

Natural Based Solutions as an Approach of Resilient Cities to Face Climate Change "Analytical Framework to Apply NBS in Cities"

Nihal Alaa' EIDien Muhamed Rafeek^{1*}, Ehab Okba², Mohga Embaby³

^{1,2,3}Faculty of Architecture, Fayoum University, Egypt; nar01@fayoum.edu.eg (N.A.E.M.R.).

Abstract. Climate change is a pressing global issue with profound implications for urban environments. This research investigates the multifaceted impacts of climate change on cities, including rising temperatures, extreme weather events, and sea-level rise. It explores the concept of resilient cities, emphasizing the need for urban planning and infrastructure that can adapt to and mitigate these challenges. A particular focus is placed on natural-based solutions (NBS), which utilize nature-based approaches to address climate change impacts. The paper examines the potential of NBS, such as green infrastructure, urban forests, and blue-green infrastructure, in enhancing urban resilience. By integrating NBS into urban planning, cities can improve their ability to cope with climate change, reduce vulnerability, and create more sustainable and livable environments. The research concludes with recommendations for policymakers and urban planners on implementing NBS to build resilient cities and secure a sustainable future.

Keywords: Climate change, Green Infrastructure, Natural based solutions, Resilient cities.

1. RESEARCH PROBLEM

Climate change refers to long-term alterations in global or regional climate patterns, primarily driven by human activities like the burning of fossil fuels, deforestation, and industrial processes. These activities release large quantities of greenhouse gases (GHGs), such as carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O), into the atmosphere, trapping heat and causing global temperatures to rise—a phenomenon known as the greenhouse effect.

The year 2023 broke records for the hottest day for a staggering 116 days in a row and marked the warmest year on record¹. According to the World Economic Forum (WEF), extreme weather events rank as the second most critical risk on a two-year horizon. Over the next decade, they emerge as the top risk (Figure 01), highlighting the growing need for effective climate actions



Figure 1: Global risks ranked by severity over the short and long term.

1.1. Impact of Climate Changes

The impacts of climate change are wide-ranging and include:

1. **Rising Temperatures:** Global average temperatures have been increasing, leading to heat waves and extreme heat events. This can have detrimental effects on human health, agriculture, ecosystems, and infrastructure.
2. **Changing Precipitation Patterns:** Climate change affects rainfall patterns, leading to more frequent and intense rainfall in some regions and droughts in others. These changes can impact water availability, agriculture, and ecosystem health.

¹Poynting & Rivault, 2024

3. **Sea-Level Rise:** Melting glaciers and ice caps, along with the expansion of seawater due to warming, contribute to rising sea levels. This presents risks to coastal cities and low-lying areas, leading to increased flooding and erosion.
4. **Extreme Weather Events:** Climate change has been linked to an increase in the frequency and severity of extreme weather events such as hurricanes, cyclones, floods, and wildfires. These events can cause significant damage to infrastructure, homes, and ecosystems, as well as threaten lives and livelihoods.
5. **Ecosystem Disruption:** Climate change affects ecosystems by altering habitats, migration patterns, and species interactions. It can lead to the loss of biodiversity, disruption of ecosystems' functioning, and negative impacts on agriculture and fisheries.
6. **Health Impacts:** Climate change has implications for human health, including increased risks from heat-related illnesses, respiratory problems due to air pollution, the spread of vector-borne diseases, and malnutrition due to agricultural disruptions.

1.2. Resilience as Solution for Climate Changes Impacts

1.2.1. What is Resilience?

Resilience refers to the ability of individuals, communities, organizations, and systems in an urban environment to endure, adjust, and prosper despite facing various ongoing challenges and sudden disruptions.²

100 Resilient Cities, initiated by the Rockefeller Foundation, aims to enhance urban resilience globally in response to the increasing physical, social, and economic challenges of the 21st century. This initiative promotes a comprehensive understanding of resilience, addressing not only acute shocks such as earthquakes and floods but also the chronic stresses that undermine a city's stability over time.³

Resilient cities often referred to as smart or sustainable cities are urban environments engineered to endure and rebound from challenges like natural disasters, climate change, economic instability, and social disparities, reflecting a proactive approach to urban vulnerability and planning.

The key characteristics of resilient cities include:

