UNDERSTANDING NATURE BASED SOLUTIONS FOR SUSTAINABLE URBAN GROWTH: A CASE STUDY OF SELECTED HOUSING SCHEMES OF LAHORE, PAKISTAN

By

Rana Muhammad Shoaib

(Registration No. 00000327330)

Department of Urban & Regional Planning

School of Civil & Environmental Engineering (SCEE)

National University of Sciences & Technology (NUST)

Islamabad, Pakistan

(2024)

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Rana Muhammad Shoaib

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A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Science in

Urban & Regional Planning

Supervisor: Dr. Irfan Ahmad Rana

Department of Urban & Regional Planning

School of Civil & Environmental Engineering (SCEE)

National University of Sciences & Technology (NUST)

Islamabad, Pakistan

(2024)

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It is certified that final copy of MS thesis written by **Rana Muhammad Shoaib Registration No. 00000327330**, of MS Urban & Regional Planning SCEE, (NICE), has been vetted by undersigned, found completed in all respects as per NUST Statutes/Regulations, is free of plagiarism, errors, and mistakes and is accepted as partial fulfilment for award of MS degree.

Signature: _____

Supervisor: Dr. Irfan Ahmad Rana

Date: 29/08/2024

Signature (HoD): _____

HoD Urban & Regional Planning
NUST Institute of Civil Engineering
School of Civil & Environmental Engineering
National University of Sciences and Technology

Date: 29/08/2024

Signature (Associate Dean NICE): _____

Date: 29.08.2024

Dr. S. Muhammad Jamil
Associate Dean
NICE, SCEE, NUST

Signature (Principal & Dean): _____

PROF DR MUHAMMAD IRFAN
Principal & Dean
SCEE, NUST

Date: 30 AUG 2024

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National University of Sciences and Technology

MASTER'S THESIS WORK

We hereby recommend that the dissertation prepared under our Supervision by: (Rana Muhammad Shoaib Regn. No. 00000327330)

Titled: "**Understanding Nature based Solutions (NbS) for Sustainable Growth: A Case Study of Selected Housing Schemes of Lahore, Pakistan**" be accepted in partial fulfillment of the requirements for the award of **Master of Science** degree with (B+ Grade).

Examination Committee Members

1. Name: Dr. Abdul Waheed Signature: _____

2. Name: Dr. Shahbaz Altaf Signature: _____

Supervisor's name: Dr. Irfan Ahmad Rana Signature: _____

Date: 29/08/2024

_____

Head of Department

HoD Urban & Regional Planning
NUST Institute of Civil Engineering
School of Civil & Environmental Engineering
National University of Sciences and Technology

Dated: 29/8/24

_____

Dr. S. Muhammad Jamil
Associate Dean
NICE, SCEE, NUST

Associate Dean

Dated: 29.8.2024

COUNTERSIGNED

Date: 30 AUG 2024

Principal & Dean SCEE

PROF DR MUHAMMAD IRFAN
Principal & Dean
SCEE, NUST

Certificate of Approval

This is to certify that the research work presented in this thesis, entitled ***"Understanding Nature based Solutions (NbS) for Sustainable Growth: A Case Study of Selected Housing Schemes of Lahore, Pakistan"*** was conducted by Mr. Rana Muhammad Shoaib under the supervision of Dr. Irfan Ahmad Rana.

No part of this thesis has been submitted anywhere else for any other degree. This thesis is submitted to the National University of Sciences and Technology (NUST) in partial fulfillment of the requirements for the degree of Master of Science in field of Urban & Regional Planning from NUST institute of Civil Engineering (NICE), School of Civil and Environmental Engineering (SCEE), NUST

Student Name: Rana Muhammad Shoaib Signature: _____

Examination Committee:

a) GEC Member 1: Dr. Abdul Waheed
Associate Professor (SCEE, NUST) Signature _____

b) GEC Member 2: Dr. Shahbaz Altaf
Assistant Professor (SCEE, NUST) Signature _____

Supervisor Name: Dr. Irfan Ahmad Rana. Signature: _____

Name of HOD: Dr. Abdul Waheed Signature: _____

HoD Urban & Regional Planning
of Civil Engineering
School of Civil & Environmental Engineering
National University of Sciences and Technology

Name of Associate Dean: Dr. S. Muhammad Jamil Signature: _____

Dr. S. Muhammad Jamil
Associate Dean
NICE, SCEE, NUST

Name of Principal & Dean: Prof. Dr. Muhammad Irfan Signature: _____

PROF DR MUHAMMAD IRFAN
Principal & Dean
SCEE, NUST

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Name: Rana Muhammad Shoaib

Date: 28/08/24

DEDICATION

To my family, who endlessly encourage, and sacrifices have fueled my journey; to my friends, whose belief in me never wavered; also, to all the mentors, educators, and individuals who shaped my academic and personal growth.

Your unwavering support and guidance have been instrumental in the completion of this thesis. This work is dedicated to you all, with heartfelt gratitude and appreciation!

ACKNOWLEDGMENT

I want to extend my deepest appreciation and gratitude to my thesis advisor, Irfan Ahmad Rana, for their invaluable and amazing guidance, patience, and never-ending support throughout this wonderful research journey. Their knowledge, insightful feedback, and encouragement have played a huge role in shaping this fabulous thesis.

I would like to express my heartfelt and very true appreciation to my beautiful and supportive family for their unconditional love, encouragement, and their unwavering belief in my great abilities. Their constant and never-ending support has been the cornerstones of my great academic endeavors.

To my truly wonderful friends, classmates, and colleagues, thank you truly for your encouragement, camaraderie, and for being such a source of so much motivation throughout this so special journey.

Lastly, I want to acknowledge the countless individuals who have contributed to this amazing thesis in so many various ways, directly or indirectly. Your contributions, no matter how small, are so deeply and truly appreciated.

This thesis is the culmination of the collective and the very best support and encouragement of all those mentioned above, and to them, I extend my sincerest and heartfelt gratitude!

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ABSTRACT

The study discusses Nature-Based Solutions (NBS) as a key strategy used in solving a variety of problems faced by urban development in Pakistan housing. As the pace of migration to cities quickens, investment in infrastructure construction dislodges workers and livestock from their usual habitat, and mines strip away hillsides for construction fill rage, this study uses NBS role in promoting sustainable development, raising urban resilience levels, and facilitating harmonious ecological balance. By adopting a mixed-methods approach, including literature review, interviews with stakeholders and case studies, and this study synthesizes the quantitative data and qualitative insights gathered to garner a more detailed understanding of today's NBS status and prospects within Pakistan. It takes a critical view towards NBS's ability to solve urban environmental problems, focusing primarily on the coming crisis in housing. The thesis sets out a robust investigative methodological framework to examine NBS, both socioeconomically, environmental, and institutional conditions. Through this analysis we can then go on to identify the main barriers and opportunities for incorporating NBS into urban planning and development policy, giving a theoretical vision well as real time recommendations. The Likert scale evaluation has been used to evaluate different institutes. A statistical analysis based on reliability measures such as Cronbach's Alpha, along with qualitative feedback from stakeholders, underscores the cumulative perception and confidence that NBS is ripe for implementation. The thesis identifies NBS as a seminal concept for the sustainable evolution of Pakistan's urban environment. It calls for a concerted effort by policymakers as well as urban planners to make NBS an inherent part of the strategy for developing cities. Through that process, it says, Pakistan will be able to handle both the challenges arising from urbanization and environmental sustainability to start on a new journey leading a resilient, sustainable, and vibrant future in cities.

Keywords: Nature-Based Solutions, Sustainable Development, Urban Planning, Housing Sector, Pakistan, Environmental Stewardship, Urban Resilience.

CHAPTER 1: INTRODUCTION

1.1 Background

According to the New Urban Agenda (2016), the urban population worldwide is set to double by 2050, leading cities to confront significant challenges regarding climate risks, environmental standards, adequate infrastructure and services, transportation, affordable housing, job opportunities, food security and more. This is especially true for cities significantly impacted by swift urbanization. Nature based solutions (NBS) like green spaces, constructed wetlands, and community gardens play a vital role in reconnecting individuals with nature and can function as educational settings for environmental teachings. NBS are crucial in helping cities adapt to climate change repercussions and play a role in reducing greenhouse gas (GHG) emissions (McPhearson T, 2018). There exists a widespread recognition and growing acknowledgment that NBS serve as effective strategies in safeguarding ecosystem services (ES), enhancing environmental quality, as well as providing significant health and wellness advantages. IUCN and the European Commission (EC) have extensively advocated for NBS as feasible approaches and measures to address various societal obstacles.

There has been an increase of the importance of offering inexpensive housing to citizens in recent years, which is crucial for the future of nations in terms of physical, social, economic, and environmental aspects (Habitat, 2005). Pakistan is currently facing an unparalleled urban housing dilemma (Jahangir, 2018). As per the census of 2023, Pakistan's population has risen by 2.4 percent annually in the interdental period, reaching 230.7 million (Government of Pakistan, 2023). Meanwhile, the urban population has grown by 2.7 percent each year during the same timeframe and is now around 75.5 million (ibid). The census reveals that the urban housing demand in Pakistan stands at 350,000 units. 62 percent of this demand is for lower-income brackets, 25 percent for lower middle-income groups, and 10 percent for higher and upper middle-income categories. The formal supply amounts to 150,000 units each year.

Pakistan is listed among the most vulnerable countries, facing increasing exposure to disasters and the challenges of climate change. Simultaneously, its haphazard urban expansion disregarding social and environmental issues is exacerbating the problem. This study will examine urban growth concerning NBS, developing optimal solutions that balance the economy, society, environment,

and biodiversity (Depietri, Y. and McPhearson, T., 2017).

NBS offer a way to adjust to climate and human-induced impacts while decreasing the harshness of climate change through absorbing and storing carbon. They can also help in handling floods, droughts, and extreme weather events. This analysis aligns with the country's requirements and future objectives to deal with the alarming issue of extreme environmental conditions and housing challenges. The housing industry in Pakistan faces substantial obstacles related to environmental sustainability, resource management, and urban planning (Haase, D., 2017). The swift rise in population and economic advancement has led to the multiplication of housing projects, often causing deforestation, habitat destruction, and increased emissions of greenhouse gases. This study aims to delve into the notion of NBS, its potential advantages, and hurdles, and suggest appropriate NBS methods for the sustainable progression of the housing sector in Pakistan.

1.2 Justification of the Topic

The most analyzed challenge is related to creating sustainable cities. Various aspects of green and blue spaces in urban regions, including urban parks, forests, gardens, and water bodies, as well as green roofs and walls, which in certain situations can be regarded as NBS, can positively influence various sustainable development objectives (Giachino, C. et al., 2022). These objectives encompass addressing poverty, promoting good health and well-being, ensuring clean water, encouraging responsible consumption, supporting life on land and in water, and reducing inequalities in access to green spaces. It is crucial to reconsider existing local, provincial, and national strategies and regulations concerning urban development in the context of NBS to align future and current development practices with nature. In modern times, individuals follow an artificial lifestyle at the expense of nature; this research aims to identify how we can optimally utilize available resources for the benefit of society, the economy, the natural environment, and biodiversity simultaneously.

Irrespective of the planning agencies' readiness, the study aims to evaluate their ability to incorporate various NBS techniques into existing legislation, SOPs, acts, or planning instruments for facilitating their execution. It also intends to analyze public opinions on environmental issues, economic incentives offered by regulatory bodies, and community attitudes towards actions against climate change. Moreover, it will investigate societal perspectives on safeguarding wildlife by endorsing infrastructure that guarantees wildlife preservation.

1.3 Scope of the study

NBS is a complex idea that spans various aspects of life, emphasizing the importance of preserving the environment and managing climate change. It holds equal significance across all sectors but is especially vital in urban development. This notion encompasses several dimensions that directly impact the natural world. This study aims to bridge existing gaps in literature by establishing a localized approach to implementing sustainable solutions for housing sector expansion within the country. When examining this research topic more closely, NBS will drive the entire real estate sector and city development towards enhancing society and nature. At a broader scale, NBS involves three key levels of operation: the restoration and protection of forests and wetlands in catchment areas, integrating nature into urban spaces, and restoring coastal habitats. The ongoing research will assist stakeholders in reintegrating nature into cities, ensuring the collective benefits of NBS.

1.4 Research questions.

- What is NBS and what are its dimensions and usage?
- What is the Role and applications of NBS at provincial and local level?
- Which institutions are responsible for incorporation of NBS to achieve sustainable urban development?

1.5 Research objectives.

The objective of research study is.

- To examine the extent of use of NBS in various local development plans and policies
- To evaluate the potential of NBS in local context
- To identify institutional/local challenges for incorporation of NBS for sustainable urban development
- To suggest recommendations for enhancing NBS in Urban Areas

1.6 Significance of the study:

This research is an original foundation study in Nature-Based Solutions (NBS) for the city of Lahore, assessing performances and impacts of various departments responsible for urban planning. The foundation set out herein will offer an exemplar for other cities wishing to develop

them in sustainable manner. By taking on board the new ideas and strategies revealed in this research, urban areas–whatever their makeup or historical context–can profitably learn about integrating NBS into homes and places of urban life.

The implications of this study are wider than just Lahore, it could well be a banner promoting the inheritance throughout urban contexts. Furthermore, It provides a complete frame foreseeing the possible effects of NBS on the ecology, society, and economy in urban housing estates. Furthermore, it suggests practicable policy recommendations that a city can apply both to make animals produce less environmental damage and ensure better life quality for its people.

The transferability of research conclusions to other cities is especially valuable–because it encourages sharing in data and experience between urban planners, decision- makers and environment experts–whilst promulgating innovation and development of the best standards, suited to each city's unique needs and conditions as appropriate.

As a result, the study not only contributes to the academic discussion on sustainable urban development but also has practical implications for all cities in the world aspiring to create more livable sustainable and resilient urban environments. For in-stead this research is a map showing how to integrate NBS into urban construction and it emphasizes their role in creating a sustainable city. Its uses in different urban contexts are all good for global efforts to realize the UN end-of-century sustainable development goals, showing once more the universality and potential impact of its conclusions.

CHAPTER 2: UNDERSTANDING NATURE BASED SOLUTIONS

2.1 Defining Nature-based Solutions (NBS)

The concept of Nature-based Solutions (NBS) was initially introduced by the World Bank back in 2008. Over the subsequent decade (2010-2020), the idea underwent significant development. The European Commission (EC) officially defined NBS in 2015, followed by IUCN. Numerous scholarly articles and research works have delved into the exploration of NBS and their potential applications in preserving natural ecosystems. However, there remain ample opportunities for further exploration as the existing research can be classified as preliminary investigations.

The EU defines NBS as "solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more and more diverse nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions" Therefore, in recognition of the role that NBS can play in providing sustainable, cost-effective, multipurpose options for more resilient cities and societies, the EU Research and Innovation Policy Agenda for NBS and Re-Nurturing Cities aims at positioning the EU as a leader in "innovating with nature".

Further it gives the relevance in following manner.

- This initiative aids real estate developers in crafting residential spaces that prioritize both human well-being and biodiversity conservation.
- By collaborating with nature, it offers solutions to societal challenges, delivering benefits for both people and biodiversity.
- Strategies encompass safeguarding, restoring, or managing natural and semi-natural ecosystems, sustainable management of productive land and seascapes, and fostering the development of novel ecosystems like urban green infrastructure.
- Further, well-planned Nature-Based Solutions (NBS) for urban sustainable development can effectively address climate change and biodiversity loss, in addition to advancing various other sustainable development objectives.

2.2 Ingredients of NBS:

Nature-Based Solutions, NBS, are an eclectic mix of approaches that integrate natural processes and ecosystems to tackle modern environmental, social, and economic problems. The solutions are multi-faceted and incorporate the ecological, physical, and societal dimensions of action to enhance urban resilience and sustainability. The ingredients of NBS include the following:

- **Utilization of Ecosystem Services:** NBS leverage the basic services from natural ecosystems such as air and water purification, flood regulation, pollination, inter alia. They are critical as they offer natural and physical functions for directly mitigating environmental problems (Cohen-Shacham et al., 2016).
- **Green Infrastructure:** They are spatial networks of natural environments, such as parks, urban forests, and green roofs, meant to provide multiple functions such as recreational spaces, aesthetic improvements of cities, and the reduction of the urban heat island effect (Lafortezza et al., 2018).
- **Blue Infrastructure:** It incorporates the water-based constituents of the environment such as rivers, lakes, and wetlands, among others, to provide services such as water purification, species habitat, and recreational uses (Matthews et al., 2015).
- **Biodiversity:** Encompasses the promotion of diverse life forms in urban environments to galvanize the natural processes of ecosystems and enhance resilience to climatic stresses and changes (Secretariat of the Convention on Biological Diversity, 2012).
- **Community Engagement:** NBS functions best when urban communities are actively involved in planning and implementing them. This guarantees that the solutions are well-tailored to suit local needs and have more longevity and acceptance (Raymond et al., 2017).
- **Sustainable Land Use:** It integrates a strategic approach to configure land usage to suit social, economic, and ecological uses. This includes sustainable forestry and agriculture practices that pay attention to conserving habitats (MEA, 2005).
- **Policy and Governance:** NBS success also depends on policy and governance systems that acknowledge the value of integrating natural aspects in city organization (European Commission, 2015).

- **Financial Mechanisms:** They include financial models such as incentives for green infrastructure or payment for ecosystem services, among others (Pauleit et al., 2017).
- **Research and Innovation:** NBS development is also a product of research and innovation that develops innovative approaches to solve unique environmental problems (Nesshöver et al., 2017).
- **Cross-sector Collaboration**: Involves the various sectors working together for purposes of integration (Frantzeskaki et al., 2017).
- **Resilience and Adaptation:** NBS development also looks at fitness for the environment, which enables recovery after disturbance (Seddon et al., 2020).

All the above ingredients of NBS are interlocked to produce a framework that is holistic, action-oriented, and focused on sustainability. It relates to recognizing the natural systems not only for ecological reasons but also as crucial players in enabling sustainable human settlements (Wendling et al., 2020).

2.3 Importance and Benefits of NBS

Although the function and meaning of parks, trees, and other natural spaces in cities have been recognized for ages, the broad acceptance and formal support for these concepts, particularly in the context of current climate and public health challenges, are relatively recent developments. The concept of "nature-based solutions" has notably advanced the integration of nature into the political, planning, and economic realms, as discussed by Palomo, I. et al., 2021. Defined as actions to maintain, sustainably manage, and restore natural or modified ecosystems that address societal challenges in an effective and adaptive manner while simultaneously benefiting human well-being and biodiversity, nature-based solutions have been instrumental. These solutions have fortified federal structures and assets to resist natural disasters and the impacts of climate change, and have also reduced operational and management costs, including those associated with heating, cooling, and stormwater management, as highlighted by Bosch et al., 2021.

Nature-based solutions (NBS) present an effective approach for addressing urban environmental challenges sustainably, offering significant environmental, social, and economic benefits. These solutions range from direct utilization of natural processes to engineered systems that mimic nature, inspired by, supported by, or copied from natural models. They offer multiple advantages

for public health, society, the economy, and the environment, often in a more cost-effective and efficient manner than conventional methods (Badura et al., 2021).

The term "nature-based solutions" initially seems self-explanatory, which is particularly true when contrasted with terms like "ecosystem services" and "green and blue infrastructure." These latter terms require immediate clarification for those not familiar with them (Wei et al., 2023). However, the concept of "green" NBS requires detailed explanation to achieve a clear and straightforward definition that facilitates effective communication. It's crucial to distinguish that NBS are not synonymous with "green" solutions, which might refer to ecologically beneficial or renewable technologies that do not necessarily emulate or utilize natural processes, such as bioenergy or energy-efficient buildings.

The categorization of NBS can be further detailed, with at least the first three types existing along a continuum rather than as distinct categories. Generally, less intervention and modification are associated with a broader range of services, whereas more intensive management or the creation of new ecosystems typically aim at enhancing or establishing specific services.

2.4 Conceptual framework for NBS

There is a growing recognition of the potential of integrating Nature-Based Solutions into our efforts to combat societal challenges such as climate change, water scarcity, and urban sustainability. The conceptual framing of NBS is based on the key principles of sustainability, biodiversity conservation, resilience, socio-economic benefits, and community involvement. NBS utilizes the unique abilities of ecosystems to absorb disturbances, enhance resilience, and deliver ecosystem services that are critical for human well-being (Cohen-Shacham et al., 2016).

