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RELATIONSHIPS BETWEEN THE BUILT ENVIRONMENT AND ENVIRONMENTAL POLLUTION, ISSUES OF MEGACITIES

Dr. Ádám Paládi-Kovács DLA

Department of Construction Materials and Technologies
Budapest University of Technology and Economics (BME) Hungary
paladi-kovacs.adam@emk.bme.hu

Abstract: *The first part of the article discusses the natural environment of humans and its evolution over the past centuries. It examines the changes that have occurred in just the last 100 years and how they have impacted human habitats. It explores how architects and engineers shaping our settlements have influenced the environment, as well as how the model developed during economic growth affects and presents challenges to our society, particularly regarding the interconnection between climate change and the development of our cities.*

The second part of the writing addresses the issue of megacities, exploring where the almost endless growth of our metropolises has led, the problems it causes, the differences observed between the growth of megacities in developed and developing countries, the reasons behind it, and the additional difficulties it poses to their residents.

Keywords: *built environment, climate change, environmental pollution, megacities*

1. The growth of humanity and our cities

The increasing human population and technological advancement have transformed the world. Engineers and architects, in their work of continuously shaping the built environment, inevitably exert an impact on the natural environment as well. However, if humanity does not take care of the natural environment the continuous growth of infrastructure networks associated with cities, such as transportation facilities, roads, railway tracks, water facilities, dams, river regulation, water and sewage systems, slowly devours our urban green spaces, thereby destroying the world around us.

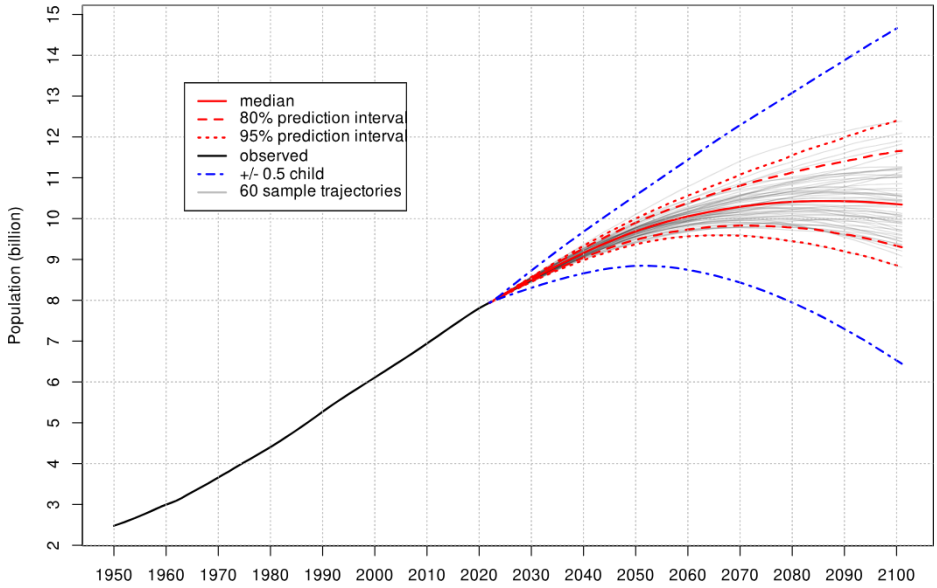

Figure 1. Global population size and annual growth rate: estimates, 1950-2050 [1]

If we pose the simple question of what constitutes the natural environment for humans today, we can only provide one answer: the built environment, the city. Although humans are inherently natural and biological beings, they have become disconnected from their original natural habitat.

According to the United Nations' World Population Prospects 2022. Summary of Results [1], the exponential nature of human population growth is accelerating this process. The report states that by the 2050s, the global population could exceed 10 billion people. In 2008, a significant milestone was reached when half of the world's population, approximately 3.3 billion people, already resided in urban areas. Based on the current projections outlined in the report, it is estimated that by 2050, more than two-thirds of humanity will live in cities, following today's trends. Furthermore, the report predicts that around 6 billion people will reside in megacities, which is nearly twice the current number.

