DIRECTORATE GENERAL OF SCIENCE AND TECHNOLOGY (DOST)
GOVERNMENT OF KHYBER PAKHTUNKHWA

KHYBER PAKHTUNKHWA
SCIENCE AGENDA

DEPARTMENT OF SCIENCE & TECHNOLOGY AND INFORMATION TECHNOLOGY
GOVERNMENT OF KHYBER PAKHTUNKHWA

# URBAN ENVIRONMENT

Urban planing and development of well resourced urban infrastructure and services will support poverty alleviation and a better quality of life

## TASKFORCE REPORT

Urban Environment: Sectoral Analysis, Local Challenges, Strategic Insights and Recommendations

2023

# FOREWORD

In alignment with the Science Agenda for Khyber Pakhtunkhwa, the Directorate General of Science & Technology initiated a landmark effort to identify and advance priority areas where science, technology, and innovation can meaningfully contribute to the province's socio-economic development. We present to you the sectoral reports in key natural resource areas that are ideally unique to Khyber Pakhtunkhwa and have been identified for R&D investments. Each of these sectoral reports marks an important milestone in advancing scientific understanding and strategic development within Khyber Pakhtunkhwa's natural resource sectors, through focused inquiry and collaborative expertise. These reports, developed by thematic Task Forces constituted under the Directorate General of Science & Technology, are foundational efforts under the broader Science Agenda for Khyber Pakhtunkhwa. This transformative initiative seeks to reposition the province as a regional leader in science, technology, and innovation as we explore the potential of Khyber Pakhtunkhwa's rich natural resource landscape.

Under the Science Agenda, we hold a bold and pragmatic approach: to build on the province's existing strengths while investing in the future. The identification of eight natural resource areas — from gemstones and herbs to fisheries, fruits and vegetables, bees and honey, micro-hydro power, archaeology, and the urban environment — presents a unique opportunity for science-led value addition and sustainable economic growth. Each thematic area represents not just a resource, but a vibrant ecosystem of challenges and opportunities, waiting to be enhanced through strategic interventions in research, development, and innovation. These reports are the outcome of months of rigorous consultation, deep research, and collaborative ideation by multidisciplinary experts drawn from academia, industry, public sector, and civil society. The Task Forces were entrusted with the mission to map the current landscape, articulate key challenges, and recommend high-impact R&D pathways that can guide smart investment in the sector. This body of work now forms a scientific and strategic blueprint for stakeholders across sectors to drive meaningful change.

This initiative is aligned with our core vision to move Khyber Pakhtunkhwa from being a consumer of technologies to a creator of solutions, driven by our local talent, informed by global best practices, and anchored in our unique natural endowments. Through this endeavor, we reaffirm our commitment to building a culture of science that is inclusive, collaborative, and forward-looking.

I extend my deepest appreciation to all members of the Task Forces, as well as the wider science and innovation ecosystem that supported this effort. We look forward to translating the insights from these reports into tangible programs, R&D investments, and partnerships that uplift livelihoods, enhance competitiveness, and leave a lasting impact on the province's development trajectory.

**Sajid Hussain Shah**
Director General
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The report is the outcome of a time-bound effort by a dedicated Task Force constituted for this thematic area, comprising local experts from diverse institutional backgrounds, including academia, government, industry, and the development sector. The Task Force worked collaboratively through multiple rounds of consultations to undertake a deep-dive analysis, identify context-specific challenges, and offer actionable insights to guide future scientific, technological, and policy interventions. The Directorate General of Science & Technology sincerely acknowledges the valuable contributions of the Task Force on Urban Environment, whose members brought together rich expertise and institutional experience across the environmental domain. Their collective insights and commitment were instrumental in shaping this report.

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# Taskforce on Urban Environment

## SECTOR SNAPSHORT

Sector snapshots on Environment in General and Urban Environment in the case of Khyber Pakhtunkhwa include:

**1.** Khyber Pakhtunkhwa has been affected by adverse environmental conditions, including erratic weather patterns, climatic variations and increased disaster onsets. The 2022 floods caused damages to the tune of 985 Million USD in KP, which requires 780 Million USD to revive lives and livelihoods in KP as per the Damage Needs Assessment on the 2022 Floods.

**2.** A study on the process of urbanization and urban growth in Peshawar revealed that annual increase in Peshawar's population ranged from 8 percent in 1981 to 14 percent in 2017 and is slated to approach 18 percent by 2030.

**3.** The number of houses and the population is increasing at an alarming rate in Peshawar. In 1981, the number of houses was 0.167 million, 0.236 million in 1998 and 0.897 million in 2015. The population growth rate of Peshawar is 3.99 per annum, which brings added challenges in the form of traffic congestion, rising temperatures, environmental pollution, and a shortage of agricultural land.

## I. THE SUBSECTOR LANDSCAPE

Pakistan's Khyber Pakhtunkhwa province in recent times has been affected by growing geo-political and geo-strategic instability. Moreover, the region has also been affected by adverse environmental conditions, including erratic weather patterns, climatic variations and increased disaster incidence have further affected the province, particularly during the last two decades[1]. Irregular weather patterns and climatic variations have led to the onset of recurring natural disasters onsets including erratic river flows leading to large-scale floods in 2010, which again affected the province in August 2022. The 2022 floods alone caused damages amounting to USD 985 million in Khyber Pakhtunkhwa, with an estimated USD 780 million urgently required for reconstruction and recovery, according to the DNA on the 2022 Floods. In addition, droughts and pest attacks have increased in frequency, affecting the resilience of local ecosystems as well as increasing food insecurity and leading to shortages, which have further increased rural poverty, inequality and marginalization in Khyber Pakhtunkhwa[2]. Unplanned urbanization and rapid expansion of cities have decreased the availability of arable lands in KP, which has entailed significant consequences for environmental conservation, affected living quality and compromised sustainable development. It is therefore critical to boost existing environmental conservation initiatives in KP. The Environmental Task Force will

[1] Saeed Khan, K. (2019). Analysing local perceptions of post-conflict and post-floods livelihood interventions in Swat, Pakistan. *Development Policy Review*, *37*, O274-O292.

[2] Govt. of Khyber Pakhtunkhwa. (2016). Climate change policy, Environmental protection agency, Govt. of Khyber Pakhtunkhwa. Forestry, Environment and wildlife Department. June, 2016.

aim to explore avenues for undertaking evidence-based value- added research with a view to creating new insights based on scientific analysis and enhance existing enforcement, as well as providing evidence-based case studies on the environment and related themes in the province. Moreover, to solve the intricate problems facing KP, interdisciplinary approaches cutting across environment, development, climate change, and resilience of social and ecological ecosystems need to be explored to create a holistic framework and lead an actionable response to the emerging challenges confronting KP[3]. The Task Force on the environment will focus on Urban and Rural environment as a whole. In the areas of environmental conservation, strengthening resilience of ecosystems and increasing disaster mitigation, the focus shall remain on rural and urban areas. While the focus on Urban Environment will be to deal with green urbanism, Urban Flooding and WATSAN issues.