The Horizon 2020 program of the European Commission embodies the spirit of incorporating NBS into urban planning and policies with an assertion that such solutions can help us build “cities of the future for and with their citizens” (European Commission, 2015). Furthermore, NBS can be a cost-effective nature-based tool for climate change mitigation and adaptation and can double as biodiversity enhancement and recreational area (Kabisch et al., 2017).

Often, the most relevant way to access this thinking is through interdisciplinary studies and consultations with stakeholders to ensure effectiveness and convergence with societal concerns (Eggermont et al., 2015). A framework to evaluate and implement the co-benefits of NBS is the

creation of spaces and activities that can be used to meet environmental, social, and economic goals simultaneously (Raymond et al., 2017).

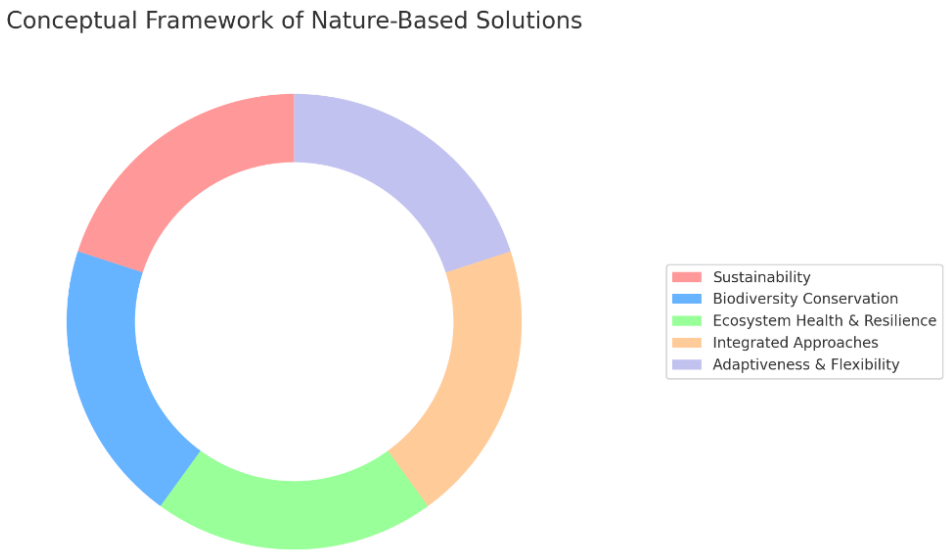

Figure 2.1: Conceptual Framework

2.5 Classification of NBS for the Housing Sector

Social housing is usually provided in low-socioeconomic-status neighborhoods. In comparison to other societies, environmental challenges, such as climate change and biodiversity erosion, are more prevalent among the population live in these communities. "Cities might become more equitable by enhancing the resilience of neighborhoods with social housing through the deployment of Nature-based Solutions (NbS)" （Nassary et al., 2022). Because current social housing practice in the Netherlands is characterized by physical, social, and financial constraints, this research addresses how far NbS can be implemented and what NbS can provide. Based on numerous Living Lab experiences and dialogues with the vast majority of housing corporations, NbS measures were found that most likely intersect with current social housing practices. For dissymmetrical justice, the ease of integrating NbS into existing policies is most likely since more NbS leads to more environmental gains（Khan et al., 2021）.

It was established that proper procedural and recognition justice was critical for ensuring that locals would value green spaces. It is essential to identify approaches to the environmental problems that low SES neighborhoods face. “’Actions that work with and enhance nature to restore

and protect ecosystems and help the society adapt to climate change and slow down further warming, while offering several additional benefits (environmental, social, and economic)" nature-based solutions should be viewed as a viable option（Bakhsh et al., 2018). To put it another way, NbS, in addition to increasing and/or preserving biodiversity, can provide a variety of services to ecosystems, such as climate adaptation and health improvement. NbS can adopt different forms (Irfan Ullah et al., 2022). They could include enhancing public and private green areas in housing (also known as "green infrastructure") like parks and (shared) gardens, as well as incorporating natural features into buildings like green walls or roofs. Nature-based solutions are not the same as "green" solutions, which can also refer to ecologically beneficial or renewable technology that does not use or imitate nature, such as bioenergy or energy-efficient structures. The above-described categories or sorts of nature-based solutions can be further subdivided, at least the first three of which exist on a continuum or gradient rather than as discrete categories.

- Minimizing waste generated not only by surplus resources but also by optimizing time and space utilization, which can help limit the harmful impact on local biodiversity.
- Enhancing opportunities for material recycling and reusability.
- Focusing on the renovation of aging assets and the transformation of pre-existing buildings into modern living spaces.
- Harnessing renewable energy sources and exploiting on-site natural resources like natural light and air circulation.
- Reducing overall lifecycle costs and environmental impacts, which leads to higher customer satisfaction, lower maintenance needs and costs, and improved dependability.

2.6 Informal Settlements Meeting Housing Demand in Pakistan

Two forms of informal settlements, namely the occupation and division of government land (referred to as katchi abadis), and the informal division of agricultural land on the outskirts of urban areas, have historically addressed unfulfilled housing needs. However, in recent times, the growing demand is being satisfied primarily through the densification of current low and lower middle-income settlements.

The housing requirement in Pakistan is projected to rise from 1.07 million units annually in 2020 to 1.24 million units annually in 2025. Most of this demand is concentrated in metropolitan regions. Property developers and experts in the field attribute this surge to the existing scarcity and demand (World Bank, 2021). Various factors contribute to this escalation, including the migration of individuals from rural to urban areas in search of better job opportunities and an improved quality of life. Additionally, the government has pledged to bridge the housing gap by providing loans under its affordable housing scheme (Clemente et al., 2023).

2.7 Current Status of the Housing Sector in Pakistan

Pakistan's housing sector confronts a slew of difficult issues. To begin with, there's a dire shortage of affordable housing available to the masses. Heightened urbanization and a surge of populations into big cities are aggravating this problem, pushing many into substandard living conditions in informal settlements or slums （Marvuglia et al., 2020). Additionally, the lack of holistic urban planning and development of infrastructure exacerbates housing woes （Ali et al., 2018). The construction of new residences lags needs, and financial solutions for homeownership are scarce, causing property prices to soar and making it unfeasible for most of the population to own homes.

Moreover, the housing sector's growth and effectiveness suffer from corruption and bureaucratic red tape, deterring investment and leading to market stagnation, which aggravates the housing shortfall. Nonetheless, researchers propose several strategies to remedy the housing situation in Pakistan（Lehmann, 2021).

Governmental intervention and policy overhaul are critical. The state must focus on building affordable housing and attracting private sector involvement. Investments in sustainable urban infrastructure and the concept of smart cities could mitigate the issues of resource scarcity and overcrowding. The integration of eco-friendly technologies and the promotion of urban greenery can improve living standards and lead to a more sustainable existence（Alshebani & Wedawatta, 2014). Also, enhancing slums and informal settlements with essential amenities could significantly better the lives of disadvantaged groups.

2.7.1 Urbanization and Population Growth

The world is going through a critical phase of accelerated urbanization, which is associated with a

high rate of population growth. This phenomenon is accompanied by the development of cultural degradation, inadequate infrastructure, and resources. When much of the nation migrates from districts to megalopolises to seek employment, such tendencies may be observed（Asadollah et al., 2022).

2.7.2 Environmental Challenges and Degradation

With urbanization, population growth significantly influences nature. The rapid construction and expansion of metropolitan regions lead to the demolition of trees, as unprotected areas are transformed into built environments. Forests, crucial for absorbing carbon, are being razed, exacerbating carbon emissions issues. Additionally, cities are sources of considerable air and water pollution, resulting in a range of health problems for inhabitants（Arshad et al., 2022). Addressing these urban challenges requires the adoption of sustainable methods, ranging from utilizing renewable resources to implementing stringent anti-pollution regulations and effective waste management strategies.

2.7.3 Inadequate Infrastructure and Resource Management

The surge of people into cities frequently surpasses the capacity of the existing infrastructure, leading to subpar services. Housing deficits are widespread, and informal settlements and slums proliferate. These areas are often deprived of essential services like clean water, sanitation, and electricity, which diminishes residents' living standards. To mitigate these deficiencies, government investment in infrastructure is crucial, with an emphasis on affordable housing, efficient transit systems, and access to fundamental services. The private sector's engagement is also key to bridging the gap in infrastructure（Kumar et al., 2020).

Urban growth and demographic expansion exert extraordinary demands on natural resources. The heightened need for water, energy, and food puts a burden on the existing supply systems. In the absence of judicious resource management, scarcity and unfair distribution ensue. Sustainable management of resources is indispensable for ensuring a stable future. Practices such as water conservation, productive agricultural methods, and a shift towards renewable energy sources are essential. Promoting conservation and recycling is also important to alleviate the stress on resources and decrease waste（Menon and Sharma, 2021).

2.8 Potential Benefits of NBS Implementation in the Housing Sector

The potential benefits of implementing Nature-Based Solutions in housing are manifold and cut across the environmental, social, and economic dimensions, making the conservation very close to sustainable urban development goals. The use of nature to secure residential areas increases ecological resilience and at the same time improves the residents' quality of life. The following are the merits of the issue, explained using proper references:

2.8.1 Environmental Benefits:

- **Increased Biodiversity:** Housing green spaces, native gardens, and green roofs can shore up urban species diversity, which play huge roles in conservation in urban parks (Beatley, 2011).
- **Better Air Quality:** Urban vegetations are natural filters that clean polluted air while ingesting carbon dioxide to generate oxygen (Nowak et al., 2006).
- **Climate Control:** Greened residential areas also help lower urban heat island impacts by creating cool urban regions (Oke, 1989).
- **Water Management:** Ecosystems in residence Areas such as rain gardens, permeable pavements promote infiltration and reduce runoff, hence avoiding floods (Fletcher et al., 2015).
- **Carbon Storage:** The green vegetation in the residence creates a carbon sink, which counters the lost tree carbon sink (Lorenz & Lal, 2014).

2.8.2 Social Benefits:

- **Health and Well-being:** There is a general belief that natural exposure, such as physically touching a living leaf or simply viewing lush environments in advertisements, does wonders for health. This belief is premised on the unbroken thread of consistent observations that interaction with natural elements -- whether energetically engaged through touch or passively absorbed visual stimuli in confined spaces -- is linked to better well-being. (Hartig et al., 2014).
- **Community Cohesion:** Shared green spaces promote friendly interaction and the formation of bonds in a community (Kuo et al., 1998).

- **Aesthetic Value:** NBS can increase the aesthetic beauty of residential areas, and this will make for a more satisfactory life for inhabitants (Ulrich, 1984).
- **Recreational Spaces:** Green spaces that are included in housing developments or around them offer residents essential opportunities for recreational activities and experiences (Coley et al., 1997).

2.8.3 Economic Benefits

- **The Market Value of Homes and Businesses:** If on his neighbor's property there are green areas, then the value of his own land could go up accordingly (Wolfe et al., 2004).
- **Energy Efficiency:** If we have the right planting done way even in urban areas, can reap benefits contributed by much lower heating and cooling costs though more use Of renewable resources for power generation (Akbari et al., 2001).
- **Employment:** The NBS management and implementation entails many subsequent economic activities. (Gómez-Baggethun et al.,2013)
- **Cutting Hard Infrastructures Costs:** By adapting urban environment so as to get rid of poured concrete water.
- Moats and industrial concrete that leave nowhere for rainfall draining off rooftop slopes too go it is possible even in cities which are large enough to achieve some scale impacts by lessening the burden on sewers or other water drainage facilities (McDonald et al. 2016)

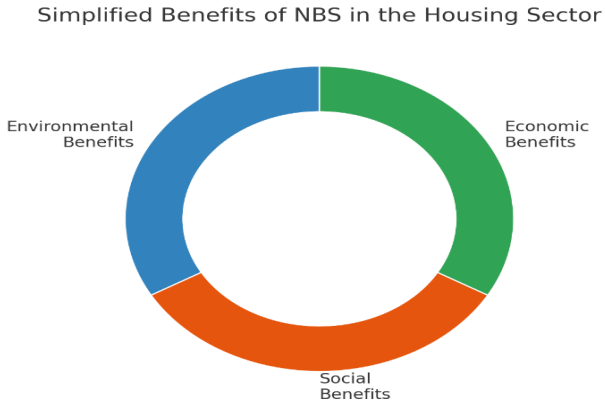

Figure 2.2: Benefits of NBS in Housing Sector

2.9 Challenges of NBS Implementation in the Housing Sector

As an effective method for addressing various environmental, social, and economic issues, Nature-Based Solutions (NBS) is increasingly gaining recognition. Its deployment requires overcoming several impediments, that may obstruct adoption and impact. Financial and economic barriers to entry also pose one of the primary challenges confronting NBS. These include the securing of sufficient funds to set up or maintain NBS infrastructure as well as the necessarily indirect and long-term nature of most of their beneficial effects making it difficult to gauge this in cost-effectiveness analysis (Geneletti et al., 2020).

There are also significant governance and institutional barriers to the adoption and implementation of NBS. The absence of a supportive policy environment, integration into existing planning mechanisms and NBS schemes goes to waste. The success of NBS further requires them to be topologically connected across government levels and sectors, which is made difficult by fragmented governance structures (Cohen-Shacham et al., 2016).

Technical and knowledge gaps also represent a major hurdle. There is a shortage of technical expertise in areas such as the design and implementation of NBS, and particularly in novel or site-specific applications. Establishing effective monitoring and evaluation mechanisms attuned to NBS yields remains a complex task (Nesshöver et al., 2017).

Historical and cultural challenges including public awareness and acceptance can further affect the success of NBS. Gaining public backing and overcoming scepticism is vital, not least for NBS whose benefits are scarcely apparent at once. Integral to reaching successful outcomes is involving all stakeholders, including local communities, meaningfully in the planning and implementation processes (Raymond et al., 2017).

Environmental and ecological factors, such as tailoring NBS to its local context and accounting for climate impacts, further compound the complexities associated with implementation. In addition the need to build NBS into existing infrastructure and the problem of scale present additional obstacles to progress that require innovative and adaptive solutions (Kabisch et al., 2017).

Confronting such obstacles calls for multidisciplinary expertise, a stakeholder engagement strategy and the development of supportive policies and funding mechanisms. By effectively

navigating these obstacles, NBS can be used to promote environments capable of enduring change and ultimately benefit society and nature alike (Seddon et al., 2020).

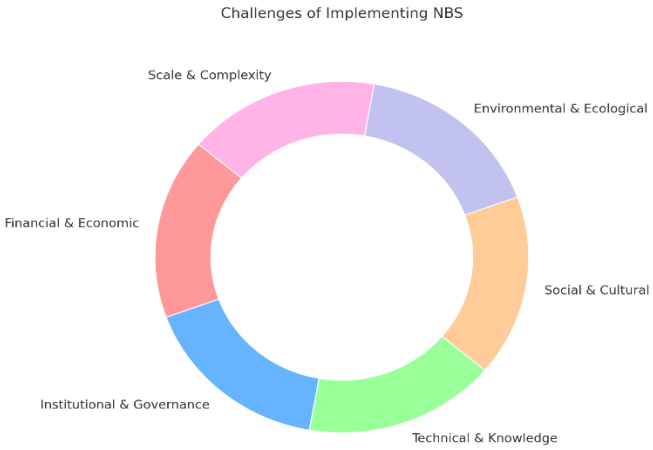

Figure 2.3: Challenges of implementing NBS

2.10 International Practices in implementing NBS for housing.

This section draws a comprehensive picture of how international practices work with Nature-Based Solutions (NBS) to solve housing problems. It comprises of research objectives, methods, general contents, and individual findings. These narratives collectively reveal all sorts of applications or benefits for NBS in urban construction, disaster prevention and so on. Together they are useful for people to think about what is involved with introducing NBS into their own community--and what they may have forgotten (or did wrong).

In a key study from 2017, the integration of grey, green, and blue infrastructures in cities is aimed at both climate change adaptation and disaster risk reduction. As the city is a Social-Ecological Technological Systems (SETS) it finds while most of the white infrastructures are helpful to an urban environment grey infrastructure are highly adaptable for urban contexts. Green infrastructures tend to be flexible and provide many no-regret measures 'with co-benefits' along their paths beyond those primary functions: for instance, it’s a practical way of decreasing air pollution as well as slowing up climate change. Hybrid approaches look particularly positive for urban areas, what is this concern with duality (Geneletti et al., 2020)?

A similarly notable executory study in 2021 on the afforestation of urban brownfields in Leipzig, Germany emphasizes the role played by urban forests in restoring such wastelands. This practice

contributes to urban microclimate, air quality, leisure areas and ecology (although there are some difficulties with planning and execution) (Kabisch et al., 2017).

There was another study in 2021 looking at Generation Z's awareness and attitudes towards NBS: it indicates that a significant service of NBS is valuation by one survey (52.02%) as nature conservation and tourism (Raymond et al., 2017).

The article "Urban Nature Based Solutions Leading the Way 2021" represents the essential role cities play in integrating natural goals of the UN Sustainable Development Goals into cities. Displaying 8 successful programs of urban and suburban NBS, it stresses the adaptability of NBS as a method for controlling climate change, environmental impact and social co-benefits (Cohen-Shacham et al., 2016).

To give another instance, a review in 2021 of sand helping canals for coast protection furnishes proof that the configurations of these structures are highly effective in capturing silt. This shows how penetrating power is important: the fact is a 'recirculating zone' that helps yourself (Nesshöver et al., 2017).

Molenaar and her group at the end of their 2021 research underscore the need all over Europe for strengthened stakeholder participation, integrating NBS into city planning and governance, and dealing with institutional, financial technical barriers to NBS scaling up. These findings in sum give us a better sense of what NBS can achieve for sustainable urban development and suggest the importance an all-encompassing approach encompassing fields such as interdisciplinary research, general evaluation formats--material input from all quarters (Seddon et al., 2020).

2.10.1 Key Takeaways:

The extensive review of international practices in implementing Nature-Based Solutions (NBS) for housing reveals a multifaceted approach to tackling urban environmental challenges, enhancing community well-being, and promoting sustainable urban development. Here are the key takeaways:

- **Holistic Integration of NBS:** The integration of grey, green, and blue infrastructures as a holistic approach for climate change adaptation and risk reduction shows that hybrid solutions can offer significant benefits. These include not only environmental protection

but also the enhancement of urban resilience and sustainability.

- **Revitalizing Urban Spaces:** The afforestation of urban brownfields demonstrates that transforming underutilized urban areas into green spaces can significantly improve the urban climate, air quality, and biodiversity. This approach also enhances the value and recreational appeal of adjacent areas, contributing to the overall quality of urban life.
- **Generational Engagement:** Research on Generation Z's awareness and attitudes towards NBS indicates a strong preference for sustainable urban environments. This demographic's engagement suggests that investing in NBS can make urban areas more attractive to younger generations, which is crucial for future urban planning and sustainability efforts.
- **Economic and Environmental Benefits**: The implementation of NBS in urban settings is shown to lead to numerous benefits, including economic savings, job creation, and environmental improvements. Employing sustainable building materials, for instance, can reduce construction costs and energy bills, while green infrastructure contributes to ecosystem health and resilience.
- **Challenges and Solutions:** The barriers to NBS implementation, including lack of awareness, resistance to change, and technical and compliance challenges, underscore the need for enhanced awareness, communication, and collaboration among stakeholders. Addressing these challenges requires comprehensive strategies that include resource allocation, technical advancements, and stakeholder engagement.
- **Innovative Approaches:** The reviews and case studies presented highlight the importance of innovative approaches to NBS, such as the use of participatory co-creation, cross-sectoral cooperation, and advanced technological solutions. These methods not only facilitate the planning and management of spatial solutions but also ensure the sustainable use of natural resources.

In summary, the successful implementation of NBS in the housing sector and beyond requires a concerted effort that involves integrating sustainable practices, engaging with communities, overcoming technical and awareness barriers, and fostering collaboration among all stakeholders. By prioritizing these elements, cities can create resilient, environmentally friendly communities that offer a high quality of life for all residents.