Figure 2. Skyscrapers of Shinjuku city, Japan. (Morio - The uploader's own work, CC BY-SA 3.0)

Currently, Tokyo leads the list of the world's largest cities with a population of 40 million, followed by Seoul, which surpasses New York and Mexico City with its approximately 25 million inhabitants [2]. London, with its population of 10 million [2], the largest in Europe, lags far behind the Asian megacities. It remains a significant question as to how livable these megacities can be and whether this development is truly the only path forward. Nevertheless, today the city is the natural habitat of humans, which is why it is crucial to consider how we shape our cities and living spaces, emphasizing aspects such as humanity, livability, and preserving the original natural environment of humans in urban development.

2. The relationship between the built environment and climate change

One of the largest sources of greenhouse gas emissions is our built environment, contributing to climate change by over 40%, which is now undeniable. Their emissions result from various activities, ranging from the production of concrete and steel to the transportation of materials and the operation of completed buildings. However, despite numerous techniques available to reduce these negative impacts, they are scarcely utilized.

The increase in emissions and concentrations is primarily linked to human activities, although rising average temperatures can further intensify the process. Among the four main greenhouse gases, carbon dioxide is emitted to the greatest extent, accounting for 76% of the total volume [3].

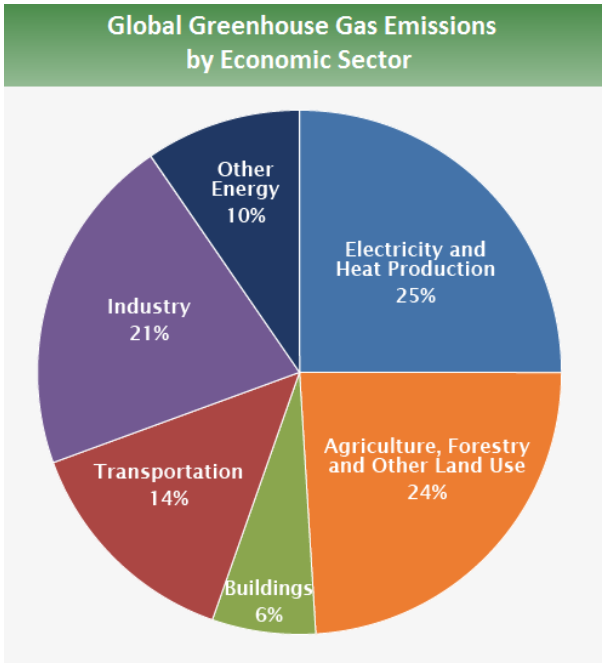

Figure 3. distribution of greenhouse gases by sector [1] [3]

As it stands, the actual reversal of climate change is difficult to imagine until the largest emitting countries, such as the United States, withdraw from the Paris Climate Agreement, [4] or until China pledges to reduce its carbon dioxide emissions by 2030. [5]

Secretary-General of the United Nations, António Guterres, words at the UN Climate Summit held in Egypt reflect the current situation well: "We're on a highway to climate hell, and our foot is on the accelerator." [6] Although a double agreement was recently reached between the two largest emitters, China and the United States, their cooperation in the climate crisis has so far been mostly verbal, without significant actions following.

Looking at the situation realistically, what we can do is try to slow down the pace of emissions. However, without a significant reduction in greenhouse gases, especially CO2 emissions, this is not conceivable.

If we look at the sources of greenhouse gas emissions by sector, we can see that 25% of greenhouse gas emissions are attributed to electricity and heat production, 21% to industry, 14% to transportation, and 10% to other energy uses. The emissions resulting from the energy and heating demands of buildings account for 6% of total emissions, while agriculture represents 24% of emissions, two-thirds of which are related to livestock farming, synthetic and natural fertilizer use, and nitrogen dioxide emissions caused by soil erosion. Excluding agriculture and other energy sectors, all emissions are attributed to our built environment. This is because the 6% emissions resulting from the energy needs of buildings do not include the

production and transportation of building materials associated with constructing the buildings. These aspects are accounted for in the industrial and transportation sectors.

Global warming, which fundamentally alters the world's climatic conditions, is caused by four greenhouse gases: carbon dioxide (CO2), methane (CH4), nitrogen oxides (NOx), and fluorinated hydrocarbons. The concentration of these gases continues to increase in conjunction with our cities and the built environment.