Cities are increasingly becoming complex systems of social, economic and ecological factors (Liu et al., 2007). However, they are very vulnerable when any of their subsystems are destroyed or fail to adapt to new challenges (Coffee, 2010). Such a situation may lead to a fatal crisis or even destruction (Rao & Summers, 2016). Uncertain factors, such as natural disasters, climate change, energy crises, political instability, financial crises, food security and terrorist attacks play an important role in threatening urban development (Spaans & Waterhout, 2017). Although these threats have already existed worldwide for a long time, few big cities have been permanently destroyed or abandoned since the 19th century (Campanella, 2006). However, some famous cities world-wide such as Hiroshima, Tokyo, Warsaw, Dresden, Berlin and Beirut, for example, although destroyed by wars or natural disasters continue to exist even more vibrantly than before because they changed their entire structure to be more sustainably developed and resilient in the face of all the challenges that were coming their way.

Peshawar is the capital of Khyber Pakhtunkhwa (KP), a road and rail centre near the famed Khyber Pass, an important military and communications centre, the historical limit of the Grand Trunk Road of Indo-Pak, and the major depot for trade with Afghanistan. It is famous for local handicrafts, fruit farms, Industries that include food processing and the manufacture of steel, cigarettes, firearms, textiles, pharmaceuticals, furniture, shoes, marble, ceramics, matches, paper and much more. It is bounded on the North by Charsadda district, on the East by Nowshera district, on the South by the tribal area adjoining Peshawar and Kohat districts and on the West by Mohmand and Khyber agencies. The total area of the district is 1257 sq Kms. Peshawar district is almost a fertile plain with small hilly area in the South-East, which is a part of the main Khattak Range, and its highest point is 1173 feet above the sea level.

Peshawar, a city that has been a victim of rapid and unplanned urbanization for the past 3 decades, once a city of flowers, has turned into a populous and stained metropolitan. Peshawar has been an important trade hub for Afghanistan and the Central Asian Republics. It had been equipping the huge influx of Afghans after Afghan war (1979-1989) and during the period of the Taliban government in Afghanistan (1996-2001). Even today, as the NATO forces are fighting an unending war against terror in Afghanistan, millions of Afghans are taking refuge in KP as a whole and in Peshawar, in particular. Internally Displaced Persons (IDPs) of Swat and Waziristan operations also migrated to Peshawar during the years 2007-2016,

[3] Nizami, A., J. Ali and M. Zulfiqar. (2020). Climate change is real and relevant for sustainable development, empirical evidence on scenarios from North-West Pakistan. *Sarhad Journal of Agriculture,* 36(1): 42-69

most of them returned following successful military operations, but the well-off settled permanently in Peshawar.

A study on the process of urbanization and urban growth in Peshawar since the beginning of the 20th century reveals a steady increase in the size of the urban population and the degree of urbanization. But the tempo of increase became faster from 1981 onward. From 1981 to 1998, Peshawar's urban population was more than three times. The urban population of Peshawar is growing at a rapid pace, from 8 percent (1981) to 14 percent (2017) and approaching 18 percent by 2030. With its considerable advantages, the technological and industrial boom has also brought enormous problems to urban citizens, instigating a huge urban influx, degradation of the environment, acute shortage of space for housing, lack of sewage treatment and health facilities, polluted water, an increase in the number of slums and transport constraints.

However, unlike the big cities in developed states, Peshawar is not able to take in more and more people because of unplanned and poor urban management and resource constraints. Out of a total 4.269 million, the urban population of Peshawar is 1.970 million, and it is estimated that the urban population of Peshawar will likely increase to 2.80 million by 2030. It is important to point out that most people, including many social scientists and journalists, believe that rural to urban migration is the prime factor of urbanization. This myth has already been exploded by demographers. It may also be noted that the data under discussion does not include the Afghan refugees. Technically speaking, the latter is not the Peshawar population, and their inclusion would make the decennial census data incomparable. But when it comes to analysis and discussion of urban problems, their inclusion and mention in the analyses becomes necessary. This aspect is, therefore, included in the analysis and discussion of the problems associated with urban sprawl, especially in the context of Peshawar city and around where these Afghan refugees live in large numbers.

A comparative study of t h e urbanity level of Peshawar vis-à-vis KP as a whole during 1901-1998, 1980-2017 brings out some interesting facts. As early as 1980, the urbanity level in KP was 12.7 percent while for the territories now comprising Peshawar, the corresponding figure was 9.8 percent. Peshawar maintained a higher urbanity level until 1941, but afterwards it lagged behind the KP's overall averages in census counts of 1951 and onwards. In the year 2017, the urbanity level of Peshawar was 18.9 percent, and of KP as a whole was 38.5 percent.

Housing growth rate in Peshawar has multiplied manifold in the past three decades. The increasing trend of urbanization in most parts of the country has its impact on Peshawar as well. In addition to improved facilities, people are trying to migrate to urban areas. In order to make them settle in these urban areas, there is an unmet demand for more infrastructure in Peshawar. The number of houses is increasing in the wake of these migrations. According to the Housing Census 2015 and data available with the Peshawar development authority (PDA), the total number of houses in Peshawar was 0.167 million in 1981. It went to 0.236 million in 1998, and the number of houses in Peshawar remained 0.897 million in 2015. The projected trend could be much more in the near future. With an alarming highest population growth rate of 3.99 per annum, the already over-populated Peshawar with massive urban sprawl

is confronting allied challenges like traffic congestion, rise in temperature, environmental pollution, shortage of agricultural land, lack of sewage-treatment facilities, contaminated drinking water, poor sanitation, law and order situation, and much more. Traffic congestion, as a regular feature, has been affecting every commuter irrespective of holidays, characterized by slower speeds, longer trip times, increased vehicular queueing, high operating costs, and drivers becoming frustrated and engaging in road rage. The problem becomes more severe in peak hours, and credit goes to inefficient land use planning, poor infrastructure, and the absence of a sound traffic-management system. Adding to the sufferings, the PTI provincial government started the Rapid Bus Transit project (BRT) in October 2017, aiming to provide better and cheaper urban transportation but the project succumbed to inefficient supervision, and it still cannot provide a completion deadline.