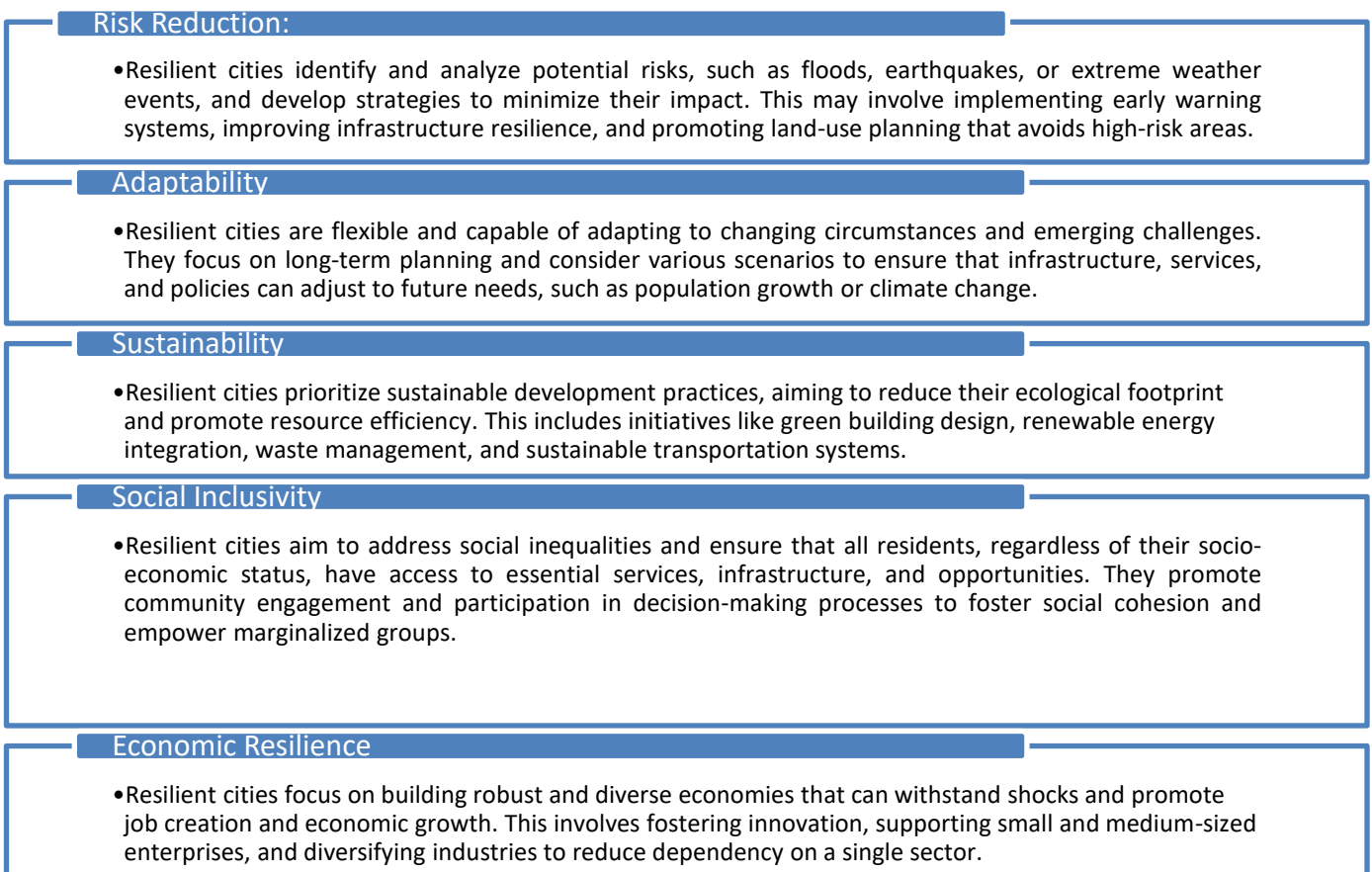


Figure 2:

To achieve these goals, resilient cities often leverage technologies like Internet of Things (IoT), artificial intelligence (AI), and data analytics to improve efficiency, monitor infrastructure, and enhance decision-making. They also emphasize collaboration among government agencies, private sector entities, academia, and community organizations to implement holistic and integrated solutions.

Overall, the concept of resilient cities represents a proactive and forward-thinking approach to urban

²100 Resilient Cities, pioneered by the Rockefeller Foundation

³www.100resilientcities.org.

planning and development, with the goal of creating sustainable, livable, and thriving urban environments for future generations.

Resilience plays a crucial role in helping communities and systems effectively face and respond to the impacts of climate change. Here's how resilience can help in the context of climate change:

1. **Adaptation Planning:** Resilience encompasses the proactive preparation and adjustment to evolving circumstances. Communities that exhibit resilience evaluate their susceptibility to climate change effects and formulate adaptation strategies. These strategies may involve establishing climate-sensitive infrastructure, diversifying water supplies, modifying land-use practices, and creating early warning systems for severe weather occurrences.
2. **Robust Infrastructure:** Infrastructure that is resilient is engineered to endure the effects of climate change. This encompasses the development of buildings and transport networks capable of withstanding severe weather, enhancing drainage to reduce flooding, and incorporating nature-based strategies like green roofs and permeable surfaces.
3. **Ecosystem Protection and Restoration:** Resilience emphasizes the critical role of ecosystems in addressing climate change effects. Communities that exhibit resilience focus on safeguarding and rehabilitating ecosystems, including forests, wetlands, and coastal regions. These robust ecosystems serve as natural defenses, sequestering carbon dioxide, minimizing flood hazards, and supporting diverse habitats for various species.
4. **Diversified Economy and Livelihoods:** Resilient communities encourage economic diversification to lessen reliance on industries vulnerable to climate change. This includes advancing renewable energy initiatives, endorsing sustainable practices in agriculture and fisheries, and nurturing entrepreneurship and innovation within sectors that can withstand climate impacts.
5. **Community Engagement and Social Cohesion:** Community engagement and social cohesion enhance resilience. Involving residents, businesses, and stakeholders in decision-making incorporates diverse viewpoints and local insights. Strong social networks foster collaboration, resource sharing, and collective efforts to address climate-related challenges effectively.
6. **Knowledge and Education:** Resilience is built on knowledge and education. Resilient communities invest in climate education and awareness programs to enhance understanding of climate change impacts, mitigation strategies, and adaptation measures. This empowers individuals and communities to make informed decisions and take appropriate actions.
7. **Risk Assessment and Early Warning Systems:** Resilience encompasses the evaluation of risks and the establishment of early warning systems to prepare for climate-related threats. By identifying their unique vulnerabilities, communities can formulate efficient evacuation strategies, emergency response plans, and communication methods to mitigate the effects of severe weather occurrences.
8. **Collaboration and Partnerships:** Resilient communities understand that climate change is a worldwide issue necessitating cooperation and alliances. They engage with various stakeholders to exchange knowledge and resources, fostering collaboration that enhances learning, resource sharing, and the development of unified strategies for climate resilience.

1.2.2. The Need to Resiliency

Statistical data underscores the urgent need for robust resiliency management plans to be incorporated into urban budgets and strategies. By 2050, it is projected that 66% of the global population will reside in cities, up from 54% in 2018. Additionally, the average annual occurrence of weather-related disasters rose to 335 between 2005 and 2014, marking a 14% increase from 1995-2004, while over 91% of people live in areas with poor air quality⁴.

The combination of these events or conditions results in persistent stress within the urban ecosystem, imposing significant financial and personal burdens. In the absence of a robust resiliency plan, this distress will persist unabated. Figure 3 below, It offers supplementary statistics that facilitate a comprehensive understanding of the importance of developing resiliency plans for all stakeholders involved.

