early 1990s.

Singapore's challenge, as a nation with no indigenous energy resources, is to ensure supply of energy in an environmentally sustainable manner. At the same time, as a low-lying island state, Singapore needs forward-looking policies to limit the impact of rising sea levels.

The City of Masdar is another example. It is an initiative of the Government of Abu Dhabi, in the United Arab Emirates, and focuses on a broad slate of renewable energy and sustainability technologies to generate the skills, institutions and intellectual capital necessary for a low carbon future. In both cities, planners have managed to align business interests with political and societal objectives. Specifically, planning for the city of Masdar focused on the alignment of the political and social agenda with economically viable designs: on the one hand, they use green materials and structures. On the other hand, they lead to significant savings in water and energy consumption over the medium to long term. Thus, the management of buildings and urban transport will become more energy efficient and less costly.

The Masdar Initiative began work in 2006, adopted a multi-pronged, global approach. To spur innovation, it has invested in renewable energy and sustainable technologies, from research and development (R&D) startups to commercial operations. The city was designed to be car-free, with public transportation powered by renewable energy and buildings that were designed to use minimal amounts of energy. The project was expected to cost around $18 billion and be completed by 2025.

It consisted of various sub-projects. One has dealt with the provision of energy, using a range of renewable energy technologies; including a range of photovoltaic plants (PV), a concentrating solar thermal power plant (CSP), evacuated thermal tube collectors, and a waste-to-energy plant.

However, the project has faced several challenges and setbacks over the years. One of the main challenges has been the high cost of building a sustainable city from scratch. In addition, the global financial crisis of 2008 and the subsequent drop in oil prices had a major impact on the funding of the project.

As a result, the project has been scaled back and its completion date has been pushed back several times. The city is currently home to a research and development center for clean energy technologies, but it has yet to be fully developed as a sustainable city.

Both examples provide important lessons, concepts and designs for crafting appropriate policies and implement designs to ensure sustainable urban development patterns. However, more research would be required to take into consideration demographic dynamics in Africa and Asia. Different solutions are required for countries with young and rising populations and for countries with declining and aging societies. For example, policies and researchers have to date focused more on urban designs and growth patterns of large cities. Another important aspect is the growth of second tier cities and towns which have encroached one another and have formed "urban clusters". Clustering requires a better understanding of the individual growth patterns and their interlinkages (e.g., data on density profiles, traffic flows, location of commercial and residential areas and their demand, etc.). Additionally, more coordination among the individual municipalities, regional and national urban planners and policy is critical to a successful implementation of green city designs.

Singapore as a relatively small city state has several advantages. Although many of its policies would probably not practical for large countries, many of the concepts and design features can provide important examples and guidance for their formulation and implementation.

In conclusion, whereas the impact of climate change and population growth on urban development is well established, the impact of demographic changes is an important aspect, which has been taken less into consideration.

A more in-depth review would help gain a better understanding of individual growth patterns of urban clusters and agglomerations in Africa and Asia. A better modeling of the various directions will contribute to more targeted policies and support sustainable urban development with a positive impact on the overall economy.

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