Unplanned urban extension and rapid population growth has resulted in a significant rise in the temperature of Peshawar. According to the Director Metrological Department, Peshawar Mr Liaquat Nazir “Average mean temperature of Peshawar remained 35 °C during summer throughout, but a constant and disturbing shift towards the higher side is observed during the past three decade, seeing the temperature of Peshawar has risen from 350C (May-Sept) to 500C (May-Sept)”. Likewise, the Directorate of Water and Sanitation, Peshawar Development Authority (PDA) admits a lack of sewage treatment facilities in Peshawar and attributes it to budgetary constraints. Visible smoke and dust all around the city are not only posing a high threat to human life but have put the environment and beauty of the city at stake.
In 2003-04, a study was conducted by Pakistan Space and Upper Atmosphere Research Commission (SUPARCO) in six cities, including Peshawar. The study concluded that emissions of all pollutant gases are too high in these cities. The study also showed that concentrations of PM10 in Peshawar are more than 150ug/m3 (micrograms/meter-cubed), which is an alarming fact. The study also indicated that air pollution levels in Peshawar are 20 times higher than the actual standard set by the World Health Organization (WHO).

These findings are based on a study conducted 15 years ago; today, the situation is even worse. According to data available from the Directorate of Water and Sanitation (PDA), they supply water to 0.335 million housing units in Peshawar, whereas the rest rely on their own sources. According to PDA, a water quality survey of the River Kabul revealed that the concentration of Coliform bacteria in the river Kabul water is 1600/100 ml of water, as compared to the World Health Organization (WHO) standard of 3/100 ml of water. Three treatment plants were established for Peshawar, but the same are not working to their full capacity.
Socio-economic changes in the city are indivisibly linked with alterations in urban policy and active investment processes in construction, engineering, development and urban landscaping. The managerial decisions focused on short-term results are unacceptable. All factors like natural, historical, social, economic, environmental, cultural, etc, must be taken into account to address and to restore the magnificence of a city that was once known for its refinement and beauty.

## PLANNING FOR SUSTAINABLE GREEN URBANISM: AN EMPIRICAL BOTTOM-UP (COMMUNITY-LED) PERSPECTIVE ON GREEN INFRASTRUCTURE (GI) INDICATORS IN KHYBER PAKHTUNKHWA (KP), PAKISTAN[4]

Rising vulnerability of the urban green infrastructure (UGI) is grabbing global attention, for which inclusive urban landscape and greening policies (ULGP) and frameworks are crucial to support green growth.

Urbanization leads to the shrinkage of urban green spaces, which directly contributes to extreme climatic hazards such as flooding, droughts, urban heat island effect, etc. These hazards then further result in the degradation of ecosystem functions (ESF) and the loss of biodiversity, which affects human health/well-being. The experts anticipate that the climate change observed today and in the foreseeable future will be influenced by the variability of anthropogenic forcing. If we cannot limit global climate change, there will be far-reaching repercussions on nature and society.

The global vulnerability of cities to climate-related hazards and stresses is expected to increase due to an increased built-up footprint compared to the population growth rates. According to research, it is estimated that the urban population will grow by 72% from 2000 The incremental trend of the world population and anthropogenic activities has changed the land cover and contributed to the greying of the natural landscape. These harmful impacts of urbanization and the corresponding high pressure on the natural environment, at an unprecedented rate, are badly hampering urban growth in the major cities of Pakistan.

In Pakistan, the urbanization rate has increased from 32.98% (year 2000) to 36.91% (2019), with further projections to reach 50% by 2025. This upsurge is transforming the local attitude towards green spaces; thus, urban centers receiving less consideration become unsafe and evolve multidisciplinary climatic challenges. Amongst other challenges, urban flooding remains the most threatening climatic hazard with the power to endanger human safety and frighten natural resources and ecosystems. Furthermore, jeopardizing the socio-economic fabric of urban (flood-affected) inhabitants remains common.

These issues call for urban green infrastructure (UGI planning is defined as “a network composed of open spaces, waterways, gardens, forests, green corridors, trees on streets, and open spaces, bringing many social, Economic and ecological benefits”. Another UGI version exists as “an interconnected network of natural areas and other open spaces that conserves natural ecosystem values and functions, sustains clean air and water and provides a wide array of benefits to people and wildlife” to enhance urban sustainability. UGI is perceived as a nature-based and cost-effective solution to achieve resilience in the land use planning process to mitigate the ever-rising climate uncertainties, a revamp of all existent contemporary ideas concerning green space planning, an approach to enrich the health of the ecosystem, minimizes the surface water runoff, improves water infiltration rate and a cost-effective strategy to mitigate urban floods. Thus, UGI planning is already tested and declared important

[4] Rayam.M, Gruehn. D, Khayyam. U. (2022). *“Planning for Sustainable Green Urbanism: An Empirical Bottom-Up (Community-Led) Perspective on Green Infrastructure (GI) Indicators in Khyber Pakhtunkhwa (KP), Pakistan”.* Berlin, Germany. Available at: https://www.researchgate.net/publication/363724385_Planning_for_Sustainable_Green_Urbanism_An_Empiri cal_Bottom-Up_Community Led_Perspective_on_Green_Infrastructure_GI_Indicators_in_Khyber_Pakhtunkhwa_KP_Pakistan

in countries such as Germany, the UK, and the Netherlands, where it is encouraged to promote innovative nature-based green solutions for climate change mitigation and adaptation. Hence, it is confirmed that planning instruments (such as UGI) play an imperative role in minimizing the urban flooding effects, thereby enhancing the socio-ecological well-being of any region. Based on its strengths, this nature-based green (NBGI) approach stands as an applicable instrument for sustainable climate-risk management (SCRM) in cities, yet importantly, in bitterly climate-affected countries such as Pakistan.

Establishing a Niche: Climate Change Impacts Pakistani urban areas pose multifaceted climatic encounters. The consistent urban flooding events observed in recent years are putting lives and livelihoods at stake. It is these growing incidences of floods, strong monsoon circulation, surface temperature rises, etc., that are making the country highly vulnerable and posing it (as per the climate risk index-CRI) (CRI is research that is centered on a comprehensive and accurate database of climate hazard effects observed in all countries in the world. In addition, low-income countries need to utilize the index as a warning signal to equip themself completely for future catastrophic disasters, the eighth most vulnerable country to climate hazards. Therefore, the disastrous impacts on ecosystems, biodiversity, agriculture, human settlements, human health, etc., are profound with different levels of adaptability. Such devastating disasters for a country such as Pakistan (an agrarian economy) directly hamper the agricultural sector, which contributes 21.9% of GDP and employs 45% of local labor. These disturbing lives and livelihoods remain prominent in the major/mega cities, which are further linked to massive and unplanned settlements at the expense of decreasing forest cover. Other factors contributing to this issue are high population density, building of new colonies or expansion of physical infrastructure, etc., that are removing the green cover and urban green spaces and rising air pollution. These aforementioned problems prevail due to non-existent UGI planning in the existing urban plans and policies of the country, where such effective strategies are perceived only as a luxury urban activity. It is mainly associated with beautification (though not an essential urban amenity) to influence urban resilience against climatic hazards.