⁴ Understanding Resilience: what it means to be Resilient city and tools to support, resiliency@siradel.com

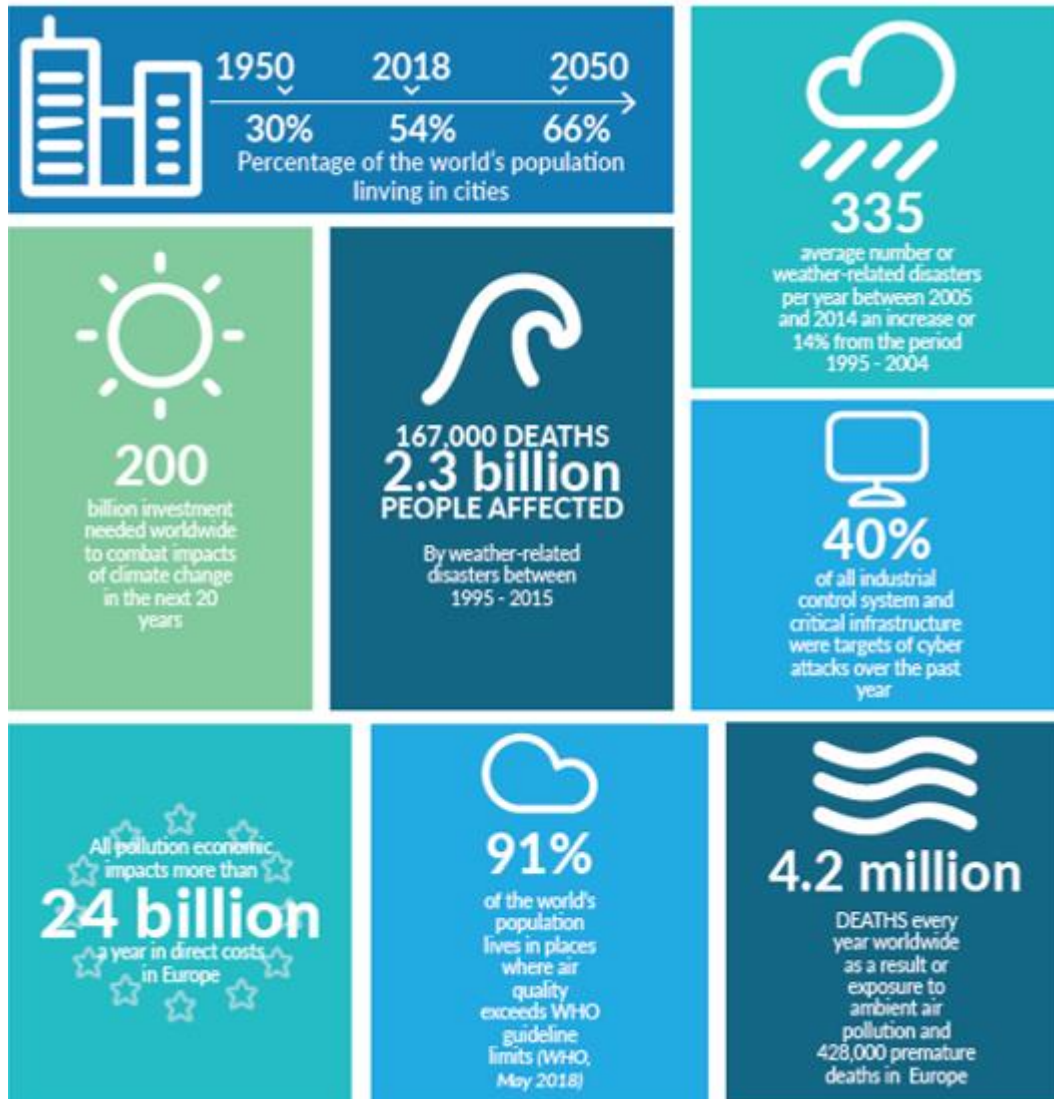


Figure 3: Ref: resiliency@siradel.com

1.2.3. How Is Resilience Different from Sustainability, Green and Disaster Risk Reduction (DRR)?

Resilience encompasses not only coping mechanisms and adaptive strategies but also transformative initiatives aimed at enhancing urban environments for both immediate and enduring benefits.

Table 1: Different Dangerous events definitions Assembly (2017).

Resilience	Sustainability
<ul style="list-style-type: none"> - It goes far beyond sustainability incorporates notions because of the holistic and proactive approach it embodies. - Looks for ways to make systems endure and even thrive in an imbalanced world. - Is about developing a proactive and integrated plan addressing both shocks and stresses, from natural disasters and to adverse socio-economic trends. 	<ul style="list-style-type: none"> - Putting the world into long-term balance amidst the depletion of natural resources. - It is about reducing the damage caused by natural hazards.

Source: United Nations, General.

1.2.4. Resilience City Concept

A "resilience city" is not a commonly used term or an established concept. However, based on the context, it can be inferred that a "resilience city" refers to a city that embodies and promotes resilience in various aspects, such as social, economic, environmental, and infrastructural.

In this sense, a resilience city would focus on building systems, structures, and communities that can withstand and recover from shocks, stresses, and challenges. It would prioritize strategies and initiatives aimed at enhancing the city's ability to adapt, respond, and bounce back from disruptions, whether they are natural disasters, economic downturns, or social crises.

The principles and characteristics of resilient cities can summarize in; risk reduction, adaptability, sustainability, social inclusivity, and economic resilience. It would emphasize the integration of innovative technologies, data-driven decision-making, and collaborative governance to build a robust and thriving urban environment.

A resilient city would embody key traits such as risk mitigation, adaptability, sustainability, social inclusivity,

and economic robustness. It would prioritize the use of innovative technologies, data-informed decision-making, and collaborative governance to foster a strong and prosperous urban landscape, enhancing the overall quality of life for its inhabitants:

1. **Integrated Planning:** Resilient cities implement comprehensive planning strategies that recognize the interconnectedness of various systems and sectors. This approach involves assessing the relationships among infrastructure, transportation, housing, healthcare, energy, and social services. By integrating planning, cities can ensure that decisions in one domain do not unintentionally undermine resilience in another area.
2. **Community Engagement:** Resilient cities prioritize community involvement in decision-making, promoting engagement from various stakeholders. By incorporating insights from residents, businesses, and local organizations, these cities enhance ownership and ensure that resilience strategies align with the needs and aspirations of their communities.
3. **Climate Change Adaptation:** Resilient cities acknowledge the threats of climate change and emphasize adaptation strategies. They incorporate climate forecasts into their planning, addressing the effects of increased temperatures, sea-level rise, severe weather, and altered rainfall patterns. Strategies include developing green infrastructure, upgrading drainage systems, strengthening coastal defenses, and encouraging energy efficiency and renewable energy use.
4. **Data and Technology:** Resilient cities utilize data and technology to strengthen their adaptability. By gathering and analyzing information, they pinpoint weaknesses, assess infrastructure efficiency, and guide decision-making. Technologies such as IoT, sensors, and predictive analytics facilitate real-time monitoring, early warnings, and optimal resource distribution, fostering evidence-based policies and interventions.
5. **Circular Economy:** Resilient cities adopt circular economy principles to reduce waste, enhance resource efficiency, and encourage sustainable consumption and production. They focus on initiatives like recycling, effective waste management, sustainable procurement, and fostering local circular economies to decrease reliance on external resources, thereby promoting environmental sustainability and economic resilience.
6. **Social Cohesion and Equity:** Resilient cities emphasize social cohesion and equity. They strive to reduce social inequalities, promote affordable housing, ensure access to quality education and healthcare, and create inclusive employment opportunities. Resilience strategies are designed to benefit all residents, with specific attention given to vulnerable communities that may be disproportionately affected by shocks and stresses.
7. **Knowledge Exchange and Collaboration:** Resilient cities actively engage in knowledge exchange and collaboration with other cities, organizations, and experts. They participate in networks and partnerships to share experiences, best practices, and lessons learned. This collaboration helps cities to learn from each other, accelerate progress, and collectively address common challenges.