2.11 Case study of Netherlands

The Housing Act in the Netherlands assigns a select group of nonprofit organizations, known as housing corporations, the responsibility of supplying social housing, a practice unique to the Dutch context. These corporations exclusively provide social housing, with 267 firms managing 2.4 million homes. This accounts for approximately 32% of the Dutch housing stock, offering housing solutions to 4 million tenants. However, the last decade has seen the sector becoming increasingly fragile, with regulations introduced in 2015 preventing the construction or leasing of properties to middle-income families, thereby limiting social housing to low-income groups. This shift has resulted in a higher prevalence of non-Western migrant families, single parents, former inmates, and individuals transitioning from psychiatric facilities within the social housing system（Aalbers et al., 2014; De Haas, 2017; De Vries et al., 2020).

The implementation of Nature-Based Solutions (NbS) within this sector faces physical constraints due to practices in social housing. High population density and limited land availability for green infrastructure development are common issues. Particularly in neighborhoods established in the 19th century, the scarcity of green spaces is notable. Although the 20th century saw the creation of more green areas within these neighborhoods（Steenhuis et al., 2016), public green spaces often do not translate into private gardens for apartment residents. Instead, communal gardens may exist, but their quality and the communal aspect can sometimes detract from their value.

Designing gardens that are both practical and affordable, while also creating inviting spaces for children to play, can contribute to increased biodiversity. Housing corporations have the flexibility to phase in garden updates, aligning with their financial capacity, through three progressively more expensive design options. In areas close to water, such as The Hague, rat infestations are common. These rodents proliferate and become more active during the day when household waste is readily available, a shift from their traditionally nocturnal habits. This not only raises health concerns, such as the risk of Weil’s disease, but also poses obstacles to enhancing green spaces. Housing corporations might be reluctant to plant shrubs or perennials to deter rats. However, it seems that the most effective strategy for addressing the rat issue is altering the local community's waste disposal practices.

2.12 Case study of Sweden

The first major green development initiative in Malmo was the Western Harbour, thoughtfully planned from the beginning. In the late 1990s, the city chose to host the 2001 City of Tomorrow housing exhibition in the western part of Western Harbour's old dock area（Stahre, 2008). This area, designated as the Bo01 development, was developed as an ecological district with the goal of revitalizing the former industrial zone. The project aimed to establish a dense, mixed-use neighborhood that prioritized aesthetics, open spaces, and energy efficiency through sustainable planning and building technologies. Drawing on the experiences and knowledge gained, two more ecological districts were later designed within the Western Harbour. These later developments incorporated various Nature-Based Solutions (NBS), including habitat biotopes designed to boost biodiversity and open drainage systems, techniques that have since been implemented in other parts of Malmo.

Most of the Nature-Based Solutions (NBS) in the Western Harbour involve landscaping and experimental habitat projects aimed at enhancing biodiversity and aesthetic appeal. These projects were largely implemented as part of the Biodiversity program, which encompasses six distinct project categories aimed at increasing biodiversity, improving ecosystem services, enhancing public health, developing urban biotopes or ecosystems, and incorporating elements like street trees, green roofs, mobile plant systems, three-dimensional greenery for shading, green facades, and walls, and tree-lined streets.

Research focusing on the specific impacts of NBS in the Western Harbour has largely centered on biodiversity monitoring and the aesthetic preferences of the local population. Interviews with residents of Bo01 revealed a generally positive reception towards water features, such as landscaped ponds and drainage canals, which impart a "unique character" to the area. Despite internal discussions about the rapid algae growth in the ponds, residents were reportedly willing to pay more for an open drainage system, perceiving litter as a more visible issue in such systems rather than a larger problem（Stahre, 2008). Although the vegetation in the ponds and other parts of the open drainage system theoretically should improve water quality, this aspect has not undergone scientific evaluation, leaving the potential impact of NBS on water quality in the Western Harbour as speculative.

2.13 Case study of China:

Urbanization acts as a primary catalyst for modernization and economic growth, representing an unstoppable trend in the socio-economic development of societies worldwide. However, China's notably rapid urbanization rate has increasingly come under scrutiny. Our research highlights that the real estate sector plays a critical role in understanding this accelerated urbanization, driving the swift transition of rural populations to urban centers by providing significant funding for urban infrastructure development. To illustrate the influence of the real estate industry on urbanization, we examined how four Chinese cities have spurred the growth of various real estate market segments, serving both as a case study for China's urbanization and a cautionary tale for other developing countries. Urbanization, however, introduces several challenges, including resource depletion, environmental degradation, and increased crime rates（Saboor et al., 2017; Liu and Li, 2017).

The necessity for substantial infrastructure investment presents a formidable challenge, as urbanization demands significant outlays for urban roads, water, electricity, gas, communication networks, and other essential infrastructures（Chen et al., 2019b). Historically, such investments have been funded through long-term taxation, but the inefficiency of tax and banking systems in industrialized nations has shown to be inadequate for meeting these needs. Additionally, the colonial history of exploiting native populations for urbanization funding has led to significant social unrest, especially in the colonization of developing countries by more developed ones（Lilley, 2000). In the modern context, without effective taxation and with local-led development rather than colonial exploitation, financing urban infrastructure poses a significant challenge.

China's response to these challenges included implementing residential housing reform in 1998, allowing individuals to own homes rather than rely on employer-provided housing. Additionally, the land supply system reform of 2002 enabled local governments to sell or lease land to raise funds for urbanization projects, known as the "land finance model"（Chen et al., 2011; Wu et al., 2015).

2.14 Takeaways from the case studies:

By examining examples from the Netherlands, Sweden and China, they have used Nature-Based Solutions (NBS) as a lens for looking at urban development strategies. Each case study offers

unique insights into how NBS can be integrated into urban landscapes: The Dutch emphasis is on a special form of social housing-maintained by nonprofit organizations and accounting for around thirty percent of all units built in the country. However, regulatory changes made since 2015 have limited this system to low-income groups only as a result its population has changed. In housing estates such changes are a barrier to realizing what one might call "NBS"-especially given physical constraints like overcrowding and shortage areas. Yet it can be done in small residential developments within public greenbelts where trees stand side by with every fire escape.

At the same time, Sweden's case study's the green development project in Malmo Western City was designed to breathe new life into a heavy industrial area. This project combines state-of-the-art technology, construction, and biodiversity. The overall look emphasizes open space, aesthetics, and energy conservation, highlighted by material science NBS integration all over the region collectively increases biodiversity we get an ecological, enchanting landscape: With interlocking complexes of open parkland. Even the inhabitants, who might not otherwise have appreciated such for the first time 'hard' water been planted with the white lotus can understand that this set-up is good.

In contrast, China's rapid urbanization—primarily driven by the real estate sector—underscores the critical importance of having very large infrastructure investment in urban development. This in turn raises an array of new and huge problems, such as the exhaustion of resources or environmental degradation. Moreover, the Chinese response to these challenges has been marked by large policy reforms which have made homeownership more convenient for individual family groups (through such cost-of-household service organizations as the walled city); and empowered local governments to raise funds through land sales or long-term leases for urbanization projects. This is just a soupcon of how to sod it across the case studies.

Together, these examples underscore the importance of cross-border cooperation and effective public-private partnerships for environmental, social, and economic development projects. They also remind us again of the value that it is essential to have flexible legal frameworks, inquisitive local communities, and forward-thinking financial mechanisms if our cities are going clean to be at all viable.

In addition, cross-sectoral collaboration plays a critical role in addressing the complex challenges of rapid urbanization and environmental degradation. These cases also provide direction for a

future where, based in strategic design and the application of nature-based solutions, cities that are sustainable, livable and resilient can be achieved.

2.15 Proposed NBS Practices for the Sustainable Growth of the Housing Sector in Pakistan

Nature-based solutions (NBS) strategically leverage environmental, social, and economic benefits to address specific challenges, embodying an efficient, adaptable method for fostering equitable and sustainable economic growth, improving human health, and protecting the environment. The potential of nature to spur scientific innovation, economic revitalization, and inspiration is significant（Zeeshan and Ali, 2023).

Demonstrated through diverse research and innovation efforts, NBS offer vast possibilities. Green walls and roofs, for example, not only diminish cooling costs for residents but also encourage urban biodiversity and enhance the aesthetic appeal of areas（Van der Linden et al., 2019). Urban gardens contribute to community food security, foster social cohesion, provide educational opportunities, and support urban biodiversity.

Local governments are instrumental in promoting urban gardens to strengthen food sovereignty, enhance green and blue spaces, improve residents' quality of life, and create popular recreational areas. Additionally, the application of green roofs and green infrastructure aids cities in bolstering resilience against extreme weather conditions.

While NBS significantly transform urban landscapes, offering diverse benefits for individuals and city administrations, their broader deployment necessitates further action. More research on NBS is essential to effectively advocate for these strategies and secure financial and resource backing for their adoption. Local governments are crucial in facilitating stakeholder collaboration to ensure NBS integration into sector-wide planning and policy, aiming for sustainable urban development.

Key strategies include:

- Establishing a robust evidence base for NBS, evaluating ecosystem services, and assessing additional values and side effects.
- Promoting NBS's versatility and their ability to support various policy areas, from economic development to public health and climate adaptation.

- Encouraging cross-sectoral support and commitment for NBS policies and planning, through cooperation among all stakeholders, including urban planners, utility operators, municipal authorities, and residents.
- Exploring both traditional and innovative financing options, like green bonds, adaptation funds, taxes, fees, and public-private partnerships, to implement NBS.

2.15.1 Beautiful, healthy, and green residential areas

Recreational green spaces contribute significantly to community well-being by facilitating neighborhood gatherings, enhancing food production, and fostering social interaction. The integration of these spaces into settlements not only makes the areas more functional and livable but also strengthens community identity and unity. Furthermore, the implementation of green infrastructure, such as natural drainage systems, renewable energy usage, environmentally friendly building designs, and strategic building placement and orientation, not only elevates property values but also plays a crucial role in mitigating the impacts of climate change.

2.15.2 Green community centers

Acting as community hubs, these spaces provide an essential opportunity to showcase and experiment with green infrastructure initiatives, enjoying support from the local community. Through the implementation of green roofs and walls, solar heating and shading, passive cooling systems, and rainwater harvesting, they exemplify sustainable building practices. Beyond offering employment opportunities in the management of green spaces, connected environments like wetlands and agroforestry also support healthful living through sports and educational opportunities. These include engaging with nature directly and participating in food production, thereby enriching community life.

2.15.3 Green Infrastructure

To enhance urban resilience, it's essential to adopt green infrastructure strategies, emphasizing the restoration and development of natural systems within residential areas. Green infrastructure involves the strategic design and construction of infrastructure assets to not only improve their functionality and durability but also to enrich the aesthetics, amenities, and multifunctionality of the communities where they are situated.

2.15.4 Recommendations for Policymakers, Urban Planners, and Developers

There is a recognized need for recommendations on Nature-Based Solutions (NbS) and applicable typologies that suit various environmental, socio-economic, and urban design contexts. An integrated and systemic approach to NbS implementation and impact assessment is essential, incorporating NbS into local policy frameworks, socio-economic development pathways, and spatial planning. Despite the availability of tools, models, design guidelines, standards, and protocols, significant gaps in knowledge and evidence hinder the widespread adoption and practical implementation of NbS. Collaborative planning and implementation processes, along with co-creation and co-management spaces, are crucial for engaging with urban social innovation and ensuring the effective deployment of NbS. Collaboration among the scientific community, the business sector, and policymakers is vital to address innovation challenges and facilitate NbS planning. Financial and governance challenges remain significant barriers to the broader application of NbS. Governance structures need reform to encourage bottom-up collaborative efforts like grassroots and civil society projects, desiloing efforts, and more flexible urban governance models.

- NbS have been acknowledged as effective solutions for improving housing and environmental quality, offering significant health and well-being benefits, and addressing various societal issues.
- There is growing interest within the scientific community in applying NbS, though their use in non-academic discourse remains limited.
- The impact of NbS can be categorized and assessed to address specific challenges and measure their effects.
- While there is a focus on urban-level applications of NbS, their use in rural settings and the evaluation of their economic benefits and contributions to social cohesion require further study.
- The cost-effectiveness and reliability of NbS, compared to traditional, grey-engineered alternatives, needs more extensive research, particularly studies focusing on economic benefits and social cohesion contributions.
- The benefits of NbS for environmental restoration, rehabilitation, and improvement in

environmental quality, ultimately enhancing health and well-being, are widely documented. However, co-benefits, synergies, and trade-offs across various designs, configurations, and scales have not been systematically analyzed, highlighting the need for further research on how NbS deliver combined multiple benefits.

CHAPTER 3: METHODOLOGY

Nature-Based Solutions (NBS) have captured widespread interest as a pathway to sustainable development across multiple sectors, notably in housing. The research utilizes a comprehensive methodology, incorporating diverse elements to guarantee the findings' reliability and validity. This chapter will detail the research design and underscore the capacity of NBS to drive sustainable development within the housing sector.

3.1 Research Design:

The mixed-method research design of the present study is a common design in literature. It is conducted within the dialectic relationship between urban development in cities and ecological sustainability under the framework of Nature Based Solutions (NBS).

3.2 Methodological Framework

The methodology encompasses the following key components.

3.2.1 Literature Review:

The research's substantive work radiates out from a comprehensive literature review. Its spectrum of reference materials is literally ground-breaking, with reports from policy think tanks, white papers released by government departments and a mass of academic monographs on Nature-Based Solutions from around the world. This approach to reviewing the literature incorporates all angles and is aimed at gaining a well-rounded understanding of the entire topic.

This review follows – as advocated by Fink (2019) – a thorough and circumspect methodology, which ensures that relevant studies of fairly good quality are included. Fink states that the literature review is essential, not just as a foundation but an essential linking mechanism in which the theory is combined, problems are pinpointed, and fresh ideas arise.

Following this methodological path allows the researchers not only to gain the appropriate depth and breadth of understanding required for a detailed analysis, but also puts their work in context with what others have done. This lets them pass on points of interest and divergence in theoretical terms, track voice in a scope of potential research directions for future inquiry. Finally, the literature review that this essay conducts sets a course for geographical research which is both

relevant to and participatory in the academic community's ongoing discourse on Nature-Based Solutions.

3.2.2 Stakeholders Engagement:

The method is unique in that it includes a mixed bag of stakeholders, from the village people and professionals such as Abram Ezzard. In essence, in terms of integration and respect for individual views, the approach meets minimal resistance. Reed et al's (2009) advocacy that in order to steer urban planning toward sustainability, both information of contemporary science and indigenous principles from history are essential along with the often-overlooked intangible cultural heritage.

The result is put forward as being an indispensable driving force for the creation of resilient urban ecosystems capable of enduring and responding to the sustainability-related challenges characteristic of any given geographical setting. This integrated methodological framework ensures that the details of local knowledge, scientific scrutiny, and environmental practice are fused together, cultivating an intellectual milieu in which sustainable urban planning may flourish. By recognizing and calling upon the collective wisdom and expertise of its extensive stakeholder network, this research hopes to contribute a robust and culturally sensitive model of sustainable urban systems to the academic dialogue, as advocated by Reed and his way of thinking.

3.2.3 Field Surveys and Inspections:

The empirical element of this study was assured through closely structured questionnaires. So too was meticulous evaluation in the field. Adhering to Babbie's (2016) methodological framework, this study makes use of a refined approach. It probes beneath surface observations into the realm of non-obvious to gain insight. This means that a strategy is adopted for methodically extracting data related to environment practices, Identifying the obstructions NBS methods currently face, as well as unravelling the most intricate factors that Influence their effectiveness.

Babbie’s research methodology helps to give rigor to this study, enabling it to strip out both quantitative and qualitative data from mute numerical factors as well as inlet Subjective Ones. This two-vision approach ensures a comprehensive understanding that is not based simply on observation but permeated throughout by the fine nuances of perception itself. Given this methodology, the study aims to map out the concrete conditions and hidden, subtly influential factors embedded in slim margin for NBS sustainability planning in towns and cities.

3.3 Analytical Methodology

This analytical methodology encompasses the following key components.

3.3.1 Quantitative Analysis:

The research verification phase involves the careful calibration of survey data with advanced statistical software offering an empirical examination of how effective Nature-Based Solutions (NBS) can be. And the statistical analysis methods employed take the idea from publications supported by Field (2013), which in fact become a treasure-trove for using social research within the context of statistical analysis.

Field's comprehensive guide investigates the subtleties in statistically based methodologies, with all manner of statistical analysis techniques featured. Using these statistical analysis procedures our research not only gives empirical weight to those theoretical discussions on NBS but also ensures that its findings are supported by solid, data-based evidence.

Field's method makes for a versatile analysis approach, finding and eliminating any newcomer bugs in the database or complex variable relationships, and revealing the underlying patterns when NBS is put into practice. By carefully applying the statistical methodologies suggested by Field, the resulting value of this vital resource is many times greater than its cost in terms of obtaining actionable insights and reasoned conclusions necessary for advancing the debate on sustainable urban development.

3.3.2 Qualitative Analysis:

In this study, qualitative methods are used to apply an angle on the cultural definition of essential stakeholders' experiences. Subsequent content analysis of interviewees' opinions and an inappropriate pair of collocations involving "one thing" on (place, therefore affordance singular) themes form the basis for this qualitative approach to architectural design study.

Oxford University Press The methodological guidance provided by Braun and Clarke (2006) gives a much-needed structure to these aspects of our research, enabling us to thoroughly examine texts as well. In addition, they try their utmost to deploy qualitative data, a rational system for categorization, transpiration, and development of themes. Their method is not just a technique but rather a channel through which to elicit rich and detailed insights into what stakeholders think of

sustainable housing. By adhering scrupulously to their thematic analysis method, the study reveals numerous determinants shaping stakeholder perspectives and experiences - from deeply held beliefs on sustainable housing to practical considerations bearing thereupon.

In a departure from merely painting a picture, the method Braun and Clarke brought to bear here allows one to interpret and report on these emergent themes which have been found in data. Such an extensive qualitative analysis is essential in sketching an accurate picture of the present situation and is important when looking to find what some of those infinity different insidious obstacles might be for adoption sustainable living ways. This is the kind of deep insight the study offers to our common understanding of sustainable housing.

3.4 The Implications of the Study

The architecture of this research design is minutely devised to make substantive contributions to urban development studies as Nature-Based Solutions (NBS) become integrated. In doing so, it leaves a distinct mark on debates about sustainable urbanism. It is especially felt in relation to the hard calls for support that Meerow and Newell make 2019 action brief. Their outstanding work highlights challenges facing urban systems New Challenges Economics Earth as local land processes such as floods and landslides seek adaptive responses to minimize their impact on the urban infrastructure — challenges that cannot be ignored.

At the heart of this design lies a global perspective on environmental science and sustainable development principles. Here design weaves together the empirical data with theoretical frameworks in order to put humanity on top of NBS, yielding new findings without ever leaving that long-term objective out of sight. The research seeks to provide a tapestry that not only accords with but also further develops discourse initiated by such eminent scholars as sustainability in urban areas.

Intermediating between theory and practice, this research hopes to show practically speaking how NBS can be applied, so that they become a real key component of sustainable urban planning. Such alignment is poised to help cities turn themselves into resilient models, capable of grasping with both natural and man-made challenges of the twenty-first century environmental juncture. The design's answer to both the burning questions of Meerow and Newell–of our age and time underscores its relevance, and tight focus on this critical area that poses today's daunting challenge

urban systems all over the world.

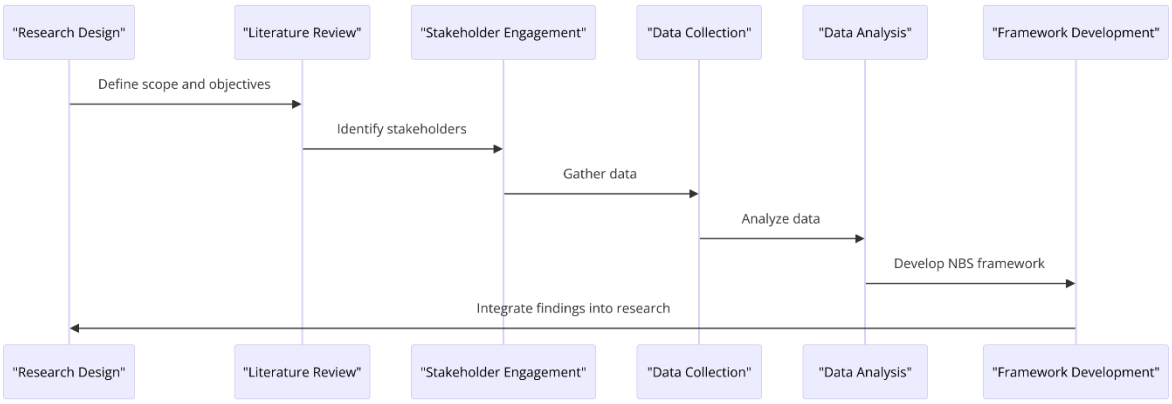

Figure 3.1: Research Design

Further this research design approach aims to fill knowledge gaps and foster the broader adoption and effective implementation of NBS, not only in Pakistan but also in other developing countries facing similar challenges (Saboor et al., 2017; Liu and Li, 2017; Chen et al., 2019b; Lilley, 2000; Chen et al., 2011; Wu et al., 2015).