The whole alarming situation is linked to the regional non-resilient outlook toward unbalanced and reactive urban planning policies that lead to unplanned settlements, further enlarging the environmental issue in the country. Aside from the planning deficiencies (as outlined above), other contributing factors are inadequate ULGP, weak laws and enforcement, undue influence, lack of scientific knowledge, lack of awareness non-existence of PP is recognized as the effective tool to promote community stewardship in the planning and decision-making process to bolster nature-based-green infrastructure (NBGI) initiatives in land-use planning; effectively tackling socio-environmental problems at grassroots levels approach, etc., all contributing to the transformation of green spaces into urban functions/activities [10,35,43]. This exerts constant pressure on land cover, so the deterioration of UGS elements. These issues declare Pakistani megacities highly vulnerable to natural calamities, with no exception of the northwest territories of KP.

At a national level in Pakistan, KP province suffered predominantly from consistent flooding events in the last decade, which marks this area as highly vulnerable and risky to in-daunting events, accounting for massive economic and human losses. Generally, these damages are linked to the region's geographic position and topographical features. The area lies on the bank of the Swat, Kabul, Kunhar, and Panjkora rivers' basin that originates from the high mountains of Hindukush, the Himalayas, and the Karakoram ranges. Being at water

banks enhances the catchment area's vulnerabilities to urban flooding. In addition, the issue also stresses the built environment service, which leads to the over-exploitation of natural green barriers, thereby endangering urban ESF and human health/well-being in urban settlements. Therefore, tackling the underlying causes and destructive effects of climate change in this region requires an immediate effort to examine the nexus between the UGI and climate-resilience notions to be incorporated (holistically) in the land-use planning process. It is to develop a rich, multi-functional/inclusive/sustainable UGI-indicator-based (framework) model structured according to the local built environment. Such a model should be grounded on the (native) community perspective or the PP process, that further leads to strengthening the climate-resilient strategies, green spaces (GS), ecosystem functions (ESF), and human well-being in catchment areas.

## ANALYZING ENVIRONMENTAL GOVERNANCE IN KHYBER PAKHTUNKHWA[5]

Under the Khyber Pakhtunkhwa Rules of Business, 1985, the Housing Department, the Local Government Department, and the Planning and Development Department are established to deal with administrative affairs in rural and urban development. The Departments of Housing and Planning and the Development Department are not given representation in the Khyber Pakhtunkhwa Environmental Protection Council, though these Departments would have been beneficial for the development of a better environment, as these Departments perform functions which are relevant to the environment.

The Khyber Pakhtunkhwa Local Government Act, 2013, has delegated some functions to the local government, which are performed through Departments devolved to such local government.

It is worth noting that the Department of Environment has not been devolved to the local government, and it is a question as to how such local government will work for the protection of the environment without having the support of the Environmental Department of the Provincial Government.

There is a lack of coherence between the Provincial Government and the local Government in the context of the environment. The administrative affairs, from view viewpoint of the environment, between the Provincial Government and the Local Government are not reflected in the Khyber Pakhtunkhwa Rules of Business, 1985, and the Khyber Pakhtunkhwa Local Government, 2013.

The Khyber Pakhtunkhwa Environmental Protection Act, 2014, has also provided for some administrative bodies, such as the Khyber Pakhtunkhwa Environmental Protection Council, which is empowered to approve environmental policies and environmental quality standards. Unlike the Pakistan Environmental Council, the composition of the Provincial Environmental Protection Council has not included any representative of the Federal Government. This situation may likely cause an imbalance in the development of measures for the protection of the environment in accordance with the spirit of international environmental conventions.

It is recommended that the above-mentioned gaps and overlaps be remedied through prompt

[5] Khan.I.U, Khan. M.A. (2017). *"Analyses of Environment Governance in Khyber Pakhtunkhwa"*. Law College, University of Peshawar. Available at: http://journals.uop.edu.pk/papers/Jan%202017%20---%204.pdf

legislation, and relations be developed between various administrative structures given in various laws. Particularly, laws related to local government, environment and provincial administration shall be linked, and coordination amongst them shall be ensured through appropriate amendments in respective laws for effective management of environmental protection.

## II. PROBLEM STATEMENTS

The rising problems of unmanaged urban and rural development in Pakistan have stressed the economy, further putting a strain on the resources available for environmental conservation and the issues that need to be dealt with through better policies. Over the past few years, Pakistan has had the highest urbanization rate in South Asia. According to the United Nations Population Division, nearly 50% of Pakistan's population will be living in cities by 2025. Urban development is usually linked with high economic activity. More than 80% of global GDP is generated by cities with planned urbanization. 55% of Pakistan's GDP comes from economic activity in cities. The per capita income in cities is also higher than that of rural areas. Only ten cities in Pakistan make up 95% of the total federal tax revenue. However, this economic activity and urbanization are not always directly proportional in the case of developing countries. The results are mostly negative for developing countries where urbanization is not supervised and planned. It is mainly because unplanned and unmanaged urbanization hinders growth and job production. This results in the formation of urban slums. Industrial development is also slow, and the government fails to meet the demands of the rising population. Pakistan's urbanization was also initially thought to positively contribute to the GDP, but it has proved otherwise in recent years. Several problems, such as unemployment, insufficient medical facilities, housing shortages, lawlessness, poverty and environmental degradation have increased.

One of the major reasons for this unplanned and unmanaged urbanization is the lack of government policies to address the needs of the growing population. Moreover, thousands of illegal housing societies are sprawling on the borders of major cities. The reports from the International Growth Centre (IGC) indicate that the residential societies on the outskirts of major cities make up 60% of the total city growth. These residential societies no doubt meet the housing needs of people migrating to cities for jobs and other business activities, but, in the long run, they cause more harm than good. According to a report by the World Bank, Pakistan's urbanization is "messy and hidden", which means that urban growth is well beyond administrative controls. It is creating an imbalance in the overall economic activity in these cities. One such example is the unrest and discontent that most of Karachi's population faces, although it was a hub of innovation and growth in Pakistan previously, which contributed to the overall GDP. Just like Karachi, the overall condition of Pakistan's other urban areas is also deteriorating. To steer the urban economy towards resilient and sustainable development, one which will in turn contribute to the country's growth on a larger scale, the first step is to identify the problems in that setting which is causing a hindrance to this growth.

There are several issues identified; following are some of the major contributors.