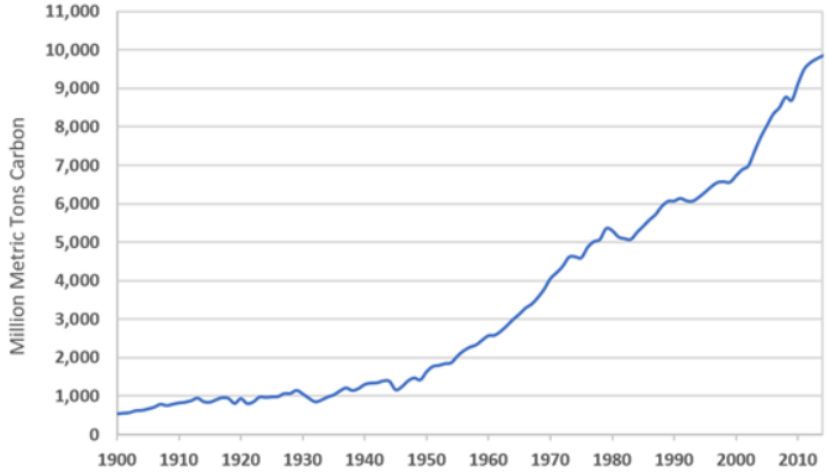

Figure 4. Global Carbon Emissions from Fossil Fuels Figure 4. Global Carbon Emissions from Fossil Fuels (Note1)

We are the ones responsible for the current state we find ourselves in. The economic model that the "developed world" has built and continues to operate on has led us to this situation. The consumer society is built on the concept of "generated scarcity," where constant growth is required to mask this scarcity. However, as long as this economic model fundamentally produces waste and pollution, the problem remains deeply ingrained. Fortunately, there are already numerous technologies available to reduce pollution caused by the built environment. However, the solution lies in a shift in mindset, where it is crucial to have and enforce rules during production that demand the lowest possible pollution emissions and compel businesses to adhere to them.

James Lovelock the recently deceased English scientist and futurist, formulated the Gaia hypothesis, which posits that all living and non-living parts of Earth form a complex system. He considered this theory to be his most important work, which he developed in collaboration with American microbiologist Lynn Margulis in the 1970s. [7] According to the hypothesis, Earth is described as a complex, self-regulating system that has been disrupted by human activities.

Lovelock expressed the human behavior of today in a wry and succinct way:

"If extraterrestrials are observing us, they would probably conclude that the main activity of humans on Earth is producing waste from the available natural resources as quickly as possible."

Initially, Lovelock's theory was rejected, but later, as the events he predicted occurred one after another (such as desertification caused by climate change, agricultural devastation, and mass migration), his hypothesis gained acceptance and became influential. He borrowed the name for his hypothesis from Gaia, the Greek goddess of the Earth in mythology.

Consumer society and its economic structure do not favor environmental conservation efforts and considerations. The world's most developed economies are built on overconsumption and perpetual growth (parasitic growth), without which these economies would collapse because their model is based on "generated scarcity." By introducing a new product with the help of marketing (e.g., advertisements), they create a sense of "lack" and generate demand, making people feel and believe that they absolutely need the advertised product to fill a void in their lives. On the other hand, the lifespan of products released into the market is deliberately limited (planned obsolescence) to encourage consumers to replace them with new ones and discard the old ones. Sadly, this is so true that fashion companies prefer to burn unsold clothing and accessories rather than clearing them from shelves, just to quickly launch a new collection. Luxury brand manufacturers operate in a similar manner. They destroy their expensive products not primarily to manage inventory but to preserve exclusivity. This mentality generates waste and harms the environment. According to a United Nations survey, the fashion industry is one of the largest sources of environmental pollution in the world. Globally, this industry is responsible for 20% of wastewater production and 10% of waste generation. [8]

Some economists, particularly during times of economic crises, occasionally raise the possibility of developing a fair and sustainable economic model, and there are already positive initiatives worldwide towards responsible production. However, most of these initiatives often remain at the level of words. For engineers involved in construction projects, it is increasingly necessary to examine and incorporate reusable and renewable materials. Even if architects have limited influence on this as designers, as it primarily depends on investor behaviour and building material manufacturers, they cannot neglect the work and thorough consideration associated with it.