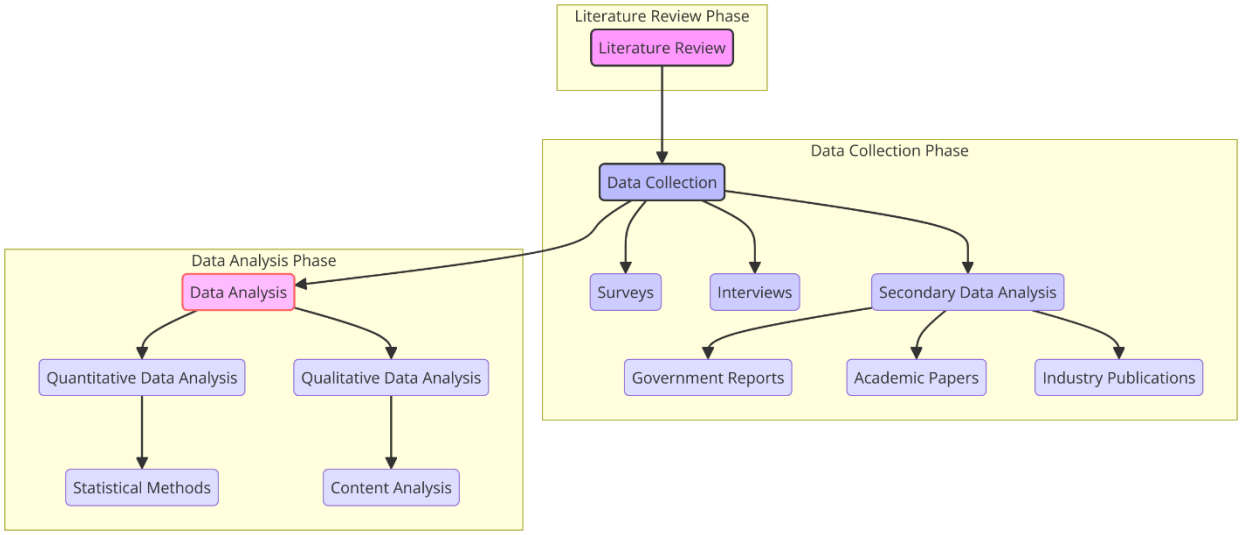

Figure 3.2: Research Flow

3.5 Case Study Areas:

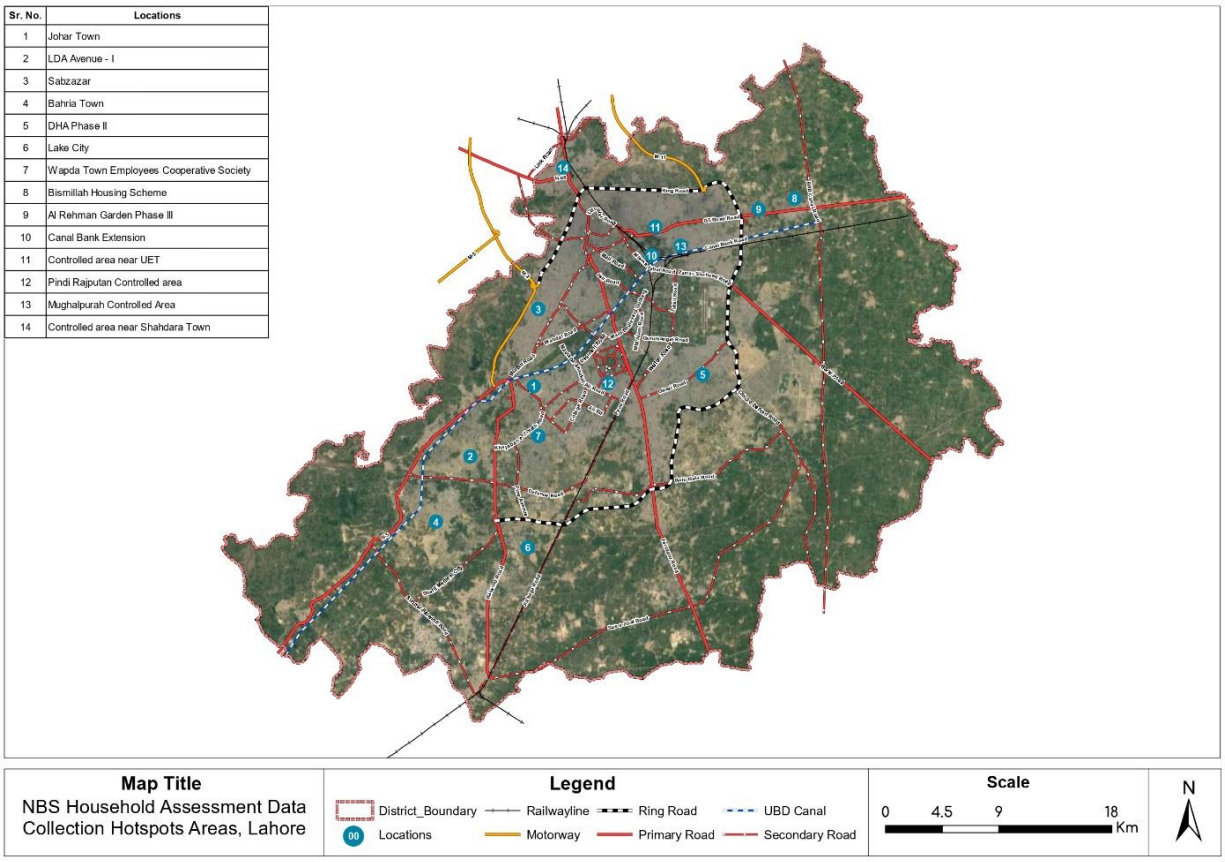

Figure 3.3: Case Study Area

Research framework is devised to explore the implications of Nature-Based Solutions (NbS), using Lahore as a pilot area for the study. Given the potential constraints that could significantly impact the research, a sampling model is utilized to gather essential information and trends. Data collection aims to ensure a diverse and comprehensive response by including various areas, income groups, and developer types (public and private). To ensure thorough coverage of Lahore, the following housing schemes have been selected:

1. Johar Town
2. LDA Avenue - I
3. Sabzazar
4. Bahria Town
5. DHA Phase II

6. Lake City
7. Wapda Town Employees Cooperative Society
8. Bismillah Housing Scheme
9. Al Rehman Garden Phase III
10. Canal Bank Extension
11. Controlled area near UET
12. Pindi Rajputan Controlled area
13. Mughalpurah Controlled Area
14. Controlled area near Shahdara Town

This selection is designed to capture a wide range of perspectives and trends across different parts of Lahore, facilitating a holistic understanding of NbS implications within the urban context.

3.6 Crafting of Questionnaire and Performa

To incorporate a range of perspectives in the dialogue, a Proforma is devised to gather viewpoints from development authorities, public sector entities, and private housing authorities using primary data, alongside structured interactions with households. This methodology is intended to offer researchers insights into perceptions around the implementation of Nature-Based Solutions (NbS). For each defined sector, three distinct Proformas are in development.

The questionnaires are sectioned into different parts, including respondent profiles. Sessions with identified stakeholders will explore inquiries about the awareness and implementation of NbS, implementation challenges, strategies for integration into policies, plans, and regulations for efficacious application, and issue identification in jurisdictions affected by environmental challenges such as flooding or drought. An open-ended question section is also integrated to elicit opinions and suggestions from the target demographics, proposing pathways forward.

3.6.1 Questionnaire Parameters

Some major parameters include

a. Environmental Sustainability

- Use of renewable energy sources

- Waste management practices
- Energy-efficient insulation systems.

b. Accessibility

- Infrastructure in place for differently abled individuals
- Availability of ramps and elevators
- Adherence to accessibility guidelines for public facilities.

c. Building Materials and Quality:

- Usage of sustainable construction materials
- Adherence to quality control standards
- Resistance to natural disasters like floods, storms, and earthquakes.

d. Cost-effectiveness:

- Affordability of housing units
- Long-term maintenance and operational costs
- Availability of financial assistance or subsidies.

3.7 Indicators

In the context of evaluating the efficacy of nature-based solutions within the housing sector, several indicators are pivotal for research. These indicators provide quantifiable measures of environmental impact, socio-economic benefits, and overall sustainability. They encompass energy efficiency, such as reductions in electricity usage; water management, tracking conservation and reuse; and waste reduction, assessing recycling rates and landfill diversions. Additionally, indicators measure the enhancement of green spaces, gauging increases in urban forestry and green cover, and resident well-being, including improvements in air quality and community satisfaction. These indicators collectively offer a comprehensive picture of the progress and outcomes of integrating nature-based solutions into urban development. Further list of indicators is given below.

- Plantation of trees

- Creation of Open Spaces
- Urban Forests
- Rooftop Gardening
- Water Treatment & Re-use
- Home Gardening
- Street-Scape
- Sewage Treatment Plan & Irrigation
- Rain water Harvesting
- Check Dams
- Limitation of Fossil Fuel usage
- Solar Power/Hydro Power
- Nature based city planning
- Nature based Building Design
- Planning for environment friendly transportation
- Master Planning & NB Housing Regulations
- Restoration of wetlands
- Recuperating corals
- Development/Restoration of mangrove forest
- Forest landscape restoration
- Community based coastal habitat restoration
- Reduction of the vulnerability of agricultural ecosystems
- Environment Awareness Campaigns
- Green-Grey Solutions for Urban Flooding
- Development of Agricultural land/Technologies

3.8 Sample Size Calculation

Sampling is a technique that helps in determining the sample size to be surveyed or to determine the population from which the data collection will be carried out. To conduct the study Yamane technique a simple formula is used. In this method statistical population is determined by dividing the number of household size by the Lahore population. Therefore, after deterring the statistical

population of 1,710,767. The margin of error is determined as 5%.

A high sample size is typically thought to be more reliable and authentic in scientific study, especially when dealing with unknowable variables. But this is also to blame for the wastage of time and money. The cost and time savings of a small sample size, however, come at the expense of some degree of uncertainty in the precision and accuracy of the results. The sample size for this study is determined using, keeping in mind the two extremes:

Yamane's formula

n= N/1+N(e^2)

Where,

n = Sample size

N = Population size= Margin of error

The nature of research is homogenous that provides margin to the researcher to have a relatively small research sample size to serve the purpose. Therefore, taking 95% confidence level, the sample size came out as 400. However, as per the discussion session with the supervisor, 450 questionnaires are planned to be conducted.

3.9 Identified institutions for Interview

NBS is a multifaceted idea that pertains to practically every aspect of life and has a direct bearing on how cities evolve. It includes three phases of work: Coastal habitat restoration, bringing nature into cities, and restoring forests and wetlands in catchments. For the overall benefits of NBS, stakeholders will be assisted by current research in restoring nature to urban areas. The purpose of conducting the research study is to understand the concept of NBS and devise suitable NBS for sustainable growth of the housing sector. To determine the purpose of this research plan, that aims to examine the extent of use of NbS in National, Provincial and Local Development Plans & Policies and devise suitable NbS for sustainable growth of the housing sector in Pakistan.

Therefore, the data collection will be carried out from three different divisions that includes the enlisted sectors and will help in determining the understanding level of NBS at various levels including Development Authorities, Private Developers and residents a pilot study is being carried out.

- Public sector
- General public
- Development Authorities

The list of institutes is created here.

Table 3.1: List of Institutes

Sr. No.	Name of Institutes
1	Lahore Development Authority (LDA)
2	Architecture Department
3	Provincial Disaster Management Authority (PDMA), Punjab
4	Environment Protection Agency (EPA), Punjab
5	Punjab Housing and Town Planning Agency (PHATA)
6	Punjab Central Business District Development Authority
7	Pakistan Environmental Protection Agency (PEPA)
8	Punjab Wildlife & Parks Department
9	Federal Government Employees Housing Authority (FGEHA)
10	Gujranwala Development Authority (GDA)
11	Ministry of Climate Change
12	Parks & Horticulture
13	Ravi River Urban Development Authority (RUDA)

When introduced into urban development schemata, the integration and application of Nature-Based Solutions (NBS) require progress to be continuously monitored. To execute content research online resources from pertinent institutions were analyzed. Using a Likert Scale that runs from 1 to 5, with 1 meaning minimal alignment with NBS principles and 5 strong alignments, this method quantitatively evaluates the promotion and transmission of NBS understanding. Common Gaps

This structured approach allows us to investigate in detail how organizations express, prioritize, and carry out NBS strategies as part of their urban planning and sustainability agendas exciting work can embellish some phases and omit others entirely, much as a painter brings brilliancy to a face while forgetting all else. It is every manager's duty to point out these possible pitfalls with his

men ahead of time. In accordance with the best practices identified by Boone and Boone (2012), this evaluative technique not only promotes a systematic evaluation of the resources at hand but also delineates how far institutions have embedded NBS within their programs for urban sustainability.

By incorporating a Likert Scale in this analysis, the researchers transform qualitative assessments into a form of measurable statistical data. In this way, assessments of progress may be measured by means of clear metrics. It can throw light on the state of NBS integration and, more significantly, reveal gaps exist in knowledge application or communication Quantifying the levels or degree of involvement with NBS guidelines in quite different types of institutional environments contributes new perspectives on how far NBS has evolved and how effective it is at the present time in laying the foundation for sustainable urban planning. Indeed, the methodology also underlines the dynamic nature of progress in this field, revealing patterns, advances, and the continued barriers. In this way, it provides a critical tool for stakeholders to assess the effectiveness of current policies and set future directions for ensuring the resilience and sustainability of urban environments in the era of NBS.

CHAPTER 4: REVIEW OF HOUSING RELATED POLICIES AND NBS

4.1 Results of interviews from public sector

In recent years, there has been a growing recognition of the importance of nature-based solutions for sustainable development, particularly in the housing sector. To gain insights into this crucial topic, interviews were conducted with experts from various public industries in Pakistan. The first interview was with an urban planner working for the Ministry of Housing and Works. He emphasized the need for integrating nature-based solutions into urban planning processes. According to him, incorporating green spaces and vegetation in housing developments enhances aesthetic appeal and provides numerous environmental and social benefits. He further highlighted the importance of using native plant species for their ability to adapt to local environmental conditions.

Moving on to the second interview, an environmental engineer from the Environmental Protection Agency shed light on the significance of sustainable water management in housing projects. She stressed the need to implement rainwater harvesting systems and use greywater for non-potable purposes. According to her, this approach reduces the burden on freshwater resources and helps maintain a balanced ecosystem.

The third interviewee was from a Ministry of Climate Change policy expert. He underscored the importance of incorporating climate-resilient designs and materials in housing projects. Mr Khan emphasized using eco-friendly building materials such as rammed earth and bamboo, which have a lower carbon footprint than traditional construction materials. He also highlighted the need for adopting passive design strategies that optimize natural lighting and ventilation.

Dr. Malik, an urban ecologist from the Pakistan Environmental Planning and Architectural Consultants, was interviewed next. He highlighted the significance of promoting biodiversity within housing developments. Dr Malik mentioned that incorporating green corridors and wildlife-friendly features can create a harmonious environment where humans and nature coexist. He further stressed the importance of involving local communities in conserving and managing green spaces.

The final interview was with an economist from the Ministry of Finance. She shed light on the economic benefits of nature-based solutions in the housing sector. Ms. Zara emphasized that investing in nature-based infrastructure reduces energy consumption, improves air quality, and reduces healthcare costs. She further highlighted the potential for job creation in green industries, such as developing and maintaining green spaces.

In conclusion, the interviews with experts from various public sectors in Pakistan emphasized the significance of nature-based solutions for sustainable growth in the housing sector. From urban planning to sustainable water management, climate-resilient designs, biodiversity conservation, and economic benefits, integrating nature into housing developments can lead to a more sustainable and resilient future. By following these approaches, Pakistan can pave the way for a greener and more sustainable housing sector, contributing to the overall sustainable development of the country.

4.2 Analysis of different departments' approaches:

This section presents a comprehensive overview of various departments and entities in Pakistan, outlining their respective laws/regulations, awareness regarding Nature-Based Solutions (NBS), their targets or focuses related to sustainability and environmental protection, and to what extent they are using NBS techniques. Here's an in-depth analysis:

4.2.1 Department of Economic and Social Affairs Sustainable Development (UN Pakistan):

Laws/Regulations: SDG Progress Report 2023 and GSDR 2023

Awareness regarding NBS: Yes

Target: The department recognizes reforestation and afforestation as effective NBS for flood risk management. These practices aim to reduce runoff and soil erosion, regulate water flow, and improve soil structure.

NBS based working: SDG 2023 Progress Report and GSDR 2023: Whole Range of Various Nature-Based Solution Systems However, the mentions of NbS in these reports only offer excerpts that are lacking detail. Overall, the focus of these reports is broad SDG achievements, challenges and that necessary actions for the future shall be vital.

The SDG Progress Report 2023 concludes that global efforts are on the verge of failure for the SDGs. The Covid-19 pandemic and thus further extended climate crisis added to this situation, as did an increase in confrontations between states. Numbers of people living in extreme poverty have gone up again this year; there is a danger of overshooting critical climate thresholds. Despite these setbacks, there have been some bright spots. Improving access to electricity and reducing under-5 mortality rates are two examples, showing how together we can achieve good change. This potential for collective action benefiting others relies upon a strong will from politicians and effective use of technology.

The GSDR 2023 insists that if the SDGs are to be achieved, then key transformations across all sectors are imperative and feasible; positive transformations are not only possible but necessary. It also emphasizes the importance of recognizing and navigating the complex interrelationships among social, environmental and economic needs to promote sustainable development. In these transitions there is a demand for stronger interfaces between science and policy making.

Yet, while the reports focus on the general challenges and achievements of the road ahead in achieving the SDGs, 'NBS' is implied within these goals on climate action (SDG 13), life below water (SDG 14), and life on land (SDG 15). NBS are needed if we are to fight climate change, maintain biodiversity and fulfill the needs of people by co-opting nature's power into solving social problems. Those solutions are critical if we wish to promote the resilience of ecosystems, absorb carbon, conserve biodiversity and secure people well into the future. This kind of gain is sustainable, both for nature and humankind itself (https://sdgs.un.org/, retrieved on 24-03-2024).

Evaluation on Likert Scale: Let us ponder an adaptable Likert scale assessment framework scaling from 1 to 5, where:

1. Very Limited Progress: Progress lags seriously in many realms, with numerous Development Goals demonstrating regression or stagnation.
2. Limited Progress: Marginal advancements are apparent, yet the overall pace is sluggish, and various targets are off track.
3. Moderate Progress: Noticeable progress in some Development Goals can be seen, with attempts towards coordinated policy and execution increasing, though obstacles stay sizable.

4. Substantial Progress: Robust advances in numerous Development Goals are achieved, with workable approaches, solid implementation strategies, and coordinated efforts leading to noteworthy improvements.
5. Exceptional Progress: Exceptional achievements cross most Development Goals are accomplished, with maintainable practices profoundly joined into national strategies, and the country is on track to meet or outperform the 2030 objectives.

For Pakistan, tackling the immense global challenges while striving to achieve the United Nations' Sustainable Development Goals requires determined action on numerous fronts. Some advancement has occurred through national attempts to integrate the SDGs into policies and establish institutional frameworks to support related initiatives. Additionally, leveraging new technologies shows promise to accelerate progress. However, reducing poverty, enhancing access to quality education for all, achieving greater gender parity, and ensuring environmental sustainability amid challenged circumstances remain steep uphills battles. Upon considering the acknowledged but limited successes to date in expanding energy access and improving some health outcomes matched against the substantial hurdles still ahead, a preliminary evaluation might reasonably rate Pakistan's overall advancement toward realizing the SDGs as falling somewhere within the range encompassing limited (2) to moderate progress (3). Continued perseverance across diverse sectors will be indispensable to further bettering conditions and more effectively addressing the diverse needs of its people.