- The role of Climate Change in the onset of Natural Disasters in Khyber Pakhtunkhwa
- Water and Sanitation
- High population density

- Inadequate infrastructure
- Lack of affordable housing
- Flooding
- Pollution
- Slum creation
- Crimes
- Congestion
- Poverty
- Air pollution
- Lack of jobs
- Biodiversity threatened

## A. THE ROLE OF CLIMATE CHANGE IN THE ONSET OF NATURAL DISASTERS IN KHYBER PAKHTUNKHWA

The recent floods, which affected Pakistan in general and KP in particular, resulted from the climatic variations in the upper reaches of the Indus River system[6]. There is a growing consensus amongst climate experts, policy makers and practitioners that Climate Change is the single biggest cause of the recent floods that hit the country. The escalating risks associated with recurrent flooding have increasingly transformed natural hazards into full-scale disasters, as the lower riparian communities and existing infrastructure remain unable to withstand intensified water flows (Ibid). Recognizing this challenge, the United Nations Secretary-General has called upon donor countries—particularly the world's leading emitters and polluters—to share responsibility for Pakistan's reconstruction and recovery efforts. This appeal underscores the country's disproportionate vulnerability, given that Pakistan contributes less than 1 percent to total global greenhouse gas emissions.[7]

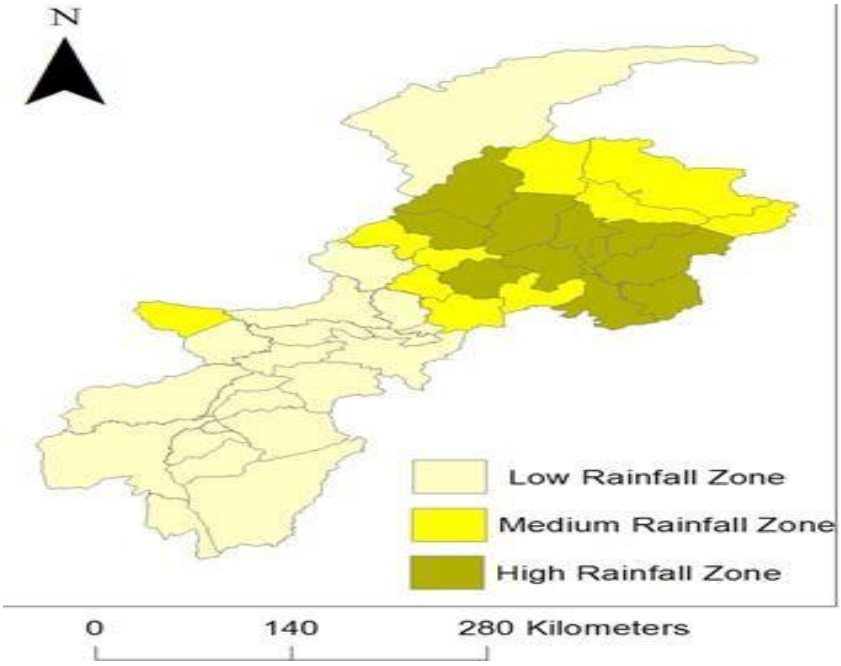
Since the Rio conference in 1992 on sustainable development, the effects of climate change have become profound with each passing day. Global warming - erratic weather patterns, including temperature variations and their impacts on galactic melting, result in increased risk of natural disasters in the form of flooding and droughts (Map 1). In the context of developing countries such as Pakistan, it is important to assess the applicability of Climate Change adaptation and mitigation policies, even more so in the context of Khyber Pakhtunkhwa, where a climate change policy was formulated and approved for implementation in 2016. It is therefore important to assess how these policies have been implemented in the context of environmental conservation, climate change adaptation and mitigation[8].

[6] UN News (2022). *UN chief sees 'great heights' of human endurance and heroism amid 'climate carnage' in Pakistan,* Global Perspective Human stories. Available online at: https://news.un.org/en/story/2022/09/1126411 (retrieved on 11/1/2022) [7] Rannard, G. (2022). How Pakistan floods are linked to climate change. BBC News. https://www.bbc.com/news/science-environment-62758811

[8] Slettebak , Rune Thokildsen (2012) *Climate Change, Natural Disasters, and the Risk of Violent Conflict.* PhD thesis, Norwegian University of Science and Technology.

Unplanned urbanization and expansion of cities are affecting KP's northern forested districts, including Dir, Lower Chitral, Swat, Shangla, Kohistan and Mansehra. Climatic variation and deforestation accompanied by land use changes have affected the watersheds across KP.

This has led to flash flooding, GLOF events and further weakened the fragile social and ecological resilience of communities and ecosystems in the countryside. Moreover, there is a need to assess the consistent unplanned intrusion in natural habitats across the province, which is leading to environmental damage and reducing biodiversity and irreversibly damaging forest-based ecosystems, where the rate of deforestation is increasing exponentially.




Map 1. Khyber Pakhtunkhwa Rainfall Zones

**B. WATER AND SANITATION**

According to an International Monetary Fund (IMF) report, Pakistan is the third most water-stressed country in the world. More than 80% of the population is facing water scarcity. Water availability in Pakistan has decreased from 5,229 cubic meters per individual in 1962 to only 1,187 per individual in 2017.

According to the Pakistan Institute of Developing Economics (PIDE), water use in Pakistan increased by 0.7% per year from 1977 to 2017, while water resources remained stagnant at 246.8 billion cubic meters. The biggest challenge to this acute water shortage problem is the rapidly growing population and urbanization.

Moreover, the water supply in most of Pakistan's major cities lasts for only 4-16 hours per day, and that too is only for 50% of the population. The Asian Development Bank recently issued a report that stated 90% of Pakistan's water supply resources are unsafe and unhealthy to drink. With the unchecked growth in population and urbanization, the water shortage problem is worsening. Urbanization is also a major reason for stress on the sanitation system. As more

people start living in an area, the installed management system becomes incapable of managing the solid waste incoming from several sources. Shared latrines are common in most parts of the country, where 20 people use 1 single latrine. This poor sanitation is costing 3.9% of Pakistan's total GDP.

**C. HIGH POPULATION DENSITY**

This problem of high population density is caused due to the heavy rate of migration from rural areas. The rapid population growth has led to an acute shortage of dwelling units, which has resulted in overcrowding, traffic congestion, pollution, housing shortages (slum and squatter housing), high rents, poor urban living conditions, low infrastructure services, poverty, unemployment, and poor sanitation, which has become pervasive and indeed a high crime rate. All of these affect the high population density in developing countries.

**D. INADEQUATE INFRASTRUCTURES**

One major serious aspect of the urban problem is the poor state of the infrastructure. Some developing countries are still faced with a bad road network, a lack of power supply, inadequate water supply and some basic amenities.

**E. LACK OF AFFORDABLE HOUSING**

Lack of affordable housing has led to confrontations with well–organized squatters, who take over unoccupied buildings to live rent-free or prevent demolitions. This has brought about, lack of housing vacancy rate, due to the rapid job growth and housing costs that have increased. Problems such as insufficient housing, especially for low–income families, are being faced, which resulted in overcrowding of already congested areas, the continuing deterioration of rundown neighborhoods, high social cost and untold personal misery. Measures proposed to offset rising costs in public housing include less exclusionary zoning regulations, reduced tax burdens, cooperation with the private builders, Encouragement of cooperative housing organization, promotion of industrialized building techniques, Use of low-cost building materials and cheaper mortgage credit.