Resilient cities strive to develop urban spaces that are adaptable, sustainable, inclusive, and prosperous by emphasizing long-term strategies, proactive planning, and investments in resilience to support residents amid current and future challenges.

Good urban resilience practice uses a systems approach to bring together a collaborative focus on managing risks (natural, man-made and hybrid) with development policy, planning and practice.

This ensures that urban development is properly scalable for all sizes of cities. Applying this lens and understanding risk as a product of – and constraint on – urban development or accentuated by it, can enhance the performance of both development and risk reduction planning and programming. This explains why addressing urban risk management and fostering resilience has become essential for achieving the objectives of different strands of the United Nations' development agenda including the SDGs, the New Urban Agenda, Paris Agreement, the Sendai Framework for DRR and others⁵.

2. NATURAL BASED SOLUTIONS

Science-driven multi-level and multi-stakeholder approaches to resilience building and financing are central to the resilience discourse. However, various other topics have also significantly enhanced urban resilience. Notably, themes such as nature-based solutions, sustainable mobility, food systems, circular development, social cohesion, and digitalization have carved out a distinct niche within the Resilient Cities Congress, enriching the overall discussions.

2.1. Nature-Based Solutions Most Common Principles⁶

Nature provides services that can remove and store atmospheric carbon, adapt to climate change and enhance resilience, Nature-based Solutions (NBS) within building designs, developments, and operations presents an opportunity to adapt to changing policy requirements, improve the resilience of built assets, reduce carbon emissions, and create environmental net gain.

⁵ E. Wilkinson, *Transforming disaster risk management: a political economy approach*, (2012).

⁶ Principles for delivering urban Nature-based Solutions. UK Green Building Council, 2021, London, UK.

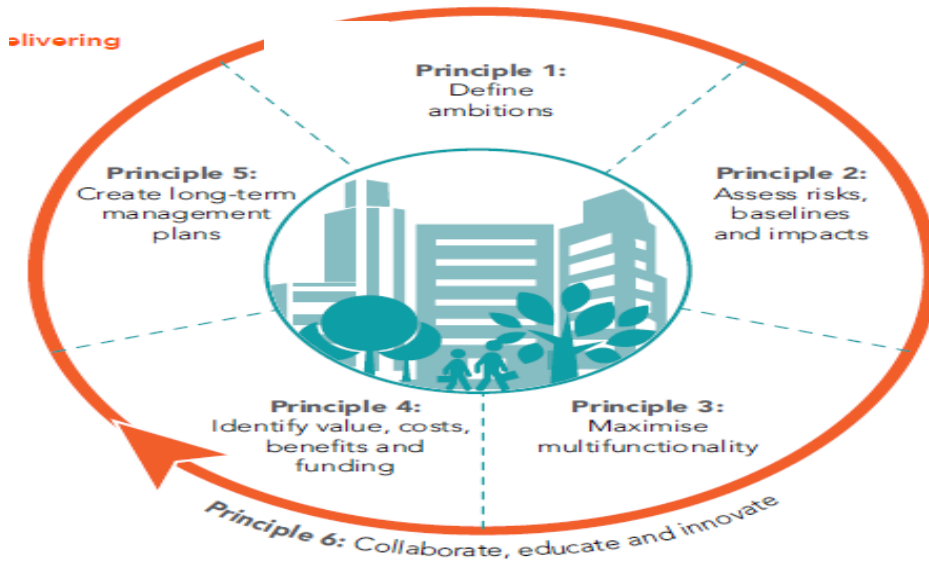


Figure 4:

Reference: Principles for delivering urban Nature-based Solutions. UK Green Building Council, 2021, London, UK.

2.2. Benefits of Using NBS For Urban Resilience

There are many benefits to using NBS for urban resilience. Some of the most important benefits include:

- **Cost Effectiveness:** Nature-based solutions (NBS) frequently offer greater cost-effectiveness compared to conventional infrastructure, exemplified by green roofs, which provide superior energy savings and lower maintenance expenses than traditional roofing options.
- **Multi-benefits:** Nature-based solutions (NBS) offer numerous advantages beyond enhancing resilience, including better air quality, diminished pollution levels, and a boost in biodiversity, contributing to overall environmental health and sustainability.
- **Community co-benefits:** NBS offers avenues for community involvement and contributes to fostering social unity among diverse groups within the community.

2.3. Examples of NBS in Action

There are many examples of NBS being used in cities around the world. Here are a few examples:

- **Melbourne, Australia:**

Melbourne has a number of NBS initiatives in place, including a green roof program, a bioswale program, and a rain garden program. These initiatives have helped to reduce stormwater runoff, improve water quality, and cool the city. Melbourne, Australia



- **New York City, USA:**

New York City has a number of NBS initiatives in place, including a green infrastructure program, a waterfront restoration program, and an urban forestry program. These initiatives have helped to reduce flooding, improve air quality, and provide habitat for wildlife.



- **Copenhagen, Denmark:**

Copenhagen is a leader in the use of NBS. The city has a number of initiatives in place, including a green roof program, a bike lane program, and a pedestrianization program. These initiatives have helped to reduce pollution, improve air quality, and make the city more livable.



2.4. Urban NBS families

Urban nature-based solutions (NBS) encompass various categories specifically tailored for cities, utilizing natural elements to tackle the challenges encountered in urban settings.

The World Bank's "Catalogue of Nature-Based Solutions for Urban Resilience" identifies 14 distinct NBS families. Each family provides specific advantages and targets particular urban challenges, contributing to enhanced resilience in urban environments through diverse nature-based approaches.

These 14 families are⁷:

- Urban Forests
- Terraces and slopes
- River and stream Renaturation
- Building solutions
- Open Green spaces
- Green corridors
- Urban framing
- Bio retention areas
- Natural Inland wetlands
- Constructed inland wetlands
- River Floodplains
- Mangrove Forests
- Salt marshes
- Sandy shores

By incorporating these NBS families into urban planning, cities can become more livable, sustainable, and resilient to climate change.