During material selection, the designer must pay attention to broader (background) considerations. For example, prioritizing the use of local materials creates shorter transportation routes, resulting in lower environmental pollution. It is also worthwhile to examine the reuse of various materials, although this opportunity is less common. However, the responsibility of the designer (investor) during material usage is to consider the environmental impact of the construction and thereby contribute to environmental protection and reduce the ecological footprint of the building or construction project.

3. Problems of megacities

Today's megacities are among the major contributors to environmental pollution in the built environment. At the same time, they generate a series of additional challenges due to the dense concentration of people in a relatively small area.

All of this is further exacerbated by increasingly intense summer heatwaves, periods of drought, and flash floods, as stated in the report of the Intergovernmental Panel on Climate Change (IPCC). [9] According to the IPCC, these are what await the European region due to climate change. The negative consequences of climate change are particularly pronounced in cities, exacerbating each other. As urban heat islands intensify the already adverse health effects, and considering that more than half of the Earth's population lives in urban environments, [10] creating livable cities has become one of the most pressing tasks of our time.

The degree of urbanization of a country is expressed by its urbanization rate. (NOTE 2) Global urbanization rates exceeded 50% for the first time a few years ago. The scale is wide-ranging: aside from city-states like Singapore with an obviously 100% rate, there are many countries surpassing a 90% rate (such as Belgium, the United Kingdom, New Zealand, Australia, Argentina, Israel, and Iceland).

Developed countries (including the United States and Russia) have rates exceeding 70%, while Hungary is at this threshold, and China stands at 45%, with India barely around 30%. Among developing countries, there are also several with rates below 20% (such as Nepal, Ethiopia, Papua New Guinea, etc.). [11]

Megacities are characterized as urban areas with a population of over ten million people and a density of at least two thousand individuals per square kilometre. Megacities emerge from the fusion of a significant population centre and the surrounding metropolitan region. In the 1950s, there were only two megacities worldwide with a population exceeding ten million. By 2000, this number had increased to 20, and the trend continues. One of the biggest issues in megacities, in addition to environmental pollution, is transportation. The high number of private cars often hinders traffic flow, resulting in constant traffic jams that harm the environment. Additionally, problems such as segregation, crime, maintaining public safety, and public health pose significant challenges in megacities.

Hungary is not threatened by this danger, and Europe is in a position to decide whether to embark on the path of megacities or prioritize smaller, livable urban structures. In Asia, South America, and Africa, rapid population growth is currently unstoppable, and this is one of the factors contributing to the creation of massive megacities. Another factor is impoverishment, for example, as a result of the agricultural mechanization in rural areas, which leads to a reduced need for labor. Consequently, people who have lost their jobs flock to big cities in search of work and a better life. However, in certain parts of Africa, South America, and Asia, the emerging megacities as urbanization hotspots pose unresolved issues in public health, public safety, services, and infrastructure. [12] These megacities are unable to cope with the increasing influx of population, eventually becoming socially and public health-wise ticking time bombs. In contrast, the population of Europe is decreasing or stagnating, allowing for the development of smaller, more livable urban systems.

The urbanization process inevitably brings about alienation when a city exceeds the human scale in its size and development. We witnessed this during the decades of socialism in Hungary when large housing estates were created. In such environments, people generally do not feel comfortable, and when given the opportunity, they prefer to move away. The brutal designs characterized by enormous dimensions and high population density have a negative impact on residents. Social studies have shown that people in such environments become disconnected from their surroundings and from each other, leading to a significant increase in aggression, vandalism, and crime. Socialist urban housing projects primarily prioritized plan targets, norm

systems, and housing numbers, while the current predominantly investor-focused (financial) approach can also create inhumane built environments.

In the more developed parts of the world, urbanization has largely already taken place. In countries such as the United States, Canada, Japan, Australia, and the Middle East, over 80% of the population lives in urban areas. As a result, the pace of urban growth has slowed, and due to the strong economies of these countries, there are fewer slums surrounding these cities. However, segregation is still present. On the other hand, in the developing or less developed regions of the world, the majority of the low-income population still resides in rural areas. Urbanization is even more pronounced in these regions, which is the main reason why most emerging megacities are found in developing countries. However, in these Asian and African megacities, a process of hyperurbanization (NOTE 3) is taking place, where urban infrastructure struggles to keep up. This leads to significant challenges in public health, transportation, housing, loss of green spaces, and increased crime rates.