**F. URBAN FLOODING**

Flooding is a very serious problem faced in urban areas, especially in developing countries, during the rainy seasons. Encroachments on drainage areas such as lakes, marshes, and

riverbeds impede the movement of excess water, producing urban flooding. Also, the pollution of water bodies is obstructing the channels through which extra water can pass. Many of the country's water bodies are clogged with non-biodegradable trash, indicating poor waste management implementation.

**G. CREATION OF SLUMS**

The growth of slums in cities is one of the serious problems created by the rapid industrialization and urbanization. The following projects are introduced to eliminate slums in urban societies; extensive slum clearance, rehabilitation and rebuilding, slum improvement scheme, construction of a network of expressways to alleviate urban decay and ensure the future propensity of the central areas, relocation of inhabitant to the suburb, slum upgrading

scheme which makes provision of some basic amenities such as street lights, drainage, and accessible roads.

**H. LACK OF JOBS**

Urbanization leads to a deficit in jobs. Businesses and governments cannot produce enough jobs to meet the demand of a fast-growing population. Unemployment rates soar as a result, causing people to apply for government-funded programs and benefits. The government loses money, reducing the amount of energy, health care, education, public transportation, waste management and physical security offered. Poverty spreads and stunts economic growth

**I. CRIME**

The increase in population leads to an increase in the crime rate. Due to the high level of urban unemployment, idleness and joblessness, this has brought about a high increase in crime rates suffered by the majority of the people in Urban cities. The government's inability to prevent widespread poverty causes an increase in theft and other crimes. "Without economic security and amid poor living conditions, crime is inevitable". Also, residents of different beliefs and behaviors thrown together suddenly do not have time to adjust or adapt to different viewpoints, leading to violence. Frustration and alienation linked to a lower status, limited access to education, money and other resources push young people to join organized crime.

**J. CONGESTION**

Traffic congestion and overcrowding have become major challenges in urban areas. Overcrowding on road networks leads to slow and inefficient movement, making mobility increasingly difficult. The rapid growth in motor vehicle usage has further intensified congestion, restricting accessibility within cities. Effective traffic management, through appropriate rules, regulations, and signage, plays a vital role in maintaining smooth traffic flow, preventing collisions, and reducing related hazards.

**K. AIR POLLUTION**

Suspended particulates in the air come from motor vehicle fuel combustion. Soot, dust, lead and smoke make up the particulates. They pose a serious threat to health. Lead alone can cause brain damage, learning disabilities and premature death in children. The World Health Organization stated that suspended particulate concentration should add up to less than 90 micrograms per cubic meter. The suspended particulate concentration soars over that measurement in cities with a population of 8 million or more.

**L. BIODIVERSITY THREATENED**

City growth destroys natural areas, flowing with new and endangered animal and plant life. No matter how small, each species plays an important role in how the Earth works. Without this variation in life, humans suffer. Biodiversity protects water and soil from contamination, stores and recycles nutrients, breaks down and absorbs pollutants and helps areas to recover faster from disasters. Biodiversity also provides people with medicine, food and air. Urbanization limits our access to these resources.

## III. ACTIONABLE MEASURES SUGGESTED

Based on the key problems identified in the sector, the following actionable measures are suggested in the context of Urban Environment.

**1. Ambient Air Quality:**

a) According to a recent report on the status of air pollution in Peshawar published by the Sustainable Energy & Economic Development (SEED) programmed, vehicular emission largely contributes to the air pollution in the city. Therefore, alternatives based on sound scientific and viable solutions may be introduced to mitigate vehicular emissions. Introduction of Electric Vehicles (cars/rickshaws) may be an option.

b) Installation of Air Quality Monitors (AQI) across the city at various locations to acquire credible and timely real-time ambient air monitoring data.

c) Industries may be encouraged and helped to install a continuous emission monitoring system (CEMS).

d) Open burning in the city is also an environmental issue, especially coal burning in the Tikka shops. Alternative solutions may be searched to bring improvement in the air quality.

**2. Water Conservation Strategy:**

a) A huge quantity of fresh water is used for cleaning at car stations in the city. Scientific solutions for wastewater collection, treatment and re-use may be provided.

b) Restoring water channels, canals and rivers to swimmable and fishable conditions is needed.

**3. Alternative to Plastic Bags:** The KP EPA has recently amended its Act 2014, and with effect from 1st February 2023, all kinds of plastic bags/shoppers, its manufacture, transportation and its use, etc. will be completely banned in the province. This is a great opportunity for researchers and manufacturers to find an alternative to plastic bags. ST&IT may include this in the actionable problem statement.

**4. Urban Forestry, Plantation and Canopy Cover** may be increased in the context of the Urban Environment. Green spaces help reduce air, water and noise pollution, provide protection from flooding, droughts and heat waves, etc.

**5. Green Building Initiative**

a. Building design is crucial in the Urban Environment ecosystem to reduce electricity consumption and greenhouse gas emissions.

b. The use of eco-friendly technologies to make materials as an alternative to traditional bricks and cement may be encouraged. There are some start-ups, groups/companies working on these lines that need financial support and encouragement to commercialize these technologies.

c. Subsidised solarization may be encouraged. The local manufacturing industry may be encouraged to make locally inexpensive and efficient solar panels. Universities and

research institutions may be encouraged and financially empowered to start working on these lines.

**6. Indoor Environmental Management:**

a) To reduce the use of pollution sources such as paints, cleaners and adhesives, etc., universities and research institutions may be given grants to find alternatives to these problems

**Urban Planning in Climate Change Policy 2022 of Khyber Pakhtunkhwa**

The Government of KP wants to improve access to public services in 22 urban areas of the province. These services include water, sanitation, drainage, streets and public infrastructure. Urban planning is of paramount importance to Khyber Pakhtunkhwa (KP) as the rate of migration, both rural to urban and urban to urban, is expected to rise. Spatial planning and management of urban land can help to reduce the number of environmental problems. Water supply, sewage and sanitation, drainage, vehicular emissions and solid waste management are amongst the top priority measures for urban planning for the Government of KP. Unplanned urban development is likely to increase environmental degradation in urban centers. It can increase water scarcity, exacerbate the energy crisis, increase air pollution and produce social issues like crime and violence. Moreover, Environmental Impact Assessment (EIA) needs to be conducted before the construction of road networks, spatial planning and management of urban land.

For the fulfilment of these purposes, the Government of KP has initiated the Community Infrastructure Program (CIP II), the provincial Urban Development Project (see National Urban Development Policy - NUDP) and the Rural Water Supply and Sanitation Project (RWSSP). Water conservation is a priority in urban planning since poor maintenance and construction result in high water losses.