Based on the Catalogue of Nature-based Solutions for Urban Resilience made by World Bank 2021 we can figure out a framework to analyze impact of applying NBS in cities, and this framework can be as the following:

⁷ World Bank, 2021. A Catalogue of Nature-based Solutions for Urban Resilience. Washington, D.C. World Bank Group

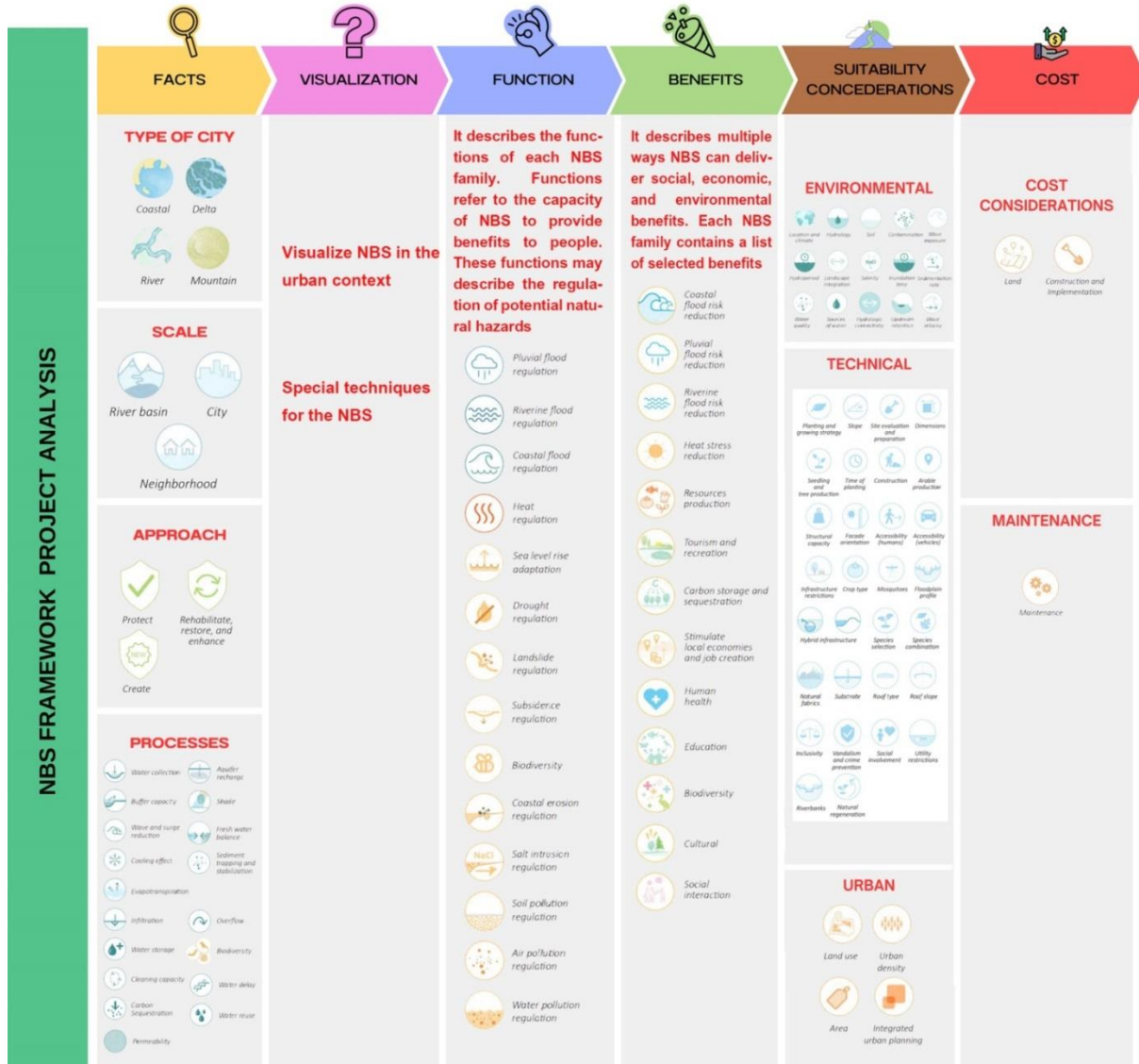


Figure 5:

3. EXAMPLES OF NBS IN CITIES DISCUSSED USING OUR STUDY FRAMEWORK ANALYSIS

3.1. Bicentenario Park, Bogotá (2007-2016)

Bicen Bicentenario Park was developed as a revitalization initiative in the heart of Bogotá and officially opened in 2016. This structure, constructed from reinforced concrete, is designed to harmonize with the local topography while adhering to numerous urban technical standards and regulations. To convert this bridge into a green public area spanning 4,600 m², a combination of extensive and intensive green roofs was implemented, resulting in the creation of eight small vegetated plazas. The Botanical Garden of Bogotá curated a diverse selection of native and adapted plant species for this project. The restoration of Parque Bicentenario has emerged as a significant factor in bridging the divide between the southern and northern regions of Bogotá.



Bicentenario Park spans over 4600 m² in the city's western zone. This expansive green space showcases a remarkable range of NBS elements, transforming a former landfill site into a vibrant ecological hub:

- **Management:** The Park integrates various sustainable water management systems, including rain gardens, bioswales, and constructed wetlands. These elements are designed to collect and purify rainwater runoff, thereby alleviating pressure on the municipal drainage infrastructure and mitigating the risk of flooding.
- **Biodiversity Enhancement:** The park boasts a variety of native plants, attracting pollinators like butterflies and bees. Additionally, the park design creates habitat for birds and small animals, fostering urban biodiversity.
- **Climate Regulation:** The abundance of trees and vegetation in Bicentenario Park helps mitigate the urban heat island effect, lowering temperatures and improving air quality for surrounding neighborhoods.
- **Recreation and Community Space:** The park provides various recreational options for residents, such as walking trails, cycling paths, playgrounds, and sports amenities, fostering community engagement and encouraging physical activity.

3.1.1. Bicentenario Park: A Testament to NBS Success

The establishment of Bicentenario Park illustrates the effective incorporation of nature-based solutions in urban planning, offering numerous advantages to Bogotá.