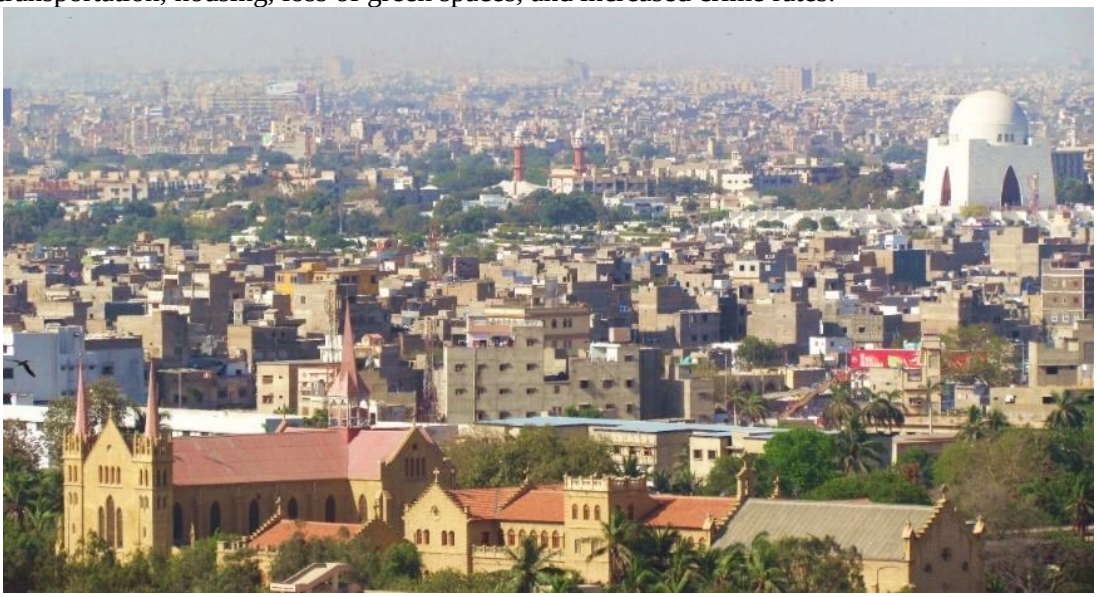

Figure 5. City of Karachi, Pakistan (Bilalhassan88 Foto: https://commons.wikimedia.org/w/index.php?title=User:Bilalhassan88&action=edit&redlink=1)

Karachi, with a population of 15 million [2], is the financial, economic, and industrial centre of Pakistan, but it is also known as a stronghold of crime. It is often said that "no one is safe in this city." In Karachi, one of the surest ways to meet death is to cling to your mobile phone. Thieves are ready to kill and then vanish without a trace in the bustling crowds. In addition to rampant crime, religious intolerance and fanaticism further complicate the situation, pitting the city's residents against each other. [13]

Megacities, especially in South America, Asia, and Africa, are surrounded by slums because the cities struggle to accommodate the inflow of massive population numbers. Kolkata, for example, is bordered by approximately three thousand slums. Globally, eight hundred million people live in shantytowns made of makeshift materials such as cardboard, planks, and tin. It

is on the outskirts of these megacities where population growth is highest, and the poor from nearby and distant rural areas flock, providing fertile ground for organized crime. These areas become immersed in the illegal world of arms, drugs, and child trafficking.

Figure 6. Makoko slum on the outskirts of Lagos (AP News Agency Photo)

Lagos, the largest city in Nigeria with a population of 21 million [2], is filled with millionaires. However, the majority of the population (66%) lives in slums. One of the most well-known slums is Makoko, a waterfront slum ironically referred to as the "Venice of West Africa." The makeshift shacks built on stilts are surrounded by polluted water, and floating debris, and inhabited by people who make a living by fishing. It is a breeding ground for diseases. Originally, Makoko was a village in the 18th century, but by the 20th century, it had become one of the most destitute areas in Lagos, even avoided by the police, and neglected by the city authorities. The majority of the community members migrated from Benin and Togo. [14] On the outskirts of Lagos stands the slum of Makoko, perched on stilts, characterized by dilapidated shacks, floating debris, and rickety boats dotting the dirty and murky water. For the thousands of poor inhabitants living in Nigeria's notorious Lagos slum, this is their home, with little chance of breaking free. [15]

The picture needs to be nuanced, of course. The growth of megacities in South America has slowed down, and cities like Seoul and Jakarta are experiencing different types of urbanization. There are places where poverty primarily increases, and there are places with social gaps, segregation, and isolation. Western examples of the latter can be found, not only in America. Suburbs around Paris or Marseille have become populated predominantly by unemployed Africans. The recent riots in France are also linked to these areas. Here, rootlessness, minimal security, weakening social protection, declining education, and violence are characteristics.