4.2.2 Lahore Development Authority (LDA):

Laws/Regulations: LDA Building and Zoning Regulations (2019)

Awareness regarding NBS: Yes

Target: LDA mandates pedestrian walkways or green spaces in urban planning to enhance urban quality of life.

NBS based working: The LDA Building and Zoning Regulations of 2019 incorporated various nature-inspired solutions purposed towards advancing environmental sustainability within Lahore. Mandated in these regulations were practices like rainwater collection, rooftop gardens filled with foliage, and deciduous planting for towering constructions. Additionally, the regulations urged the transformation of requisite set-aside spaces in commercial regions into verdant areas and walking

routes to improve pedestrian mobility while simultaneously decreasing motorized travel, in this way contributing to an eco-friendlier urban landscape through reducing pollution and increasing oxygen generation (https://lda.gop.pk/website/, retrieved on 24-03-2024).

Evaluation on Likert Scale: According to the Lahore Development Authority Building Zoning Regulations 2019 including provisions for rainwater harvesting, green rooftops green areas accessible to all citizens walking communities, the rank would be given the LDA a 4 out of 5 assessments on Likert 's scale. This reflects their effort to incorporate ecological sustainability and natural strategy into urban development and is an important signal of how building construction planning can go green.

4.2.3 National Disaster Management Authority (NDMA):

Laws/Regulations: National Disaster Risk Management Framework Pakistan 2012

Awareness regarding NBS: Yes

Target: NDMA focuses on adaptation and mitigation interventions to address the risks associated with natural disasters.

NBS based working: Under the National Disaster Risk Management Framework for Pakistan, which was drawn up in 2007 with the participation of a variety of stakeholders, it aims to fashion a safe Pakistan. It advocates collaboration between different stakeholders, emphasizes vulnerability reduction, and enhancing the risk reduction capabilities of local communities. Combining modern scientific knowledge with traditional local expertise, it pays equal attention to technologies that are culturally, socially, economically, and environmentally relevant, as well as sustainable livelihood practice. It also focuses on acquiring the specific capacities that the country's hazard-risk profile demands and encourages international cooperation in disaster risk reduction (www.ndma.gov.pk/, retrieved on 24-03-2024).

Evaluation on the Likert scale: Taking into account the principles and aims of the National Disaster Risk Management Framework for Pakistan, which emphasizes collaboration among multiple stakeholders, building community resilience, sustainable practices, if it was to be rated on a cynical or quasi-Likert scale, one might sloppily tag the National Disaster Management Authority (NDMA) at 4 Points. This rating supposes that these principles are implemented

effectively into the practice of disaster prevention and reduction in Pakistan, demonstrating a strong country commitment to reducing vulnerability and enhancing communities' as well as nations' own ability to cope with natural disasters.

4.2.4 Ministry of Planning Development & Special Initiatives (MoPD&SI):

Laws/Regulations: National Adaptation Plan Pakistan 2023

Awareness regarding NBS: Yes

Target: The ministry aims to leverage NBS for managing climate risks, indicating a strategic approach toward climate resilience.

NBS based Working. In order to make the country more resistant to the extreme impacts of climate change, Pakistan's National Adaptation Plan (NAP) for 2023 is an important strategic document. Despite having one-twentieth the CO2 emissions of India and China, Pakistan finds itself in a position of vulnerability to many changes in its climate direction. This shift also marks something significant: It is a necessary first step towards curbing the adverse effects of climate change in Pakistan. The plan spans from 2023 to 2030 and outlines a comprehensive strategy that includes NbS and Ecosystem-based Solutions. It reflects Pakistan's commitment on climate vulnerabilities[filename-hashed] with international collaboration and funding mechanisms as its back weapon. (Centre for Strategic and Contemporary Research, 2023)

The NAP places strong emphasis on promoting NbS, action at the local level, strategic and evidence-based decision-making, and addressing areas critical to climate adaptation such as the agriculture-water nexus, natural capital, and urban resilience. However, despite this large-scale setting, many criticize the NAP for potential gaps in actionable steps; continuity with previous efforts; and reliance on foreign funding for its adaptation strategies. Focus shifts significantly here to detailed planning, involving stakeholders and financing mechanisms that are robust enough for initiating a successful national adaptation project. The NAP, in focusing on nature-based solutions, presents a sustainable path forward that requires implementation and widespread collaboration. (Centre for Strategic and Contemporary Research, 2023)

Likert based evaluation: Rating the Ministry of Planning, Development & Special Initiatives' efforts regarding the National Adaptation Plan 2023 involves a subjective assessment based on comprehensiveness, vision, framework, and engagement. Given available information:

The NAP exhibits meticulous structuring, addressing agriculture, water, nature, and urban areas impacted by climate change. Alignment with global goals and focus on natural solutions indicates a strategic adaptation approach.

It establishes a resilience-development vision, outlining priorities to mitigate impacts, especially on marginalized groups - a progressive, inclusive outlook.

While strategies are outlined, critique of action details and past integration suggests the framework could gain from fuller explanation and lesson incorporation.

Involving bodies like the Ministry of Climate Change and UNFCCC signals collaboration. However, criticism of consultation breadth implies engagement scope could widen.

Reliance on foreign funds and critique of financial planning raise questions about long-term resource sustainability within the NAP.

Based on the observations / considerations and without direct insight into the internal assessments or the outcomes of the NAP's implementation phases, an assumptive rating of 3 out of 5 could be considered appropriate. This acknowledges the plan's strategic direction and the critical areas it aims to address, while also recognizing the need for more detailed implementation frameworks, broader stakeholder engagement, and a robust financial strategy for its successful execution and sustainability.

4.2.5 National Energy Efficiency & Conservation Authority:

Awareness regarding NBS: No

NBS related working: The unmarked site of the National Energy Efficiency and Conservation Authority fails to explicitly denote files explaining the constructs of nature-mediated remedies within the milieu of their projects. Headed under the Ministry of Energy, NEECA essentially concentrates on initiating, catalyzing, and synchronizing energy protection actions crosswise diverse sections of the economy. Their initiatives and guidelines potentially include nature-dependent angles inside more extensive energy competency and preservation schemes, although

certain records on this facet are not directly sketched on their platform. For more elaborate intelligence, a visit to the NEECA formal website would prove beneficial. Alternatively, contacting their office may provide supplementary information on any documents related to green solutions and their integration within the organization's aims to boost sustainability via decreased consumption nationwide (https://neeca.gov.pk/, retrieved on 24-03-2024).

Likert based Evaluation: Evaluating NEECA's role in advancing natural climate solutions proves rather difficult due to their published works mentioning nature-based strategies sparingly, if at all. While NEECA prioritizes efficiency and conservation across many domains, accomplishing such aims could align with ecosystem-focused approaches. Regrettably, without overt documentation of direct involvement in natural-based solutions, rating their efforts poses a challenge. A more nuanced appraisal would require additional particulars outlining how NEECA actively fosters such work. So, based on these factors, it would be rated as 1 out of 5 on the Likert scale.

4.2.6 Laws/Regulations: Punjab Emergency Service Act

Awareness regarding NBS: Yes

Target: The goal is to establish healthy, resilient, and safer communities in Pakistan.

NBS based working: The Punjab Emergency Service Act, established under the banner of Rescue 1122, is designed to manage an array of emergencies efficiently and effectively within the populous Pakistani province of Punjab. This comprehensive approach toward emergency preparedness and response encompasses road accidents, medical crises, fires, as well as natural disasters, demonstrating the all-hazards framework adopted for timely assistance. Representing a significant evolution in emergency services across South Asia, Rescue 1122 provides an exemplary model of an integrated system optimized for coordination between various capabilities.

While the Act outlines the overarching structure of emergency management operations, the ingenious initiatives carried out by Rescue 1122, such as the pioneering Motorbike Ambulance Service leveraging nimbleness and rapid deployment, and the establishment of over five thousand community groups ready to assist in their neighborhoods, accentuate principles aligned with nature-based solutions. By leveraging community participation and resources strategically, resilience is fortified from the ground up through locally tailored efforts that supplement top-down coordination, reflecting the philosophy of harnessing natural and social capital.

Notable achievements as a result of this legislation include saving over fourteen million people in their hours of need and responding promptly when seconds count, preventing countless losses. The founding of the Emergency Services Academy in Lahore to consistently train and develop first responders underscores the long-term vision of cultivating an expert workforce equipped to serve the diverse needs of the population for generations to come, as highlighted by its certification as South Asia's first INSARAG team passing international standards (https://rescue.gov.pk/, retrieved on 24-03-2024).

Likert Scale Evaluation: Evaluating Rescue 1122 on a Likert scale from 1 to 5, specifically in the context of nature-based solutions (NBS), proves to be a nuanced task requiring careful consideration. Based on available information, Rescue 1122 has exhibited noteworthy accomplishments in emergency response through community engagement initiatives like Community Emergency Response Teams (CERTs) and innovative services such as motorcycle ambulances navigating congested areas. However, the reports do not explicitly cite inclusion of traditional NBS approaches such as ecosystem restoration or green infrastructure development. Strictly scoring Rescue 1122 solely on direct implementation of NBS may fail to fully acknowledge the full scope of their work and indirect contributions to fostering resilient societies and environments through community-focused, resource-efficient methods.

Given the absence of explicit reference to conventional NBS activities but with awareness of NBS principles within their community-centered, efficient solutions, a rating of 3 out of 5 on the Likert scale seems warranted. This acknowledges Rescue 1122's efforts building communal resilience and leveraging innovative solutions to emergency management aligned with broader NBS aims. It also recognizes the potential for more direct integration of NBS into strategies enhancing effectiveness in disaster risk reduction and climate change adaptation.

4.2.7 Pakistan Environmental Protection Agency (PEPA):

Laws/Regulations: The Pakistan Environmental Protection Act 1997

Awareness regarding NBS: Yes

Target: PEPA ensures compliance with environmental standards and promotes NBS to address environmental challenges.

NBS based working: The Pakistan Environmental Protection Act of 1997 marked a watershed moment for safeguarding nature in the South Asian nation. This groundbreaking legislation established a robust framework empowering myriad actors to collectively curb contamination and promote sustainability. It allocated duties to new agencies like the Council and EPA while directing existing ministries to strategize green initiatives and enforce strict but fair standards.

The Council coordinates national policies aimed at conservation and cleaner industries. They validate environmental benchmarks and wildlife security blueprints. Concurrently, the EPA implements the Act's provisions, plans policies and reports, and bears responsibility for myriad preservation tasks and authorities. Projects proponents must now submit impact reviews for agency approval before breaking ground or beginning operations to mitigate harm.

Additionally, an array of rules and rules have supplemented the Act to reinforce its articles in practice. This incorporates industry self-monitoring rules, sustainable development funding roadmaps, levies for polluting enterprises, and comprehensive environmental court regulations. Oversight also encompasses hazardous substance administration and cross-sector quality criteria.

Since 1997, the Pakistan Environmental Protection Act has driven important progress in addressing Pakistan's ecological crises through consolidated legal and institutional reforms. However, fully realizing its vision across government, businesses and communities remains critical for the future of both people and planet in this environmental crossroads nation (https://environment.gov.pk/, retrieved on 24-03-2024).

Likert based evaluation: Rating the Pakistan Environmental Protection Act (PEPA) of 1997 on a Likert scale from one to five regarding nature-based solutions introduces a nuanced assessment. The Act primarily establishes an environmental framework, outlining conservation, pollution management and sustainable development within Pakistan. It emphasizes regulating and managing ecological concerns including pollution control, environmental impact evaluations and safeguarding natural assets.

However, while PEPA forms Pakistan's legislative backbone for environmental governance, explicit references to integrating nature-based solutions into provisions remain unclear. Nature-based solutions utilize nature's power addressing societal challenges through restoring, sustainably managing and conserving ecosystems. Though indirectly supporting implementation by promoting

conservation and sustainable development, a clearer focus on nature-based solutions could strengthen its impact further.

Given PEPA's foundational role in establishing environmental standards, advancing sustainable development and regulating environmental impacts, in addition to implicitly supporting practices encompassing nature-based solutions, a rating of three (3) out of five (5) seems fitting. This acknowledges the Act's significant contributions to governance and potential underpinning future efforts more explicitly incorporating nature-based solutions within Pakistan's environmental policy and practices. Enhancements to explicitly include nature-based solutions in its framework or subsequent policies could elevate its effectiveness leveraging nature for societal benefits.

4.2.8 Punjab Wildlife & Parks Department

Awareness regarding NBS: Yes

Target: This department is dedicated to preserving wildlife and natural parks within Punjab, emphasizing conservation.

NBS based working: The Punjab Wildlife and Parks Department is deeply dedicated to conservation efforts, striving tirelessly to maintain balance within Punjab's natural habitats. Using diverse strategies, the department works assiduously to rehabilitate wildlife spaces, forcefully enforce anti-poaching laws, closely regulate hunting, and engage communities through education to cultivate a culture of preservation. The genesis of protected territories, wildlife breeding centers, sanctuaries, and wetlands plays a pivotal function in these endeavors, aspiring to safeguard varieties of species and reclaim endangered creatures.

The department's participation in expansive initiatives for instance the Ten Billion Tree Tsunami Program (TBTTP) demonstrates a considerable commitment to nature-based remedies. This ambitious project, aimed toward combating deforestation and climate change impacts, involves extensive tree planting and ecosystem restoration efforts across Pakistan. By concentrating on reforestation, afforestation, and conservation, the TBTTP seeks to enhance biodiversity, better air, and water quality, prevent soil erosion, and assist community livelihoods. The program aligns with global environmental commitments and represents a proactive approach to guaranteeing ecological balance and resilience in the face of climate change (https://pwl.gop.pk/conservation/, retrieved on 24-03-2024).

Likert based evaluation: Evaluating the multifaceted efforts of the Punjab Wildlife and Parks Department regarding nature-based solutions implementation demands a prudent assessment. Their documented endeavors, including restored habitats, anti-poaching enforcement, protected areas establishment and endangered species recovery programs, demonstrate a staunch commitment to preserving biodiversity and ecological balance. These undertakings directly align with NBS principles by capitalizing on natural processes and ecosystems for environmental and communal benefits.

Moreover, involvement in expansive initiatives, for instance the massive Ten Billion Tree Tsunami Program aimed at addressing deforestation and climate alteration underscores a proactive tactic of integrating NBS into conservation strategies. Such projects not only contribute to biodiversity enhancement but likewise offer abundant ecological boons involving climate regulation, soil erosion prevention and improved air and water quality.

Given this context, assigning a rating of four (4) out of five (5) seems suitable for the department's NBS-related efforts. This score recognizes their significant contributions to biodiversity conservation and ecosystem restoration within Punjab and their engagement in ambitious endeavors like the TBTTP exemplifying a forward-thinking approach to environmental stewardship. It also reflects room for ongoing enhancement and expansion of their NBS strategies particularly fostering broader community participation, bolstering monitoring and reporting mechanisms and scaling up thriving conservation models across diverse ecosystems within the province.

4.2.9 Forest Wildlife & Fisheries Department:

Laws/Regulations: Forest Act 2016

Awareness regarding NBS: Yes

Target: The Forest Act aims to protect forests from illegal logging and encourages reforestation to combat deforestation.

NBS based working: The Forest Act of 2016 likely prioritizes protection and sustainable management of forestry practices to maintain the health and resilience of forest ecosystems This approach accords with core principles in NBS by preventing the destruction of natural habitats,

preserving their ability to afford essential ecosystem services: Forests play a major role in sequestering carbon, thus contributing to the mitigation of climate change Furthermore, intact forest ecosystems help with climate adaptation. They act as a natural shield against climate impacts such as storms and flash floods, thus embodying NBS strategies for Disaster Risk Reduction.

Forests are also crucial for Water Security, affecting Hydrological but also maintenance of water quality and availability, all of which are key aspects in NBS Then there are the act's provisions for sustainable forest management, considering that livelihood can be pursued only if the forest is kept healthy. This underlines the social and economic justifications for NBS. As an embodiment of NBS, the act enhances the abiding environmental services provided by the forest which are so vital to human well-being and sustainable development. Such services include air and water purification, climate control, and maintaining soil fertility (https://pwl.gop.pk/, retrieved on 24-03-2024).

Likert based evaluation: According to the 2016 Forest Act, if Forest Wildlife and Fisheries Department gets 3.4 points out of 5 then they would be fine with that! This is associated with government policy conformity and reflecting a majority of natural ecosystems and biodiversity, (environmental protection). But there is room for improvement in implementing law or treaties; more emphasis needs to be put on enforcement measures enforcement ratio increase will be critical; while evidence revealing it works also speak for itself Community transmission channels provide multiple opportunities on NBS.

4.2.10 The Department of Forestry

Awareness regarding NBS: Yes

Target: The National Forest Policy guides this department in managing forest resources and promoting afforestation.

NBS based working: By collaborating and participating in many institutions, the Department of Forestry is an active servant in carrying out denaturalize solution (NBS) to take care of environmental problems in Pakistan. Under its umbrella of restoration and conservation, particular attention is paid to key ecosystems such as the unique Chilgoza thistle fir forest at Hindukush-Karakoram-Himalaya that offers protection for some ecologically hot bird species. These forests play not only an ecological role, but also have considerable benefits to the local populace by

providing pine nuts, medicinal plants and honey. Measures are taken to arrest this decline, including promoting sustainable methods and forming voluntary-based conservation committees under the auspices of communities to given management and protect these precious ecosystems.

In an inventive example from the Liberty Market urban forest demonstration project in Lahore, one can see an urban application of NBS. This project has turned a park into an urban forest teeming with biodiversity that not only filters out air pollution, helps counteract the heat island effect, and provides space for social interactions as well as natural enjoyment in areas where people live. The public-private partnership behind the forest, established using native species with rapid growth and high density following Miyawaki method, meanwhile contributes to both area biodiversity overall ecological health.

Forests are playing a critical role in mitigating climate change, for they absorb carbon emissions and provide both a sustainable development path consistent with international climate goals. Protecting forest habitats is crucial to protecting biodiversity and offering climate solutions. Nature-based solutions, like the conservation and sustainable restoration of ecosystems, are gaining recognition for their ability to make substantial contributions to climate change adaptation goals and the protection of biodiversity. They are both cost-effective and necessary if we are to meet commitments made at an international level such as those contained within the Paris Agreement: Hence a systematic approach be wanted for utilization as well as earn its own way echo-clock-tower but how can one get sustainable social benefits out of environment? (fwf.punjab.gov.pk, retrieved on 24-03-2024)

Likert based evaluation: Comparing the overall performance of the forest department in Nature-Based Solutions terms: On a scale from 1 to 5, assess their measures and projects consistent with NBS principles. These typically contain efforts to enhance ecosystem services, promote biodiversity conservation, help deal with climate change mitigation and adaptation, as well as sustainable community livelihood supports.

From their experience and insight deploying Nature-Based Solutions in such efforts as chilgoza pine forests conservation, crucial to ecological cohesion and local people's very living locally, or even the Liberty Market urban forest in Lahore, which themselves illustrate successful urban applications of NBS, the Forest Department of Pakistan seems committed to doing NBS across landscapes.

But with such considerations, marking the Forest Department 4 out of 5 looks justified. The mark notes its positive engagement in NBS projects. It acknowledges that NBS presence in Pakistan has much room for further expansion and deepening. It reflects an understanding of the importance for continual improvement and adjustment to strategies facing new environmental realities.

4.2.11 Ministry of Climate Change:

Laws/Regulations: Climate Change Policy 2021, National Climate Resilience, and Adaptation Plan 2023-2030

Awareness regarding NBS: Yes

Target: Pakistan's vision includes transitioning to renewable energy and electric vehicles by 2030, banning coal imports, and expanding NBS.

NBS related working: The Updated National Climate Change Policy (NCCP) and the National Climate Resilience and Adaptation Plan 2023-2030 are comprehensive frameworks aimed at steering Pakistan towards a climate-resilient and sustainable future. These policies make nature-based solutions (NBS) an integral part of Pakistan's climate action strategy.

For instance, the NCCP 2021 aims to make mainstream climate change across vulnerable economic sectors as well as promote sustainable growth by integrating national climate policies. It stresses adaptation and mitigation with a strong focus on pro-poor, gender-sensitive strategies that are visible throughout the entire system of action on all levels. One aspect is government-led programs such as the Ten Billion Tree Tsunami Program and the Prime Minister’s Urban Forest Project that aim to have 15% of Pakistan protected by 2023. Indeed, the NCCP seeks to move Pakistan in distinctive ways—toward environmentally resilient industries and towards more ecologically directed endeavors in terms of practice. The main objectives of the NCCP 2021 range from pursuing sustained economic growth while dealing with climate challenges, integrating climate policy with national policies, and promoting the country's transition to cleaner, lower emission, less carbon-intensive development.