- **Improved Water Management:** The Park's NBS features significantly reduce stormwater runoff and the risk of flooding in the area.
- **Enhanced Air Quality:** The abundance of trees and vegetation acts as a natural filter, removing pollutants from the air and contributing to a healthier environment.
- **Increased Biodiversity:** Bicentenario Park provides vital habitat for various wildlife species, promoting urban biodiversity.
- **Improved Quality of Life:** The Park offers recreational opportunities, green space for relaxation, and a space for community gatherings, all of which contribute to a better quality of life for Bogotá's residents.



3.1.2. Beyond Bicentenario: The Legacy of NBS in Bogotá

Bicentenario Park exemplifies Bogotá's dedication to nature-based solutions. Its achievements encourage the integration of NBS in urban planning, fostering a sustainable, resilient, and enhanced quality of life for residents.

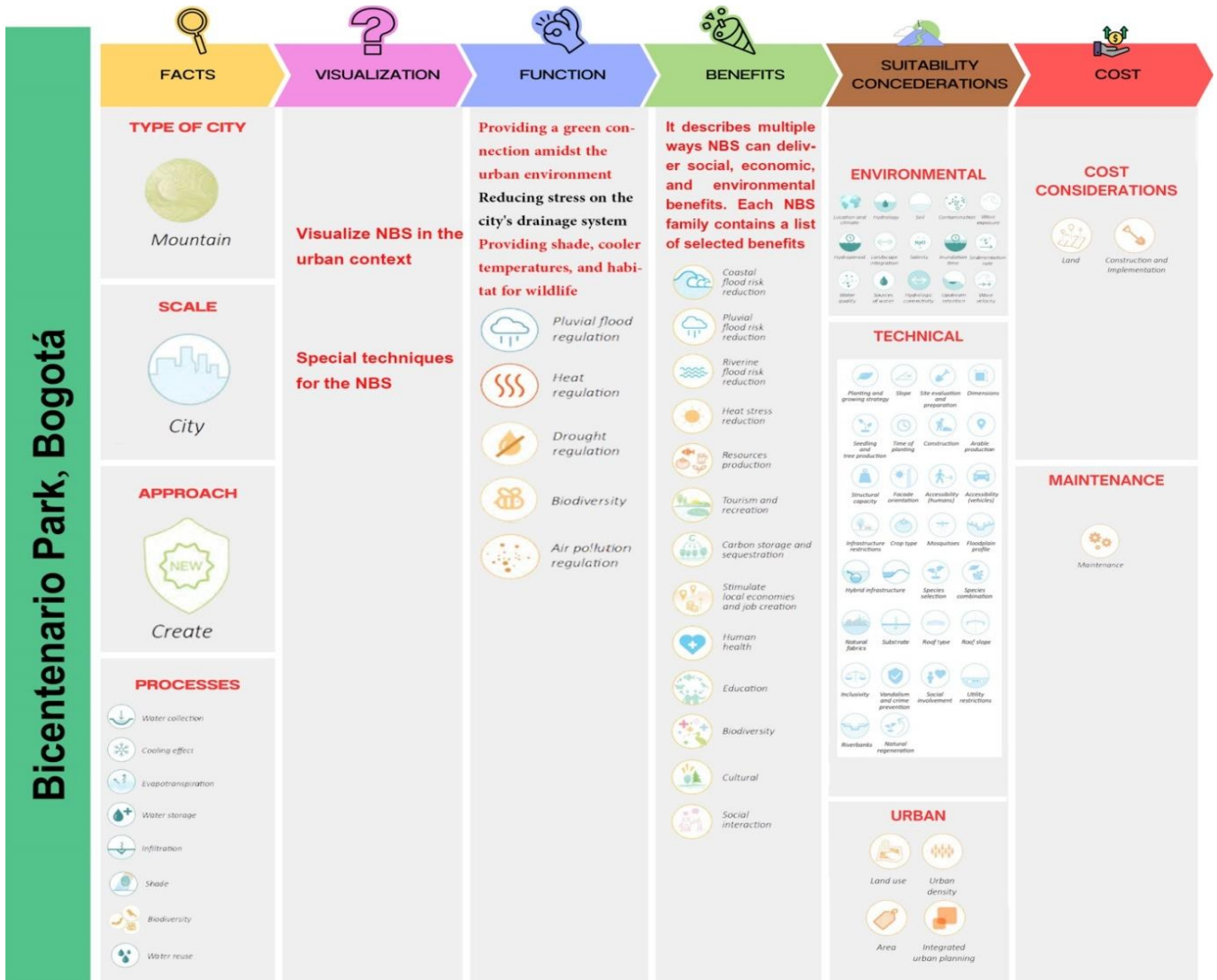


Figure 6:

3.2. The Farming Kindergarten in Biên Hòa, Vietnam (2013-2015)

Architects in 2013 conceived a new kindergarten building as a continuous productive green roof supplying fresh produce, providing a food-growing experience to children. The building is located next to a shoe factory and serves about 500 children of the factory workers. The contemporary design of the kindergarten provides a large playground and an innovative combination of developmentally important activities: growing food and hands-on learning. The kindergarten projects aim to preserve a better understanding of the natural processes, and to make it more fun for early learners to spend time outdoors.



Incorporates Nature-Based Solutions (NBS) primarily through its **green roof**. Here's a breakdown of how this green roof exemplifies NBS principles:

3.2.1. Green Roof as the Core NBS Element:

The Farming Kindergarten's notable nature-based solution is its expansive green roof, which exemplifies key

principles of sustainable architecture.

- **Reduced Urban Heat Island Effect:** The green roof's vegetation serves as insulation, absorbing sunlight and providing shade, thus regulating temperature and lowering cooling energy needs.
- **Improved Air Quality:** The green roof acts as a natural air purifier, capturing pollutants while plants absorb carbon dioxide and release oxygen, enhancing environmental quality.
- **Enhanced Biodiversity:** The green roof fosters biodiversity by supporting various plant and animal species, attracting pollinators and providing nesting opportunities for wildlife.
- **Stormwater Management:** The green roof effectively manages stormwater runoff by absorbing rainwater, mitigating flooding, and alleviating pressure on urban infrastructure.

3.2.2. Vegetable Garden: Connecting Children to Nature and Food Production

Although not a formal nature-based solution, the rooftop vegetable garden supports the project's aim to engage children with nature sustainably.

- **Educational Tool:** The vegetable garden provides children with practical learning opportunities, allowing them to engage in planting, nurturing, and harvesting, thereby enhancing their understanding of agriculture and environmental responsibility.
- **Sustainable Food Source:** The vegetables grown on the roof can potentially supplement the children's diet or be shared with their families. This promotes a more sustainable food system by reducing reliance on processed and transported food and encouraging local food production.