The circle of identification narrows down to the neighbourhood, the block, and the buddies. Their self-definition is always in opposition to something else, making another rival group their enemy. Those who have nothing internal to build their self-awareness on can only look outward, feeling cornered. The descendants of third or fourth-generation immigrants are particularly susceptible to the promise of religious fanaticism, such as Islam, which offers self-awareness, identification, and self-definition, while painting a clear enemy image in the form of "infidels" or the native population.

In North America, the situation is not any better in Los Angeles, where there are over ninety thousand members of urban gangs, and twenty-eight out of every hundred thousand people die a violent death each year. The April 1992 ghetto riots, as well as the Bombay riots (resulting in thousands of deaths), showed something about the possible future of megacities.
Eventually, megacities break away from their surroundings and gain immense economic weight, even competing with the economic power of their own countries. Bangkok, the capital of Thailand with a population of 15 million [2], generates 70-80% of the country's GDP. Seoul, with its population of 26 million, produces as much as the entire country of Turkey or surpasses the GDP of Sao Paulo with its population of 23 million [2], exceeding that of Poland.
In European cities, this issue has only just begun to emerge, as relatively few megacities have been established in this part of the world. Examples include Istanbul with a population of 16 million at the meeting point of Europe and Asia, and Moscow with a population of 18 million [2]. Alongside them, cities like London and Paris are also joining the ranks of megacities, where these challenges have also started to surface. However, much of Europe still has the choice of how to handle the increasing pressure of migration and the influx of people. They can decide how to settle and shape their cities, to what extent they want to follow the trend of megacities, as global changes are pointing in that direction.

4. Conclusions

Global warming fundamentally alters the world's climatic conditions, driven by greenhouse gases. The concentration of these gases continues to rise alongside our cities and built environment. The decades-long increase can be attributed to human activity, where a clear correlation exists between the growth of our built environment and the emission of air pollutants and greenhouse gases. The livability of megacities, among the world's largest polluters, is further degraded by the urban heat island effect and the summer heatwaves, periods of drought, and flash floods stemming from climate change. The achievement of climate goals is still pending.

With the growth of the human population and industrialization, our cities have grown immensely, creating more and more megacities. In developed countries, this growth has been accompanied by quality improvements, while the rapidly growing megacities in third-world countries have failed to keep up with necessary infrastructural developments. The resulting inadequate development has led to infrastructural and public health problems, the formation of slums, increased crime rates, and decreased quality of life. Additionally, the congestion associated with urban growth has further burdened the environment.

To avoid these problems, one of the most reliable paths is to prevent them from arising in the first place by not allowing our cities to endlessly expand. Instead, we should favor a more livable, smaller, human-scale urban structure, which can be a realistic alternative in Europe. However, the human population and urbanization rate continue to grow, and a reversal of this trend is not expected for now. Nonetheless, efforts can be made to create livable urban structures.

One approach is to create smaller but complete urban structures within large cities, represented by the concept of the 15-minute city [16], where everything we need in our daily lives is within a 15-minute walk, bike ride, or public transportation trip. Most often, we commute to work, shop, go to school, or have fun. This would not only make life easier for city dwellers but would also be beneficial for the climate.

A good tool to mitigate the negative effects in cities could be the increased greening of megacities, including the implementation of green roofs and green facades, which would help reduce these effects while filtering the polluted urban air and reducing cooling costs and energy consumption by shading buildings.

Today's urban planners and developers need to find answers to these questions if they want to create humane, human-centred urban environments and, consequently, normal residential communities, livable spaces, and cities.

NOTES

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NOTE 2: urbanization rate: value expressed as a percentage, which shows the proportion of city dwellers within the total population

NOTE 3: Hyperurbanization: too rapid urban growth, resulting in undeveloped and incomplete infrastructure and low service standards, where social deviance is amplified

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