Pakistan's National Adaptation Plan (NAP) is now being developed in addition to the NCCP 2021, with support from the UN Environment Program and funding by the Green Climate Fund. It is seen as an important mechanism through which to adapt to climate impacts by means of

comprehensive medium- and long-term planning embracing adaptation techniques within national policy. Nature-based solutions and ecosystem-based adaptation are part of Pakistan's climate resilience efforts at national level. For example, the Ten Billion Trees Tsunami Program, Ecosystem Restoration Fund and Recharge Pakistan all reflect this approach. All these efforts provide evidence of Pakistan's proactive stance in enhancing the adaptation part of its Nationally Determined Contributions (NDCs) under the Paris Agreement.

These policy frameworks and plans show that Pakistan is serious about mitigating the effects of climate change and using nature-based solutions as a cornerstone of its work on adaptation and resilience. Through research in ecosystem restoration, conservation of biodiversity, sustainable management of natural resources, Pakistan seeks to counter vulnerabilities in its various sectors-so as to ensue for the future one that is sustainable and resilient (https://mocc.gov.pk/index, retrieved on 24-03-2024).

Likert Scale Evolution: Nature based solutions are to be realized in concurrent with achieving five pointer grades this century at the Climate Change Ministry. Key points to consider include; Having a comprehensive strategic vision for the integration of NBS; The extent of initiatives aimed at Tackling precise environmental problems such as Ten Billion Trees Tsunami Program; And efforts towards ecosystem restoration and species protection.

Recognizing the Ministry's efforts, which include many enrichment campaigns not all in vain aimed at ecosystem regeneration, reforestation, now also into national climate adaptation and mitigation strategies NBS must be commended. These programs are not only for coping with climate change and the restoration of environmental pollution; deliver such benefits as more solid community structures from less susceptible disasters, living in harmony with modern civilization on nature's own terms.

Looking at the width of such initiatives, alignment with the international climate agenda and Pakistan's enhanced climate resilience through NBS approach to bundling environmental protection into its overall restoration project, it is appropriate to give an initial score. This score reflects Ministry's considerable efforts and strategic focus on utilizing NBS to tackle climate; And at the same time is also aware that implementation must go on, expanded further and involve more public participation categories in order to increase its overall effectiveness.

4.2.12 Wildlife Department:

Laws/Regulations: National Forest Policy, Biodiversity Action Plan

Awareness regarding NBS: Yes

Target: The department aims to enhance forest cover and biodiversity through afforestation and reforestation.

NBS based working: In the context of flood risk and climate resilience in Pakistan, the implementation of Nature-Based Solutions (NBS) involves shifts to lower-cost and more durable strategies in response to floods. Key NBS measures include reforestation, afforestation, restoration of wetlands and sustainable land management as well as green infrastructure. These initiatives not only aim at tackling flood risk from the bottom up but provide other benefits too: carbon sequestration, biodiversity conservation and better livelihoods. Such strategies signal Pakistan's intention to help flood risks through nature-based measures that enhance both ecosystems and community resilience.

Likert based Evaluation: Given the information available and considering the Wildlife Department's potential involvement in implementing nature-based solutions for climate resilience and flood risk management, a rating of 3 out of 5 could be appropriate. This rating acknowledges the importance of wildlife conservation in broader NBS strategies and recognizes room for enhanced integration and contribution of wildlife management practices to Pakistan's NBS initiatives. Further details and evaluations of specific projects would be necessary for a more precise rating.

4.2.13 Water and Sanitation Agency (WASA):

Laws/Regulations: The National Water Policy

Awareness regarding NBS: Yes

Target: WASA's focus is on integrated water resource management, increasing water use efficiency, and equitable water access.

NBS based working: According to the National Water Policy 2018, the Ministry of Water Resources It requires concerted efforts to ensure that Pakistan overcomes the serious challenges

facing its water sector. The policy is a “CALL FOR ACTION” and pronounces a “WATER EMERGENCY”, but it calls upon the people to prioritize areas where water is produced even if doing so takes many years and when funds for water besides the table have fallen into decline. This policy calls for continuity in water governance and water-sector skills to persist among different governments (wasa.punjab.gov.pk/, retrieved on 24-03-2024).

Likert based Evaluation: In the absence of detailed description of specific cases in which WASA made use of nature-based solution (NBS)it would be overly hasty to give a higher rating than 3 out of 5. This rating points out the potential, but perhaps underreported roles WASA is playing in sustainable water management, a vital part of NBS. At the same time, however, continued demand is made for clearer verification and larger spread over its actions. Even better documentation of its initiatives and corresponding promotion is called for here. For a more comprehensive evaluation, it is recommended that closer scrutiny be given to WASA's programs and plans.

4.3 Summary:

A unified approach towards the development of Nature-Based Solutions (NBS) is coming into view within government departments. It has three key objectives: improving and sustaining the livelihoods of people; conserving resources for future generations; providing local environmental and ecological benefits. The initiatives cover land and water resource sustainable management, reforestation, afforestation, and enhancement of biological diversity. These efforts demonstrate Pakistan's dedication to using natural processes for the good of society, despite challenges such as climate change and resilient ecosystems. Green infrastructure, improved water uses and equitable access to resources become the focus for these departments. Their strategies attune to global sustainability goals, born out of a sense for environmental protection and our obligations towards posterity.

The dataset comprises evaluations of various departments' progress towards sustainability and environmental goals on a Likert scale, ranging from "Very Limited Progress" to "Exceptional Progress." The Ministry of Climate Change showcases the highest level of achievement with an evaluation indicating "Exceptional Progress," underscoring its pivotal role and effective strategies in addressing climate change and environmental sustainability within the region. On the other end, the National Energy Efficiency & Conservation Authority received the lowest score, labeled as

"Very Limited Progress," pointing to significant areas for enhancement in energy efficiency and conservation efforts.

Most departments, including the Lahore Development Authority (LDA), National Disaster Management Authority (NDMA), and Punjab Wildlife & Parks Department, received evaluations of "Substantial Progress," reflecting a strong commitment to environmental and sustainability goals. However, a few, like the DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS SUSTAINABLE DEVELOPMENT (UN PAKISTAN), have been marked as having "Limited Progress," indicating room for improvement in integrating sustainability into their operations and policies.

This brief analysis highlights a general trend toward positive engagement with sustainability and environmental initiatives among the evaluated departments, though it also underscores the variability in progress levels and the need for targeted improvements in specific areas.

Table 4.1: Likert Scale Evaluation of all departments

Sr. No.	Department	Likert Scale Description	Details / Description
1	Department of Economic and Social affairs Sustainable Development (UN Pakistan)	Limited Progress	Limited to Moderate Progress: Progress varies across sectors, with some advancements but significant challenges remaining.
2	Lahore Development Authority (LDA)	Substantial Progress	Substantial Progress: Strong advances in environmental sustainability and urban planning.
3	National Disaster Management Authority (NDMA)	Substantial Progress	Substantial Progress: Significant strides in disaster management and risk reduction.
4	Ministry of Planning Development & Special Initiatives (MoPD&SI)	Moderate Progress	Moderate Progress: Noticeable efforts towards integrating SDGs and climate resilience but facing implementation challenges.
5	National Energy Efficiency & Conservation Authority	Very Limited Progress	Very Limited Progress: Sparse documentation and unclear direct involvement in NBS, highlighting a need for greater clarity.
6	RESCUE 1122	Moderate Progress	Moderate Progress: Acknowledges the importance of community resilience but lacks explicit NBS action.
7	Pakistan Environmental Protection Agency (PEPA)	Moderate Progress	Moderate Progress: Established environmental framework but needs more explicit inclusion of NBS.
8	Punjab Wildlife & Parks Department	Substantial Progress	Substantial Progress: Strong commitment to biodiversity conservation and ecosystem restoration.
9	Forest Wildlife & Fisheries Department	Progress	Just over Moderate Progress: Government policy conformity with nature ecosystems and biodiversity, with room for improvement in law enforcement.
10	The Department of Forestry	Substantial Progress	Substantial Progress: Positive engagement in NBS projects with room for further expansion and deepening.
11	Ministry of Climate Change	Exceptional Progress	Exceptional Progress: Comprehensive and strategic focus on utilizing NBS for climate action.
12	Wildlife Department	Moderate Progress	Moderate Progress: Importance of wildlife conservation in NBS strategies, with room for enhanced integration.
13	Water and Sanitation Agency (WASA)	Moderate Progress	Moderate Progress: Potential for sustainable water management, a vital part of NBS, but detailed cases are underreported.

CHAPTER 5: HH NBS ASSESSMENT

5.1 Overview

The literature reveals various economic, cultural, social, and economic impacts of urban spaces. Researchers have categorized these impacts into several key areas: environmental, socio-economic consequences, urban quality of life, the influence on stakeholders, and resident satisfaction within Lahore city. Specific issues identified include air pollution exacerbated by vehicle dependency, water pollution partly due to expanding non-permeable surfaces, the disruption or loss of vulnerable ecosystems (e.g., wetlands, wildlife corridors), shrinking open spaces, heightened flood risks, and the overall negative effects highlighted by residents' interviews. Notably, car dependency has deteriorated air and water quality and intensified fossil fuel consumption. The increase in motor vehicle numbers and a surge in population have led to unprecedented levels of car ownership in Pakistan's cities.

5.2 Profile of the respondents

Based on the information provided and considering the survey was conducted in Lahore city, the pie chart illustrates that a larger percentage of male respondents were interviewed compared to female respondents. The blue section of the chart, which is larger, represents 278 male participants, while the orange section represents 122 female participants. This visual suggests that approximately 69.5% of the survey participants were male, while about 30.5% were female, indicating a male-dominant participant group in the survey. As shown in graph 5.1.

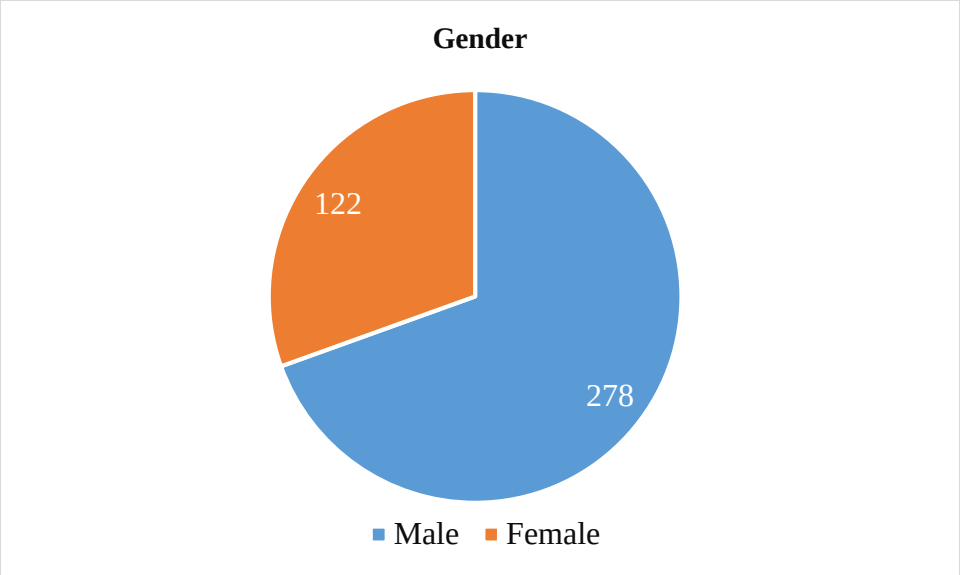

Figure 5.1: Gender Division

Table 5.1: Household Size

Range	Frequency	Percent	Valid Percent	Cumulative Percent
1-3	26	6.2	6.2	6.2
4-7	320	76.2	76.2	82.4
8-11	74	17.6	17.6	100.0

The household sized of the selected community rages from 1-3, 4-7, 8-11 people.

5.3 Awareness regarding Nature based Solutions

In recent years, the rapid urbanization and industrialization in Lahore have taken a toll on the environment, resulting in issues such as air pollution, water scarcity, and loss of biodiversity. To effectively tackle these problems, it is imperative to create awareness among the residents. The researcher asked the residents regarding awareness through survey, the results portray that 30-40% of the residents are aware of NBS. The respondents agree on the stance that citizens should be encouraged to participate actively in conservation through volunteering and community engagement programs (Depietri, Y. and McPhearson, T., 2017). By involving residents in tree plantation drives and clean-up campaigns, individuals can gain firsthand experience of nature-

based solutions' positive impacts on their surroundings. Residents can develop a sense of ownership and responsibility towards their environment through active involvement.

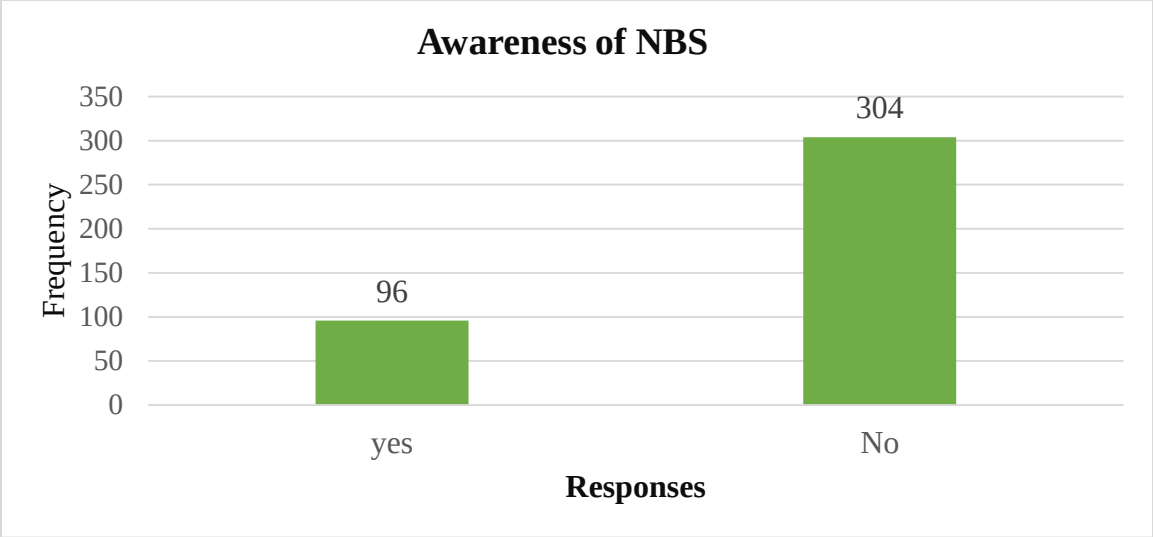

Figure 5.2: Awareness of NBS

5.4 Perception of people regarding implementing nature-based solutions

A sample of (n=400) was taken to record the response of citizens of Lahore city. The scale was 1 to 5 for all buildings, from very low (1) to very high (5). The two structures constituted two dependent variables; the first was to assess citizens' perception of environmental changes, socio-economic factors, stakeholder interventions and quality of life, and the second was to examine in what way the citizens thought the changes in the sample were observed. The constructs both showed a reliable reliability test value of 0.7 and 0.6 for the Cronbach alpha which revealed a high internal coherence level. Results of all assumed environmental and socio-economic factors are shown in tables respectively.

Involved parties have a huge effect on managing land use. They form and influence decision makers and laws on their dreams and culture (Subiros et al. 2016). Today, urban development is one of the causes of land loss and causes significant environmental, social and economic problems. These developments in rural areas are primarily due to shifts in lifestyle, cultures, mobility increase, house prices in urban centers, bad air quality, noise, tiny flats, unhealthy environments, green areas shortages, competition among municipalities, transport network growth and social problems. This however, depends significantly on residents' age and occupation (Pereira et al.,

2014). However, the opinion of stakeholders with regard to this position is very little understood. Stakeholders were asked to determine 1 to 5 by significance (1 = very low; 2 = low; 3 = medium; 4 = high and 5 = very high) of the question and asked the interviewers to evaluate. A general reliability study was performed to determine whether the characteristics of the respondent affected the rates assigned to the questions posed.

5.5 Relation between NBS and Environmental issues

An increasing number of roads and car parks are required to encourage a car transport system which causes increased water pollution from non-source sources and contamination of supplies of water (oil / gas runoff, metals, nutrients and organic waste, for example). This could have a potential effect on humans. Increased erosion or water supply causes environmental damage which can affect plants for water treatment and also affect water quality.

5.5.1 Statistics of Reliability

Table 5.2: Reliability analysis on environmental factors

Alpha of Cronbach	Alpha focused on structured pieces of Cronbach	Number of Items
.708	.725	4

Environmental Factors	Mean scale if Item is removed	Variance scale if object is removed	Complete item correlation corrected	Multiple squared correlation	Alpha of Cronbach if item removed
Less energy consumption reduces climate change impacts	5.39	9.295	.412	.292	.682
Human activities have no significant impact on global temperatures	5.13	9.474	.562	.453	.634
The rain water can be stored and recycled	5.36	8.812	.495	.386	.647
Pollution from industry should be tackle in environment friendly way	4.95	9.340	.492	.397	.651

The above analysis shows that environmental issues can be resolved by implementing NBS. NBS provides a viable solution for the conservation of biodiversity. Rapid urbanization and habitat destruction have led to a significant decline in plant and animal species diversity. By employing NBS, we can create green spaces within urban areas and restore degraded ecosystems, thus providing much-needed habitat for various species. Moreover, NBS supports the preservation and restoration of natural habitats, which in turn helps to conserve biodiversity on a larger scale. The table shows that values are significant at 0.5 which means the above highlighted issues need to be addressed to make a better environment.

5.5.2 Descriptive Analysis of Environmental Factors

The cities of Pakistan have been rising mainly on former agricultural land in recent years. Usually, urban growth and agriculture compete on the same land as rural fields adjacent to existing urban areas. Agricultural losses have important impacts on biodiversity as many animal species and particularly birds lose valuable biotopes (Haase, D., 2017). Spreading cities also risk consuming the best agricultural land, moving agricultural activities to both lower-producing areas (requiring higher water- and fertilizer-input) and more remote highlands (increasing soil-erosion risks).