3.2.3. Additional Considerations

- **Local and Sustainable Materials:** The Farming Kindergarten was built using local, sustainable materials to reduce environmental impact and bolster the local economy.
- **Natural Ventilation and Lighting:** The architectural design features operable windows and skylights, enhancing natural ventilation and daylighting while minimizing energy use and promoting sustainability.

The Farming Kindergarten in Biên Hòa, Vietnam exemplifies the integration of Nature-Based Solutions in educational settings, fostering a healthier, sustainable, and nature-oriented learning atmosphere. Its green roof and vegetable garden highlight NBS's role in enhancing biodiversity and environmental awareness among children.

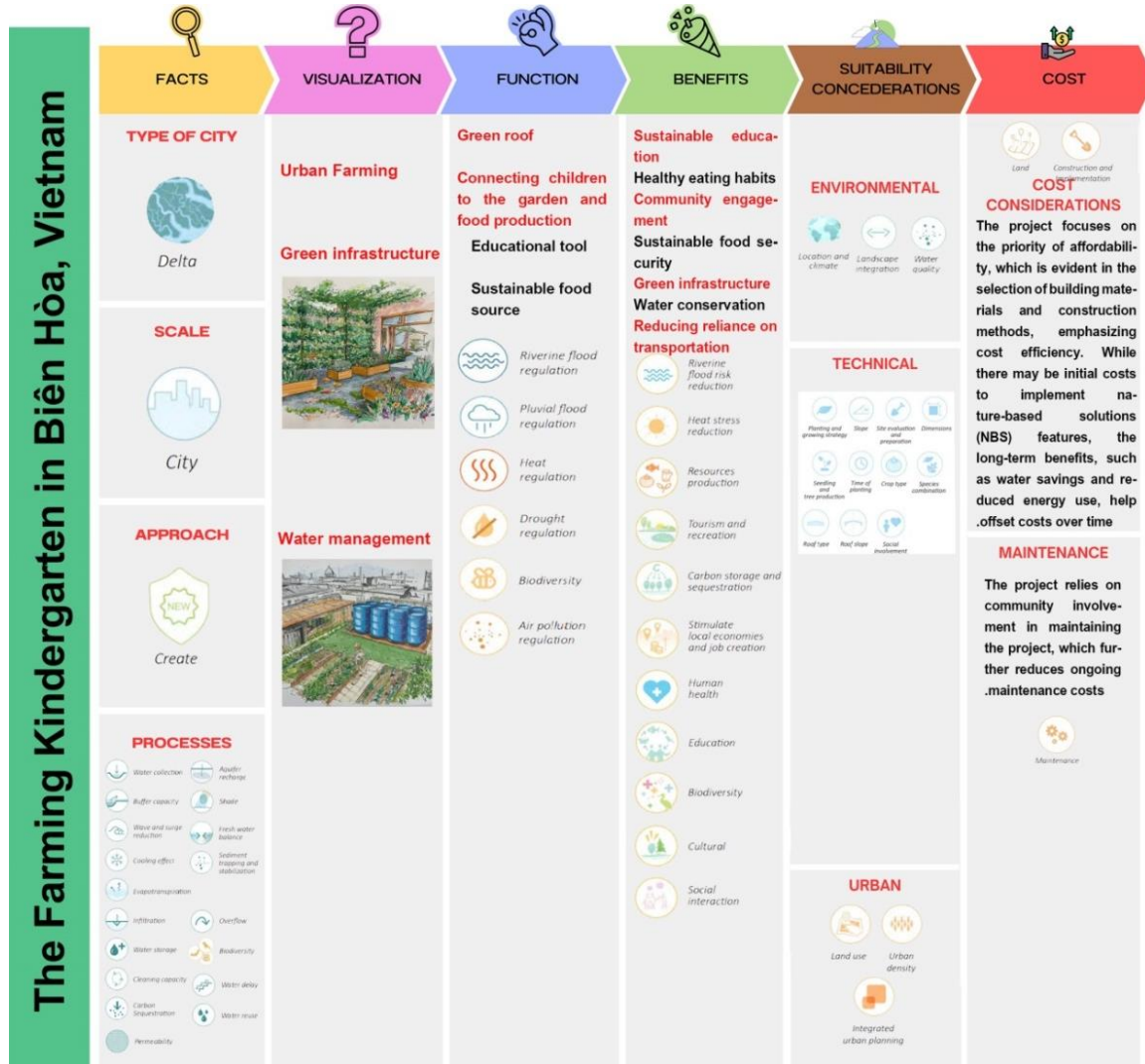


Figure 7:

3.3. Chulalongkorn Centenary Park, Bangkok, Thailand (2012-2017)

Chulalongkorn Centenary Park, established in 2017 in Bangkok, serves as the city's inaugural green infrastructure, addressing ecological challenges. Spanning 48,000 m² and featuring the nation's largest green roof, it exemplifies the ecological and social benefits of landscape architecture in urban settings.



Chulalongkorn Centenary Park in Bangkok demonstrates effective integration of Nature-Based Solutions (NBS) within urban green spaces, showcasing innovative design principles that enhance environmental sustainability.

- **Reduced Urban Heat Island Effect:** Bangkok's high temperatures are mitigated by the park's greenery and triple-ring roof, which enhance cooling through transpiration, improving visitor comfort and reducing urban heat.
- **Improved Air Quality:** The park serves as a green refuge in the city, filtering air by absorbing pollutants and dust, thereby enhancing air quality, particularly in pollution-prone Bangkok.

- **Enhanced Biodiversity:** The Park serves as a habitat for diverse flora and fauna, enhancing urban biodiversity. Indigenous trees and shrubs draw birds, butterflies, and pollinators, enriching the city's ecology.
- **Stormwater Management:** The park's design effectively manages stormwater runoff through features such as a green roof, which absorbs rainwater and delays its entry into the drainage system, thereby mitigating flooding risks and promoting groundwater replenishment via permeable surfaces.



Overall, Chulalongkorn Centenary Park demonstrates the potential of NBS in urban planning.

By incorporating these principles, the park offers multiple benefits:

- **Improved Public Health:** Cleaner air, cooler temperatures, and opportunities for physical activity contribute to a healthier environment for park users.
- **Increased Resilience to Climate Change:** NBS features like green roofs and permeable surfaces help mitigate the effects of extreme weather events like floods and heat waves, which are becoming more frequent due to climate change.
- **Enhanced Aesthetics and Community Space:** The park provides a visually appealing and tranquil green space for residents to relax, socialize, and connect with nature.