**Policy Measures**

a. Assess the hazards, vulnerabilities, and threats posed by climate change in urban areas.
b. Formulating and implementing the necessary strategies, guidelines and working procedures to support a socio-economic development that is climate-friendly and resilient.
c. Promote urban forestation and plantation.
d. Relocate hazardous industries from urban areas.
e. Develop laws and regulations to manage urbanization and prohibit the conversion of land from one particular use to another. Promote vertical growth, mixed land use, development of open spaces, efficient transport system, horticulture and landscaping and installation of energy-efficient street lighting systems.
f. Develop and strengthen urban policy and planning institutions, including city development agencies for improved urban planning, land use planning for commercial, residential and industrial activities, and resource mobilization.
g. Ensure provision of education, health, waste management, water and sanitation, and hygiene facilities, particularly in urban slums.
h. Upgrade areas with high cultural, social and economic value in cities, including historical architecture, slums, parks, etc.

i. Develop, revise and update master plans for major cities to prepare for contingencies like climate-induced migration, and reduce risks from extreme temperatures, minimizing the heat island effect, where possible, in new settlements.
j. Ensure all urban planning is informed by appropriate disaster risk reduction (DRR).

**POLICY IMPLICATIONS**

This research proposes essential policies guidelines/changes to create resilient urbanism against climatic risks (such as urban flooding):

**(1).** Increase awareness and understanding among all the native inhabitants toward a better understanding of UGI planning, a sustainable, cost-efficient, and innovative nature-based climate adaptation strategy for spongy green cities.

**(2).** A need to develop an inclusive policy that supports community participation at all levels, which will then promote community ownership and further strengthen the planning process for UGS.

**(3).** Balanced, proactive planning reforms are essential that encourage collaborations among the decision-makers and the local community. It should be linked with bridging the planning gap and improving the scientific knowledge regarding green initiatives, extending from policy making to decision making and implementation for greener growth.

**(4).** Considering the UGI planning examples of the Netherlands and Germany, there is a high need to incentivise green grassroots initiatives that would foster eco-friendly living practices and local stewardship of green practices to build a sustainable environment.

**(5)** Jobs–housing balance. Proximity in terms of the crucial human system activities of living and working will increase productivity and efficiency and also reduce natural resource consumption and waste generation.

**(6)** Spatial integration of employment and transportation. Facilitated access will improve systemic connectivity and increase productivity and efficiency among the residents of the human system.

**(7)** Mixed land use. Increased proximity and diversity in terms of available interactive opportunities among the residents of a community will result in reduced transportation energy consumption and improved organizational efficiency.

**(8)** Use of locally produced, clean, and renewable energy sources. An energy strategy that replaces imported energy with energy that is locally produced, clean and renewable will help maintain the long-term sustainability of a community by matching its growth and development with local carrying capacity.

**(9)** Energy and resource-efficient building and site design. Constructing buildings under energy-efficient guidelines will protect against natural resource depletion and make renewable alternatives (i.e. non fossil fuels) more feasible.

**(10)** Pedestrian access (walking and biking) to work and leisure. Increasing the amount of non-motorized transportation will reduce transportation energy consumption and protect against resource depletion and pollution, as well as have positive health impacts on the

residents of a community.

**(11)** Housing affordability (for all income groups). A lack of affordable housing for all income groups is a manifestation of a lack of empowerment among some residents of the community (as agents in a system). The provision of adequate housing for all income groups will help protect against social (systemic) dysfunction.

**(12)** Housing diversity (of style, type and tenure). Sustainable systems are marked by diversity in terms of agents and interactions. A diverse housing stock will encourage interactions among people with more diversity of backgrounds, interests and skills.

**(13)** Higher-density residential development. More compact development will reduce the development pressure on open space, which is an essential biological and agricultural resource necessary for the preservation of both the local human community as well as the human system in general.

**(14)** Protection of natural and biological functions and processes. Due to its reliance on nature, the sustainability of the human system requires that the integrity of natural systems be maintained.

**(15)** Resident involvement and empowerment. Increased organizational capacity among the residents of a neighborhood increases the ability of that neighborhood to identify and respond appropriately to changing conditions.

**(16)** Social spaces (public spaces to encourage social gathering). Increased social contact among the residents of a community can improve the community's ability to organize and respond to changing conditions.

**(17)** Sense of place. A sense of place increases attachment to place. This increases the propensity toward meaningful involvement and interaction, which improves a community's ability to organize and respond to changing conditions.

**(18)** Inter-modal transportation connectivity. Increased connective efficiency will (a) create the opportunity for increased frequency of interactions among the residents of a community, and (b) reduce dependency on modes that are polluting and highly energy-consumptive.

**SCOPE OF FUTURE RESEARCH**

1. Further research needs to be conducted to analyze the relationship of Climate Change adaptation in relation to forestry-based ecosystems, particularly in the context of Upper Khyber Pakhtunkhwa. Moreover, the sustainable use of Non-Timber Based forestry products from the northern districts needs to be assessed and how best practices in relation to afforestation and agro-forestry can be replicated in the context of KP.

2. Further research can be conducted to study the relationship of the same (and additional) variables across socio-demographic groups to design micro-level urban greening policies.

3. The social dimension of the sustainable urban landscape and greening policies (ULGP) and frameworks at the macro, micro, and meso levels need to be investigated, which can help build a new cultural paradigm to support and monitor green urbanism.

4. The scalability of urban green space (UGS) elements must coincide with the magnitude of the climate hazards, knowing the appropriate green/natural-based climate mitigation and adaptation measures to plan safer, healthier, and climate-resilient urban regions.

5. In studying and analyzing green spaces, it would be interesting to consider different species of green roofs in different climates. It will help to better understand the potential role of green roofs in reducing climatic stress and improving the ecosystem's functions (ESF) and health/well-being of inhabitants. Green roofs are becoming increasingly popular, especially in high-density urban clusters, where open spaces are limited. It is easy to implement and monitor, and they offer similar benefits to traditional green spaces.

6. Pandemics (such as COVID-19), though, pose less stress and do not degrade the UGI indicator more exclusively; however, this aspect needs to be further explored. There

## CASE STUDIES

### 1. CLIMATE CHANGE ADAPTATION & RESTORATION (RESILIENCE) OF FORESTRY BASED ECOSYSTEMS

A case study by Roberts et al. (2020) published as part of the issue on Climate Change and Ecosystems: threats, opportunities and solutions established the link between Climate Change mitigation and nature conservation globally[9]. It specifically spelt out that habitat protection and conservation need to be accompanied by bringing down greenhouse gas emissions, which in turn will promote societal adaptation to climate change.

Moreover, the case study emphasizes that targets related to environmental protection need to be increased to 30% from the at present 10% of sea and must be ensured at 17% in relation to land protection. These targets, if ensured and met, will reduce the incidence of climate change risks and allow for the transition to global warming to be much slower and less damaging. In addition, climate change adaptation best practices indicate that climate vulnerabilities can be reduced through landscape restoration and reforestation. This is a key takeaway from this case study in relation to the context of Khyber Pakhtunkhwa.

### 2. URBAN AGRICULTURE

Demographic challenges require new solutions that enable not only global hunger to be alleviated, but also future food requirements to be anticipated.