Table 5.3: Gender vs Public responses for ”People should be made to reduce the energy consumption if it reduces climate change” Cross tabulation

Count		**People should be made to reduce the energy consumption if it reduces climate change**					**Total**
		Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**	
What is your gender?	Male	133	85	46	10	4	278
	Female	72	44	4	2	0	122
Total		**205**	**129**	**50**	**10**	**4**	**400**

Table 5.4: Gender vs Public responses for "Pollution from industry should be tackled in environmental friendly way" Cross tabulation

Count		Pollution from industry should be tackled in environmental friendly way					Total
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	
What is your gender?	Male	114	82	46	13	25	276
	Female	67	26	17	6	6	122
Total		**181**	**108**	**63**	**17**	**29**	**400**

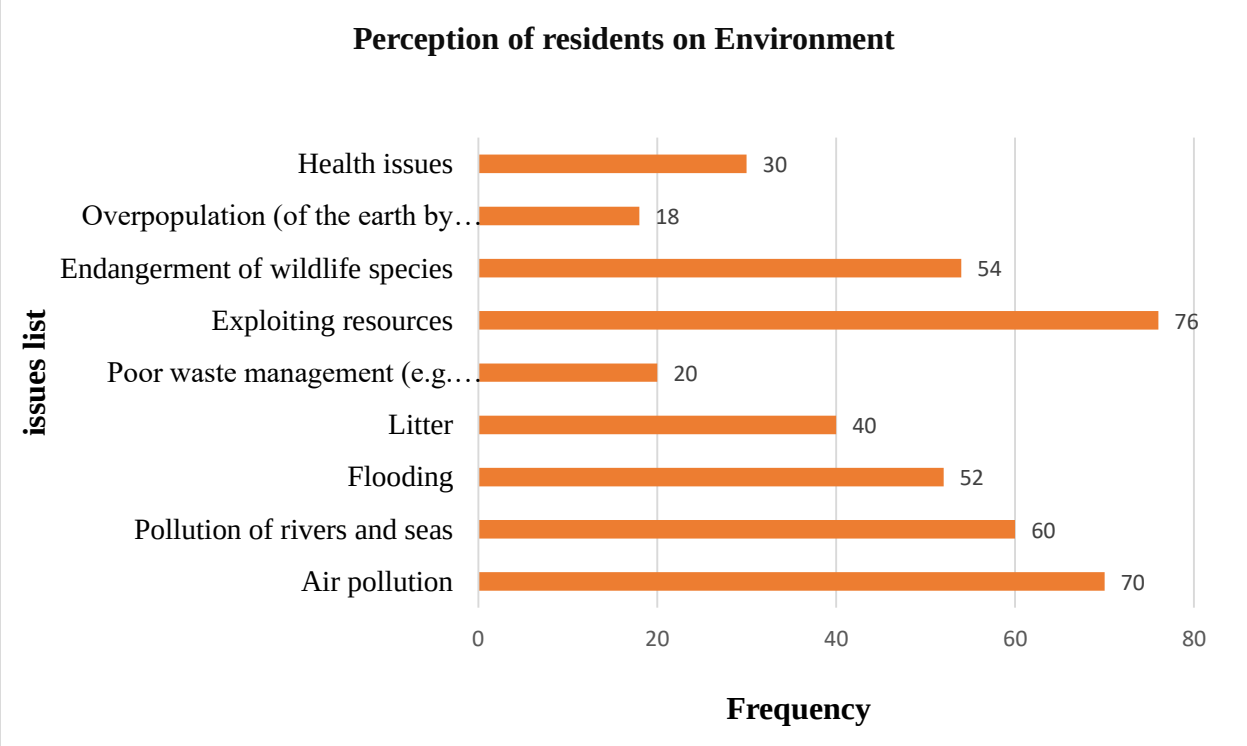

Figure 5.3: Environmental issues

Another critical environmental issue that can be tackled using NBS is mitigating climate change. Climate change has resulted in rising temperatures, extreme weather events, and increased greenhouse gas emissions. NBS offers practical strategies to reduce carbon emissions and enhance natural carbon sinks. For example, reforestation projects can absorb significant amounts of carbon dioxide from the atmosphere, acting as a natural carbon sequestration mechanism. Additionally,

the restoration of wetlands and the creation of green roofs can help mitigate the urban heat island effect, reducing energy consumption for cooling purposes.

Furthermore, NBS can play a crucial role in addressing water-related issues. Water scarcity and pollution have become major concerns worldwide. NBS provides innovative solutions for sustainable water management. For instance, implementing natural water retention measures such as constructed wetlands and permeable pavements can help regulate water flow, recharge groundwater, and filter pollutants. These measures ensure a more sustainable water supply and improve water quality.

In addition to the previously mentioned issues, NBS can contribute to tackling air pollution. Urban areas often suffer from high levels of air pollution caused by industrial activities, vehicle emissions, and other human activities. NBS interventions such as urban green spaces, vertical gardens, and green infrastructure can act as natural filters, improving air quality by capturing pollutants and releasing oxygen. This approach can significantly enhance the health and well-being of urban populations (Giachino, C.et al, 2022).

Moreover, NBS has the potential to address social issues related to the environment. Sustainable urban planning incorporating NBS can create vibrant and inclusive communities. Green spaces and accessible nature areas serve as recreational spaces for people, promoting physical and mental well-being. Additionally, NBS projects can provide job opportunities and skills development in areas such as ecological restoration, horticulture, and sustainable landscaping.

5.5.3 Relation between NBS and Socio-economic Needs of Citizens

From some kind of sociological perspective, urban sprawl creates more income separation in terms of housing growth. As a consequence, urban social and economic divisions can be intensified. In suburban and peripheral regions, the socio-economic character is characterized by medium and high incomes families with children who have the requisite mobility and lifestyle to operate in these communities effectively (Rink, D. and Schmidt, C., 2021). However, the suburban experience will vary widely and minimize social connections with the other classes, particularly the young and old who lack mobility and resources. Significant segments of urban society in these areas are furthermore excluded from living.

- Urban expand is at least a more expensive method of urban planning from an economic

perspective.

- Housing expenses on driving from home to work over longer distances.
- Congestion costs in extensive city centers with inadequate transit networks.

The additional expenses of urban infrastructure enlargement, including utilities in the urban area.

Table 5.5: Analysis on Socio-economic factors

Alpha of Cronbach	Alpha focused on structured pieces of Cronbach	Number of Items
.744	.742	5

Socio-economic factors	Mean scale if Item is removed	Variance scale if object is removed	Complete item correlation corrected	Multiple squared correlation	Alpha of Cronbach if item removed
Public spaces/Parks are a great source for social interaction & cultural cohesion	5.02	6.227	.561	.333	.678
Industry and business should be doing more to implement NBS	4.85	7.650	.370	.152	.745
Increased budget for transportation from home to work	4.78	6.551	.563	.364	.678
Provision of water and sewage facilities	4.83	6.853	.531	.345	.691
Sustainable solutions/NBS are economic friendly	4.88	6.837	.516	.292	.696

As cities proliferate, there is an increased demand for infrastructure and resources. However, this can lead to negative consequences such as environmental degradation and social inequalities. To tackle these concerns, NBS can be employed to create green spaces in urban areas, enabling improved air quality, enhanced biodiversity, and recreation opportunities. Additionally, through

NBS, urban areas can become more resilient to climate change impacts, reducing the vulnerability of disadvantaged communities. Furthermore, poverty eradication is a pressing socio-economic factor that requires immediate attention. By employing NBS, impoverished communities can benefit from ecosystem services, such as access to clean water and food security. Moreover, the implementation of NBS projects can generate employment opportunities, contributing to economic growth and social well-being.

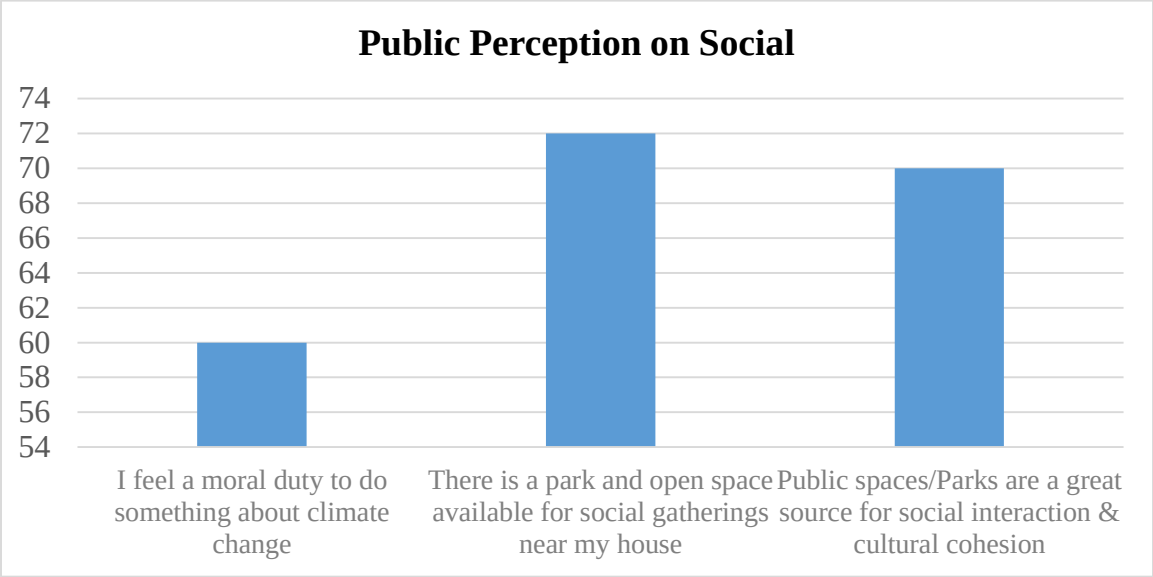

Figure 5.4: Descriptive Analysis of Social Factors

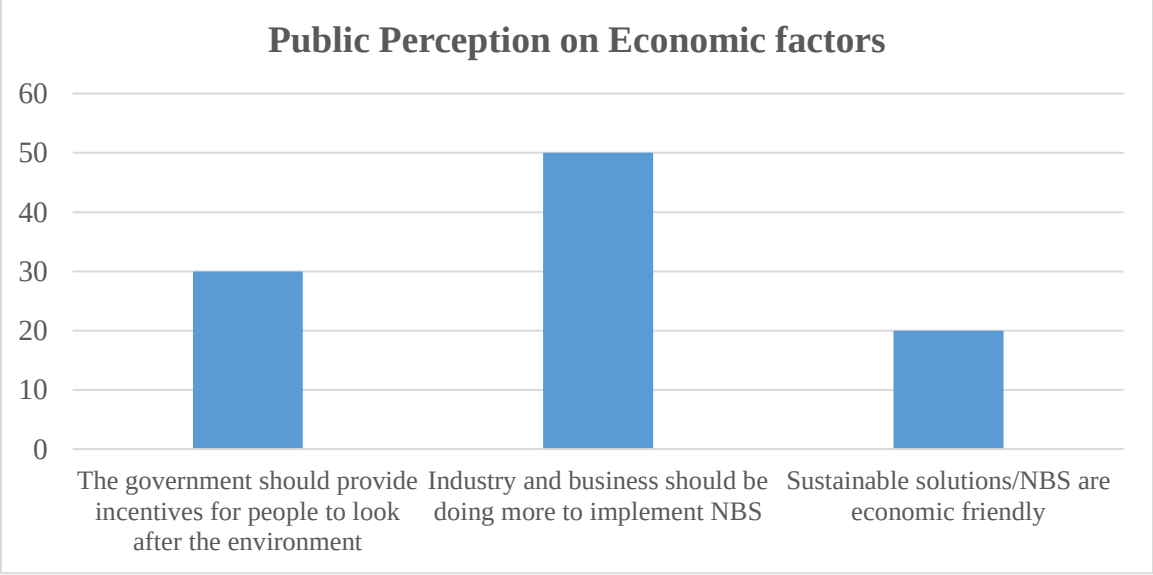

Figure 5.5: Descriptive Analysis of Economic Factors

Inequalities, particularly regarding access to resources and services, are another socio-economic factor that needs to be addressed. Active voice sentences like "NBS empowers marginalized communities" emphasize the role of NBS in promoting social justice. Through NBS, marginalized communities can access affordable housing, improved healthcare facilities, and better educational opportunities, thereby narrowing the gap between different socio-economic groups.

5.6 Relation between NBS and Wildlife Conservation

5.6.1.1 Statistics of Reliability

Table 5.6: Analysis on Wildlife

Alpha focused on structured pieces of Cronbach	Number of Items
.742	5

Wildlife	Mean scale if Item is removed	Variance scale if object is removed	Complete item correlation corrected	Multiple squared correlation	Alpha of Cronbach if item removed
Increase in respiratory problems/deforestation	5.48	5.931	.577	.444	.505
Habitat destruction is a primary threat to the continued survival of species	5.33	6.245	.438	.318	.557
Stop hunting to protect wildlife	5.44	6.933	.277	.222	.617
Public parks should be designed to protect animal and plant species	5.99	6.354	.453	.242	.553
Extinction of some species	5.15	6.812	.187	.162	.665

When a species becomes extinct, the intricate web of life is disrupted, leading to imbalances in nature's processes. Wildlife conservation is essential for its intrinsic value; every living organism has an inherent right to exist. To address this issue, Nature-Based Solutions encompass various strategies that work harmoniously with nature to address societal challenges as explained in the

table, By leveraging natural ecosystem services, NBS offers sustainable and practical remedies for wildlife endangerment. A significant advantage of NBS is its ability to restore and rehabilitate habitats, providing much-needed refuge for endangered species. These solutions can include habitat restoration projects, reforestation initiatives, and the creation of protected areas.

Table 5.7: Public Responses for question "I have noticed the extinction of some species?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	139	34.8	34.9	34.9
	Agree	135	33.8	33.9	68.8
	Neutral	100	25.0	25.1	94.0
	Disagree	18	4.5	4.5	98.5
	Strongly Disagree	6	1.5	1.5	100.0
	Total	**398**	**99.5**	**100.0**	

Table 5.8: Habitat destruction is primary threat to the continued survival of species

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	155	38.8	39.0	39.0
	Agree	143	35.8	36.0	75.1
	Neutral	66	16.5	16.6	91.7
	Disagree	20	5.0	5.0	96.7
	Strongly Disagree	13	3.3	3.3	100.0
	Total	**397**	**99.3**	**100.0**	
Total		**400**	**100.0**		

Table 5.9: Public parks should be designed to protect animal and plant species

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	184	46.0	46.2	46.2
	Agree	116	29.0	29.1	75.4

		Frequency	Percent	Valid Percent	Cumulative Percent
	Neutral	69	17.3	17.3	92.7
	Disagree	15	3.8	3.8	96.5
	Strongly Disagree	13	3.3	3.3	99.7
	14.00	1	.3	.3	100.0
	Total	**398**	**99.5**	**100.0**	

Table 5.10: Sport hunting should not be encouraged in order to protect the wild life

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	180	45.0	45.2	45.2
	Agree	97	24.3	24.4	69.6
	Neutral	69	17.3	17.3	86.9
	Disagree	27	6.8	6.8	93.7
	Strongly Disagree	25	6.3	6.3	100.0
	Total	**398**	**99.5**	**100.0**	

It is crucial to highlight that NBS empowers local communities and fosters their engagement in conservation efforts. By involving indigenous peoples and local communities in decision-making processes, their invaluable knowledge and expertise can be utilized effectively. Local communities play an instrumental role in monitoring and managing wildlife populations, as their traditional practices often reflect sustainable resource management techniques. Emphasizing local ownership and participation in conservation can lead to more successful outcomes and long-term sustainability.

It is vital to acknowledge some of the current NBS initiatives being implemented to combat wildlife endangerment. For instance, several organizations work tirelessly to restore degraded habitats by planting native vegetation and reintroducing keystone species. Additional efforts focus on reducing human-wildlife conflict through community-based conservation programs that provide alternative livelihood opportunities for local communities dependent on natural resources.

5.7 Residents Preference on Implementation of NBS

Implementing Nature-Based Solutions (NBS) relies on various stakeholders who can bring about change, foster innovation, and promote sustainable development. These actors encompass multiple individuals, organizations, and institutions, each with unique roles and responsibilities. By understanding the diverse range of implementers, we can better comprehend the intricacies of facilitating NBS projects. The researcher asked the public about the responsibility of implementing NBS, the results are shown in figure 5.3.

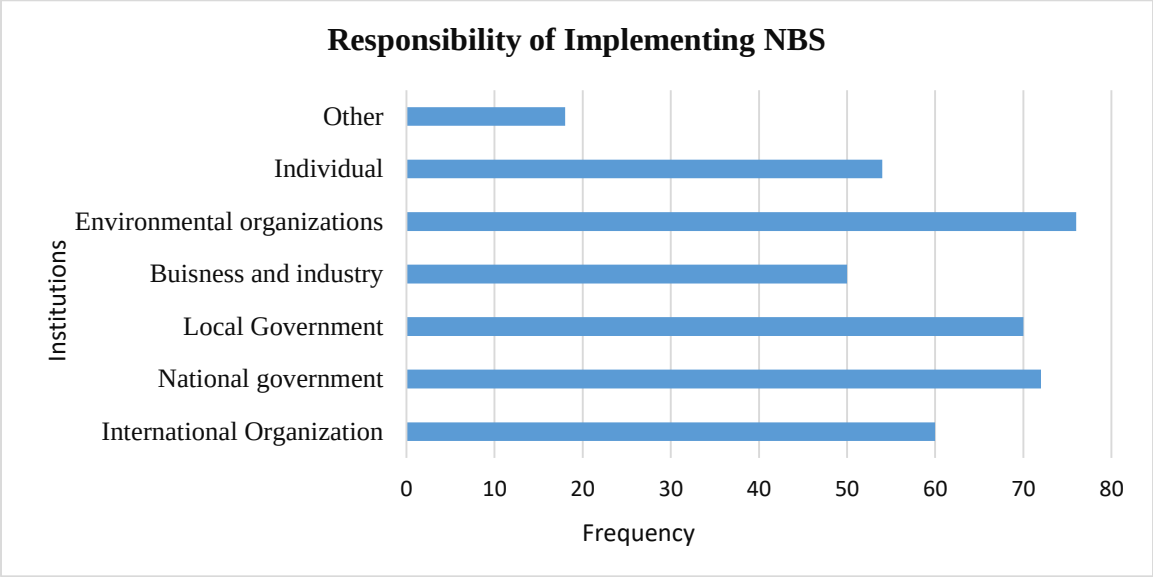

Figure 5.6: Responsibility of Implementing NBS

Firstly, local governments play a pivotal role in executing NBS initiatives. As key decision-makers within their respective jurisdictions, local authorities can mobilize resources, allocate funding, and establish policies that encourage the adoption of nature-based strategies. By prioritizing sustainability and environmental considerations, city councils and municipalities can lead by example and inspire other entities to follow suit (Voskamp, I.M. 2021). Furthermore, these governmental bodies often collaborate with other stakeholders to facilitate the successful implementation of NBS projects.

Likewise, non-governmental organizations (NGOs) also play a crucial part in ensuring the realization of NBS. These organizations, driven by a strong sense of advocacy and community engagement, often act as catalysts for change. NGOs foster community participation through their expertise and grassroots initiatives while bridging the gap between residents and policymakers. By

facilitating dialogue and promoting consensus-building, NGOs empower communities and reduce the initiation of NBS interventions (Baldwin, J. et al.,2019).

The private sector constitutes another critical implementer of NBS. Companies across industries can contribute to sustainable development by incorporating environmentally friendly practices into their operations. Through corporate social responsibility initiatives, businesses can invest in nature-based projects, such as reforestation efforts or implementing green infrastructure. Beyond direct financial contributions, the private sector can also collaborate with research institutions and provide innovative solutions that further the advancement of NBS.

Educational institutions also have a significant role to play in implementing NBS. Universities and research centres can contribute through knowledge generation, conducting studies that enrich our understanding of nature-based approaches. By fostering interdisciplinary collaborations and providing training programs on NBS, academic institutions equip future generations with the skills to drive change. These educational establishments can also act as hubs for technological innovation, incubating ideas that translate into practical applications of NBS (Albert, C. et al., 2021).

Community-based organizations (CBOs) are integral actors in the implementation of NBS. Rooted in their local context, CBOs intimately understand community needs and priorities. Their proximity to the affected areas enables them to mobilize resources and engage directly with residents in planning and executing NBS interventions (Arlati, A.,2021). By leveraging local knowledge, CBOs can ensure that NBS strategies align with the communities' aspirations and unique characteristics. Lastly, international organizations and funding bodies are pivotal in implementing NBS globally. Organizations such as the United Nations Environment Programme (UNEP), the World Bank, and regional development banks provide financial support, technical expertise, and policy guidance to countries pursuing nature-based approaches. By pooling resources and coordinating efforts, these entities enable the dissemination of best practices, capacity-building, and knowledge-sharing to countries and regions facing environmental challenges.

5.7.1 Residents Willingness to contribute in implementing NBS

The willingness to contribute to the environment can manifest in various forms, including personal

lifestyle choices, community involvement, and institutional change. Individually, being mindful of our consumption patterns and adopting sustainable practices can contribute to environmental conservation efforts (Khan, N. et al.,2019). Simple actions like reducing plastic usage, conserving water and energy, recycling, and supporting local produce contribute in significant ways to the overall well-being of our planet. Furthermore, spreading awareness and educating others about the importance of environmental preservation can inspire collective action and create a ripple effect.