Chulalongkorn Centenary Park serves as a model for other cities looking to create sustainable and resilient urban green spaces using Nature-Based Solutions.

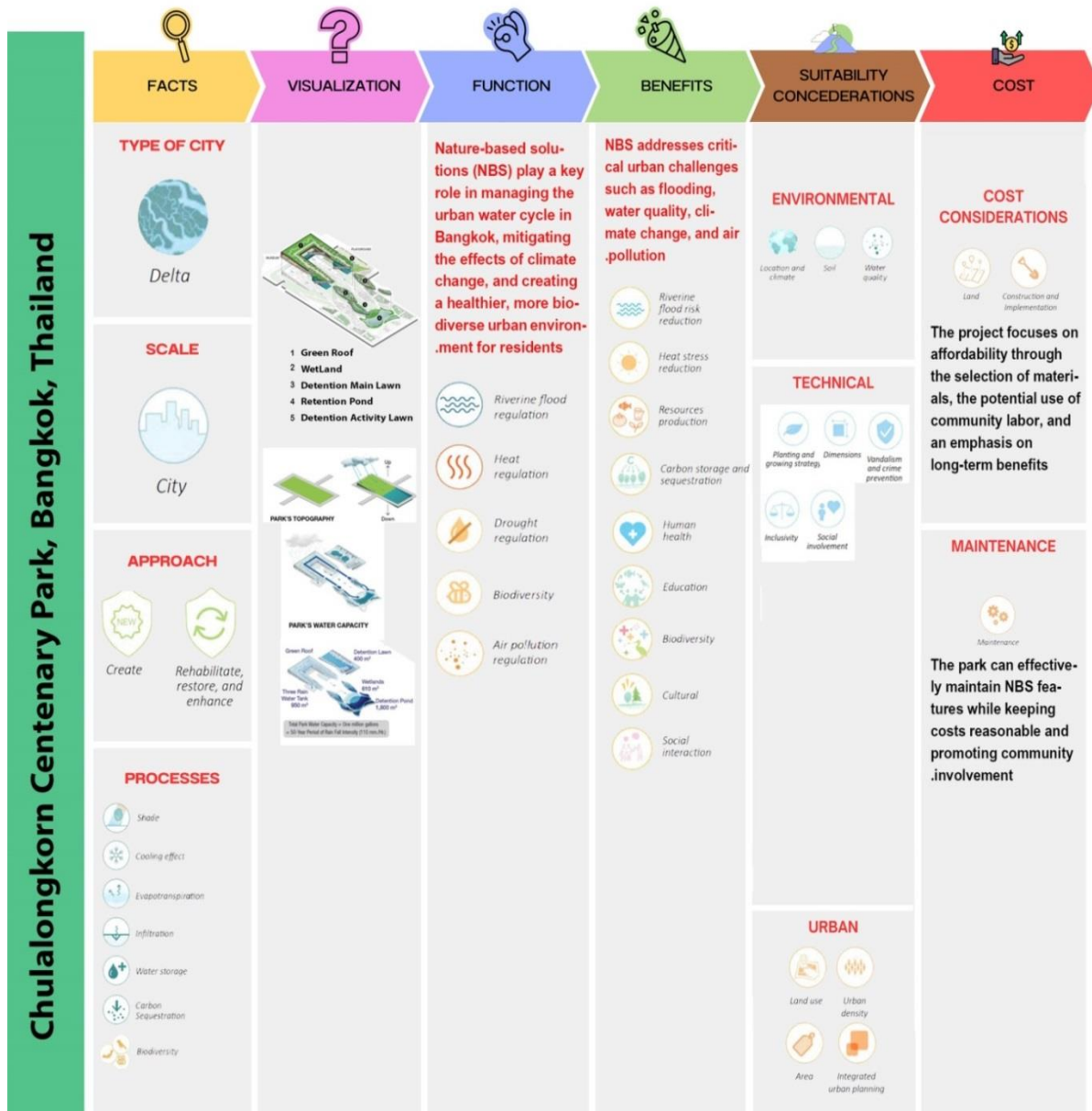


Figure 8:

4 CONCLUSION

This study thoroughly examines the essential function of nature-based solutions (NBS) in creating resilient urban environments in response to the growing threats of climate change. By utilizing these approaches, cities can successfully reduce climate change effects, improve their adaptability, and promote sustainable development within urban settings.

The study's key findings underscore the efficacy of nature-based solutions (NBS) in tackling climate change issues. Green infrastructure, including green roofs and walls, mitigates urban heat islands, enhances air quality, and manages stormwater. Urban forests offer essential ecosystem services such as carbon capture, biodiversity preservation, and flood management. Additionally, blue-green infrastructure improves water quality, lowers flood risks, and provides recreational spaces.

Incorporating nature-based solutions (NBS) into urban planning necessitates a comprehensive strategy that addresses the unique attributes and requirements of individual cities. Effective collaboration among policymakers, urban planners, landscape architects, and community members is vital for successful execution. Furthermore, sufficient funding and strategic long-term planning are imperative for the sustainability of NBS projects.

In conclusion, natural-based solutions offer a promising pathway for cities to become more resilient to climate change. By embracing nature-based approaches, cities can create sustainable, livable, and climate-resilient environments for future generations.

REFERENCES

WEF 2024
 Poynting & Rivault, 2024
 100 Resilient Cities, pioneered by the Rockefeller Foundation
resiliency@siradel.com

Understanding Resilience: what it means to be Resilient city and tools to support, resiliency@siradel.com www.100resilientcities.org
Principles for delivering urban Nature-based Solutions. UK Green Building Council, 2021, London, UK
E. Wilkinson, *Transforming disaster risk management: a political economy approach*, (2012).
World Bank, 2021. A Catalogue of Nature-based Solutions for Urban Resilience. Washington, D.C. World Bank Group
Principles for delivering urban Nature-based Solutions. UK Green Building Council, 2021, London, UK..
Holling, 1973: 14
Berkes and Ross 2013: 14, as quoted in Alexander, 2013: 2 712).
Alexander, 2013; Meerow, Newell and Stults, 2016
Schipper and Langston, 2015
Comparative tables of definitions can be found in Stein (2013); Winderl (2014); and Meerow, Newell and Stults (2016)