This is the intention behind urban farms. These are alternatives to conventional farming that seek the inevitable degree of sustainability required to prevent negative phenomena associated with the primary sector, such as deforestation, water consumption or pesticides. To achieve this, they use the benefits of connected agriculture.

Hundreds of millions of people around the world live in areas exposed to natural disasters of all sorts, from flooding and tornadoes to earthquakes and tsunamis. In many of these places, such as in Japan, the authorities have implemented policies aimed at improving the resilience of their cities through regulations and laws establishing that buildings and infrastructures must be built that can withstand large-scale earthquakes

[9] Roberts, C. M., O'Leary, B. C., & Hawkins, J. P. (2020). Climate change mitigation and nature conservation both require higher protected area targets. *Philosophical Transactions of the Royal Society B*, *375*(1794), 20190121.

A similar thing applies to the power supply. Although electricity is the first thing to go during a natural disaster, generators and solar panels can be used to provide a minimum supply in the event of an emergency. The issue of food is trickier, particularly in isolated areas. This was the case in Puerto Rico, which, in 2017, lost 80% of its agriculture after being destroyed by Hurricane María Puerto Rico pulled through, but food security on the island was annihilated, and the situation was critical for months; only food sent from the United States prevented the continuous lack of supply from turning hunger into a generalized famine. The temporary elimination of Puerto Rico's farming capacity was accentuated by poor management of the aid received. For the first time in many years, a developed country witnessed what happens when the stable food supply is taken for granted. Suddenly, the media and politics began to pay attention to what academics have been saying for years, that food, more so than electricity, is critical for the survival of cities.

Countries such as Thailand experience enough extreme weather events to be familiar with this. This was confirmed by Karndee Leopairote, Chief Advisor at Future Tales Lab, during her intervention in the Smart City Expo World Congress 2019, where she presented an interesting urban vegetable garden project that aims to maintain a minimum food security. According to Leopairote, the administrative area of Bangkok could only feed itself for one day if food could not be imported from other provinces. And since Thailand tends to
experience flooding, creative solutions need to be established to alleviate this initial supply shortage. The response includes building rooftops as community vegetable gardens where they are safe from floods. Green rooftops cannot feed a block of apartments continuously, but they can provide a minimum amount of food until help arrives. Furthermore, Leopairote explained that vegetable gardens help strengthen the community spirit among neighbours, which is also a critical aspect in the resilience of any society. Other projects that seek to take the idea of urban vegetable gardens one step further. Romainville, in France, is completing the Cité Maraîchère, glass food-farm towers used for local farming to plant different types of vegetables. The structure has been designed following efficiency principles, and it seeks to reduce energy consumption, creating a multi-level greenhouse with room in the basement to grow mushrooms. The Cité Maraîchère, said the mayor of Romainville, will be able to produce up to twelve tons of food per year, including tomatoes, carrots and mushrooms.

The crops are sold at an affordable price to residents, and they will be used in the cafeteria located on the ground floor. In terms of fertilizers, the towers will use locally sourced composted organic waste.

### 3. VERTICAL FARMS: A POSSIBLE INDUSTRIAL AND SUSTAINABLE SOLUTION TO TRADITIONAL FARMING

Nevertheless, the daily requirements of cities with hundreds of thousands and even millions of inhabitants cannot be met solely with the produce from urban vegetable gardens. Industrial farming is still required; however, unfortunately, this activity can be immensely destructive. Countless hectares of jungles and forests are burned every year to make way for farming land, while the indiscriminate use of pesticides contaminates aquifers. Nor can we ignore the fact that intensive farming has a considerable impact on air pollution and on climate itself, due to the use of fuel during the cultivation, harvest and transport process, until the food reaches its destination. James Macdonald believes the industrialization of vertical farming may be the

future. This researcher specialising in controlled environment agriculture systems and sustainability, outlined the advantages of this form of farming, which does not require large open spaces, since it is structured on multi-level buildings totally isolated from the exterior for greater efficiency. In essence, it involves taking the farm to the industrial estate. His company, Urban Crop Solutions, aims to create buildings with various hydroponic crops, first leafy vegetables and in the future, cereals such as wheat and rice. According to Macdonald, the use of vertical industrial farms would allow farming land to be reincorporated into the natural environment to help combat climate change but also take food production to cities themselves. Other benefits of large-scale vertical farming include less use of water and pesticides, the virtual absence of pests and greater circular use of resources, since waste is composted and converted into fertilizer. On the other hand, there is significant use of power given the use of lamps to simulate sunlight; an aspect which is not exactly trivial

**4. SMART LIGHTING SOLUTIONS**

Cities do not need their entire lighting network to be left on at the same intensity during nighttime hours. Smart lighting solutions use this premise to manage light usage and intensity. In fact, in cities like Amsterdam, their residents appreciate it when they are resting. The Dutch solution reduces energy dependence and light pollution. One of the goals of smart cities is resource optimization and energy efficiency. However, today many cities still light up their streets using timers or ambient light sensors. These devices do cut down the length of time the lights are on, however, they do not control the intensity of the lights. This means, regardless of the number of vehicles or people present, the same light intensity is maintained everywhere and at all times. Apart from the unnecessary use of energy, it also causes added wear and tear on infrastructures and generates light pollution that seriously interferes with citizens' rest and endangers the health of plants and wildlife in the area.

Citizens have taken this situation very seriously, so much so that, according to a survey conducted in the Netherlands, 61% of the survey respondents would like to see the intensity of public lighting reduced at night. The problem arises when it comes to achieving a balance between lighting and the safety of citizens who, for pleasure or necessity, walk through the streets at night. In order to solve these problems, Luminext has developed a new urban lighting system, which regulates its light intensity based on the needs of citizens. The system, which can be programmed remotely from a control center, enables the city's authorities to choose to reduce the intensity of specific streetlights depending on the areas in which they are located. Thanks to movement sensors and traffic density, the streetlights reach their maximum intensity when people or vehicles pass through their area of influence, returning to the lowest intensity point when less visibility is required. Police departments and traffic offices can also increase the maximum intensity of the streetlights in the event of an accident or an emergency. Of all the possibilities offered by this system, however, the most striking is that implemented in Atlas Park, located in the Port of Amsterdam. Thanks to the GeoLight mobile application, citizens themselves that walk, run or cycle through that particular area of the city can control the intensity of the streetlights from their smartphones. This allows them to improve visibility, thus creating a safer environment for citizens and, once they have passed the streetlights, the light intensity drops. All the streetlights in the port are equipped with LED technology and are powered with solar panels and wind turbines, which in turn allows them to be independent from the general power grid in optimal conditions, which therefore also saves money on wiring and infrastructure. The benefits are such that the authorities have

decided to gradually extend the project. There are currently around forty streetlights that can be controlled via a mobile phone; however, in the coming months, they will be installed in the remaining areas of the port and, later, in other areas of the city.

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KHYBER PAKHTUNKHWA
SCIENCE AGENDA

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