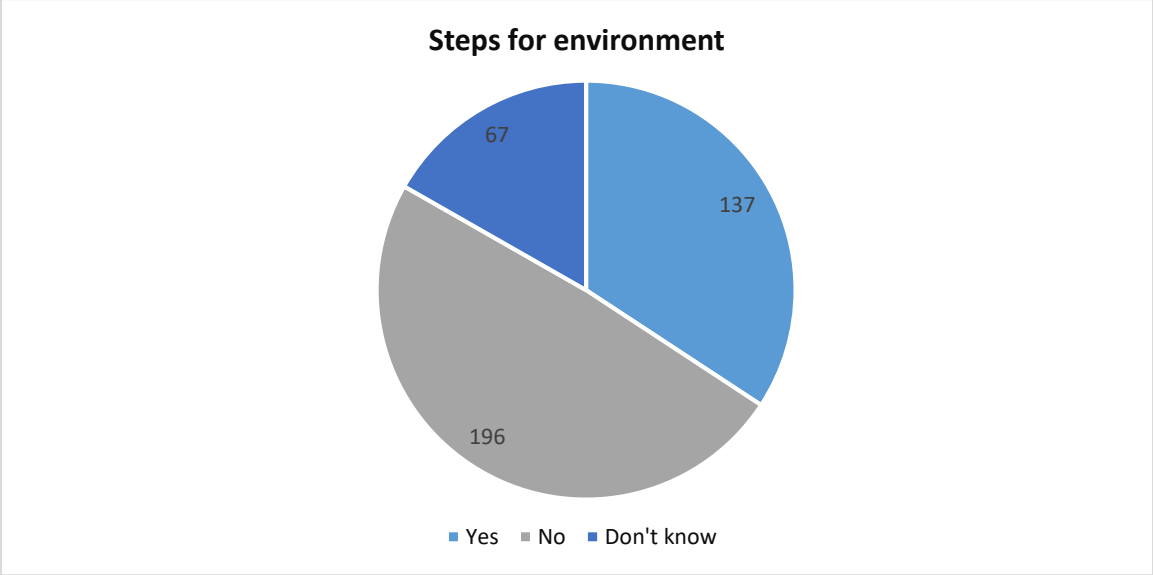

Figure 5.7: Steps for Environment

In terms of community involvement, participating in local campaigns, volunteering for organizations dedicated to environmental causes, and actively engaging in discussions and activities can have far-reaching effects. By collaborating with like-minded individuals, we can pool resources and knowledge to implement impactful projects such as tree-planting drives, beach clean-ups, or educational workshops to promote sustainable living practices. This collective effort amplifies our willingness to contribute to the environment and creates a sense of unity among individuals with shared values.

Table 5.11: Mean/Std. Deviation for public response to opt sustainable practices?

	Mean	Std. Deviation
People should be made to reduce their energy consumption if it reduces climate change	4.31	.896
Human activities have significant impact on global temperatures.		1.527
Planting a tree is also a type of NBS	4.27	.928
I should turn off the lights in my house when not in used	4.37	.920
The rain water should be stored and recycled	4.06	1.132
Pollution from industry should be tackle in environment friendly way	4.06	1.159

Moreover, institutional change is also vital in addressing environmental issues on a large scale. By advocating for policy changes to favor renewable energy sources, lobbying for stricter regulations on pollution control, and promoting green technologies, we can influence and shape the decisions made by governments, corporations, and institutions. Encouraging businesses to adopt sustainable practices and incorporating environmental education into school curricula are additional ways in which willingness to contribute to the environment can be nurtured and commemorated. Majority of the respondents were willing to contribute in the steps taken by government for the betterment of the environment.

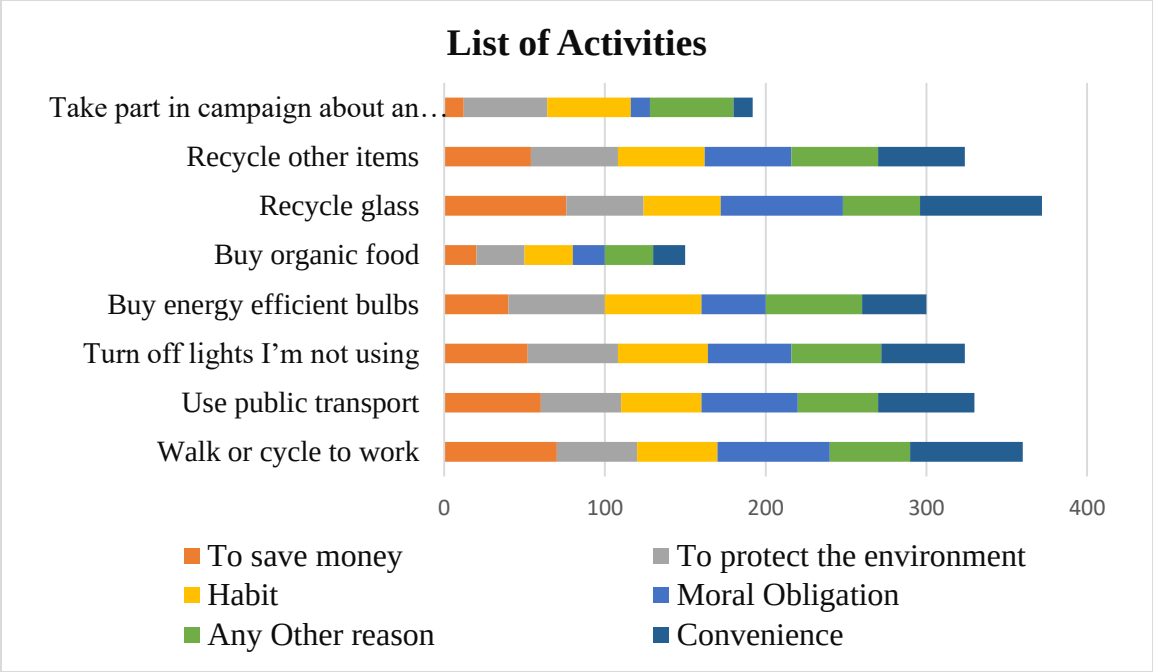

Figure 5.8: List of activities.

The figure shows that willingness to contribute to the environment is an essential responsibility all share. Through combined efforts, small and large, one can create a lasting impact and ensure a sustainable future for existing and generations to come.

5.7.2 Human activities have significant impact on global temperatures

Human activities such as burning fossil fuels and deforestation have a profound impact on global temperatures. These actions release greenhouse gases into the atmosphere, trapping heat and causing the Earth's temperature to rise at an alarming rate. Additionally, industrial processes and agricultural practices also contribute to the increase in greenhouse gas emissions, further exacerbating the problem.

Table 5.12: Impact of Human activities on Global Temperature?

Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	146	34.8	34.8	34.8
Disagree	88	21.0	21.0	55.7
Neutral	43	10.2	10.2	66.0
Agree	68	16.2	16.2	82.1

Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Agree	75	17.9	17.9	100.0

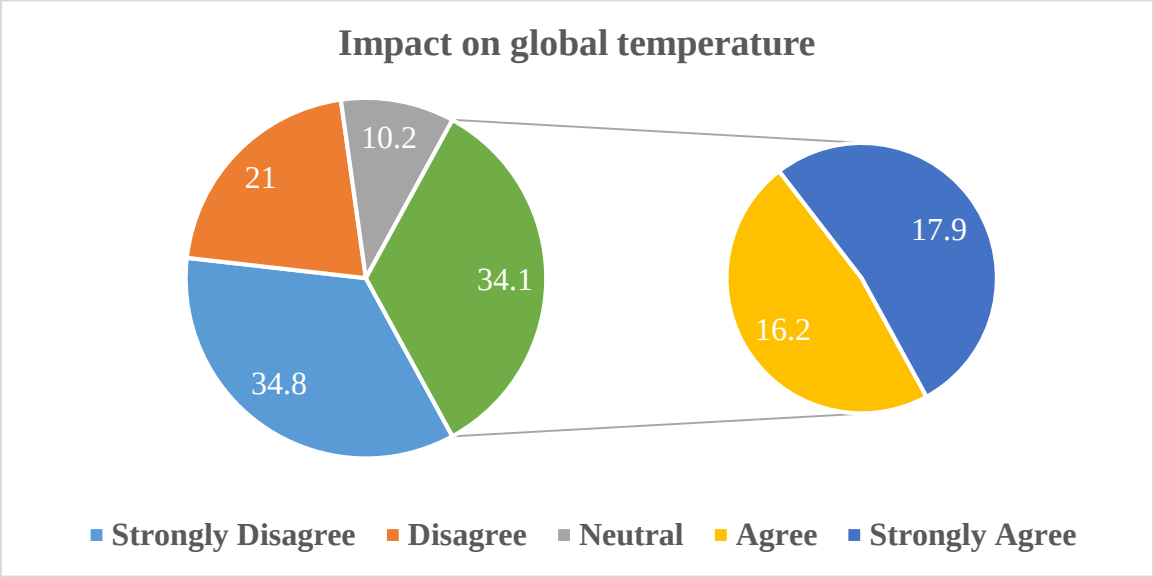

Figure 5.9: Public response: Impact of Human Activties on Global Temperature ?

Table 5.13: Walk or cycle to work

Indicator	Frequency	Percent	Valid Percent	Cumulative Percent
Convenience	110	26.2	26.3	26.3
To save money	80	19.0	19.1	45.3
To protect environment	61	14.5	14.6	59.9
For my health	122	29.0	29.1	89.0
Moral Obligation	20	4.8	4.8	93.8
Other reasons	7	1.7	1.7	95.5
Habit	19	4.5	4.5	100.0

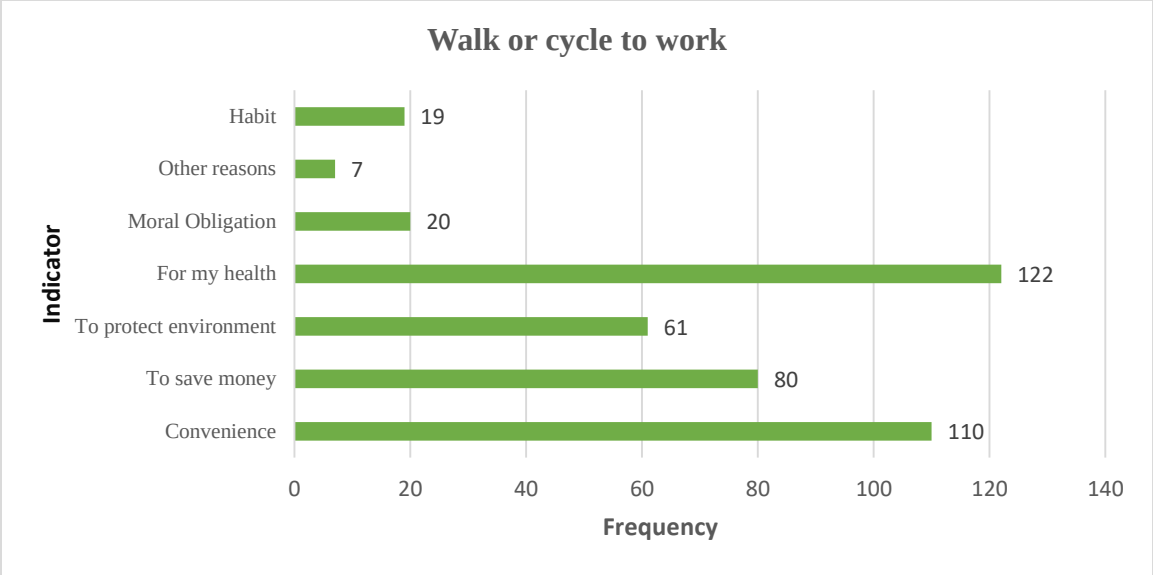

Figure 5.10: Reason to Walk or Cyle to Work

According to the Analysis, 30% of the people agree that they walk or cycle because they feel convenient. 30% of the people do it because of health concerns. 20% people walk or cycle because it save money, 15% of the residents only do it to protect environment. Walking and cycling are both eco-friendly modes of transportation. In addition, they improve physical fitness and overall wellness. It can save people money on transportation costs, assist reduce traffic congestion in congested places. Another reason people opt to walk or cycle is the sense of freedom and independence they get.

Table 5.14: Use of public transport

Indicator	Frequency	Percent	Valid Percent	Cumulative Percent
Convenience	110	26.2	26.2	26.2
To save money	195	46.4	46.4	72.6
To protect environment	60	14.3	14.3	86.9
For my health	14	3.3	3.3	90.2
Moral Obligation	7	1.7	1.7	91.9
Other reason	11	2.6	2.6	94.5
Habit	23	5.5	5.5	100.0

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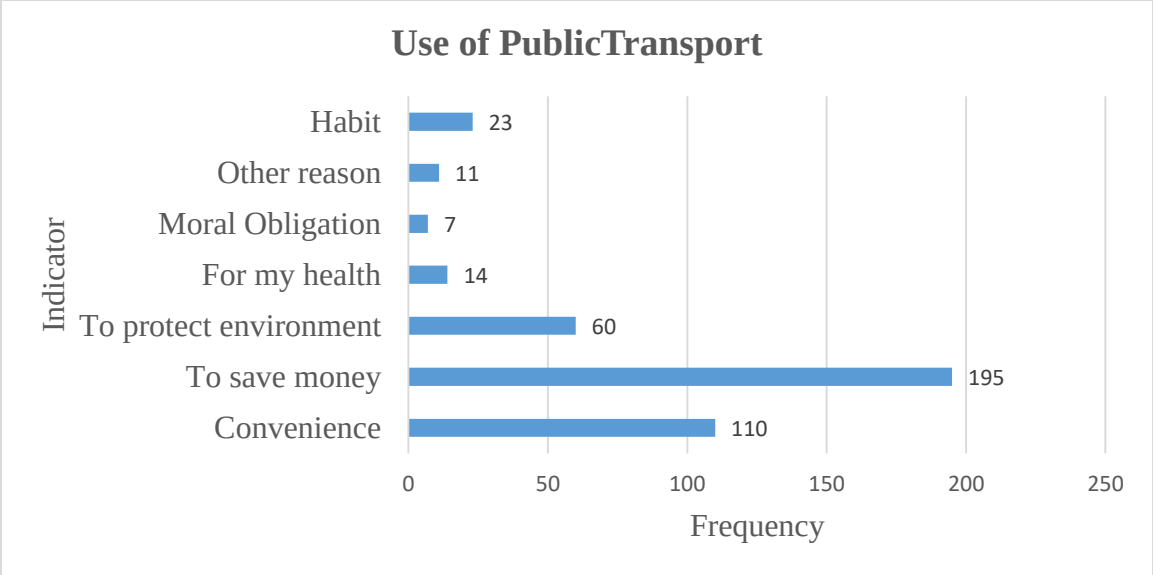

Figure 5.11: Reason for Use of Public Transport

According to the results, shown in table and graph 26% people use public transport because it is convenient. Most of the people approx. 45% use it because it is cost effective. Residents use public transport because it is affordable and helps to decrease automobile congestion on the highways. In addition, public transportation is a more environmentally responsible option than driving a private vehicle. Public transportation enables simple access to many sites inside a city. Residents can use public transportation to avoid the trouble of locating parking in congested regions. Public transportation is a safer option for those traveling alone, especially at night.

5.7.3 Rain water stored and recycled

The rain water should be stored and recycled

Table 5.15: Rain water stored and recycled

Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	23	5.5	5.5	5.5
Disagree	19	4.5	4.5	10.0
Neutral	61	14.5	14.5	24.5
Agree	122	29.0	29.0	53.6
Strongly Agree	195	46.4	46.4	100.0

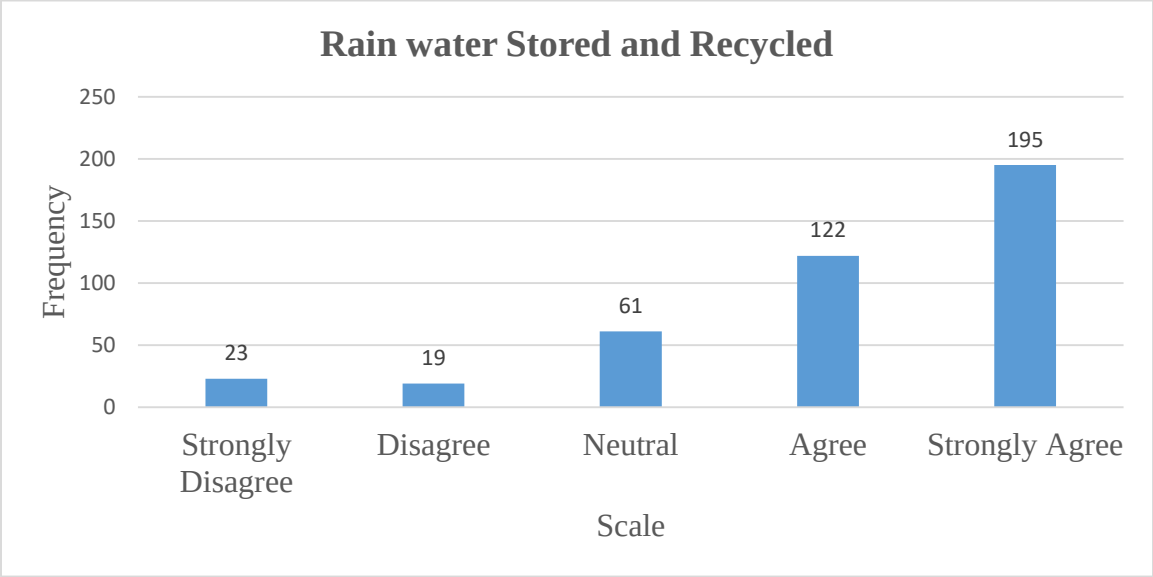

Figure 5.12: Public Perception on Rain Water to be stored and recycled

Rainwater collection has gained popularity in recent years. 46% residents strongly agree on the fact that rainwater should be recycled as more people become aware of the environmental benefits of this technique, there is an increased demand in installing rainwater harvesting systems in homes and businesses. This shift in mentality reflects a stronger emphasis on sustainability and conservation. Rainwater collection is a critical practice that should be adopted by society. This initiative's success is heavily dependent on public perception. By storing and recycling rainwater, we may lessen our reliance on traditional water sources, thereby saving important resources.

5.7.4 Industry and business doing more to implement NbS

Table 5.16: Public Response for "Industry and Business should be doing more to implement NBS?

Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	14	3.3	3.3	3.3
Disagree	23	5.5	5.5	8.8
Neutral	73	17.4	17.4	26.2
Agree	142	33.8	33.8	60.0
Strongly Agree	168	40.0	40.0	100.0

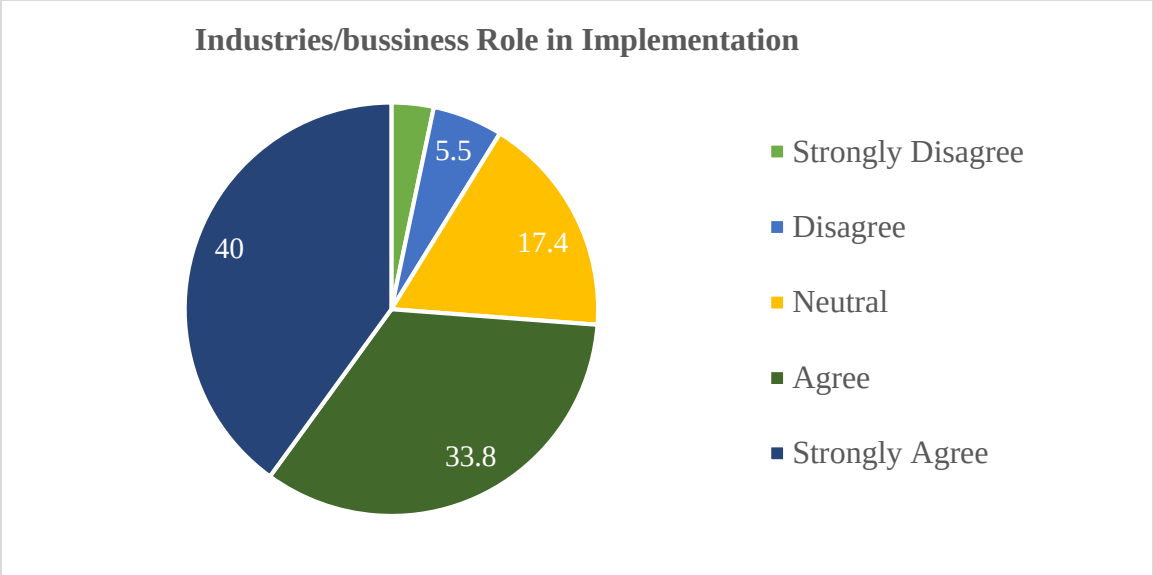

Figure 5.13: Industries/Business should play their role in NBS implementation

40% of the people strongly agree that Implementing NBS in industry and business allows to sequester carbon dioxide from the atmosphere. Companies can offset their carbon emissions and mitigate climate change by implementing natural processes. This not only benefits the environment, but it also enables businesses to accomplish their sustainability objectives and demonstrate their commitment to lowering greenhouse gas emissions. Businesses can safeguard the long-term health of ecosystems that supply vital resources such as clean water, pollination, and soil fertility by preserving natural habitats and promoting biodiversity. This benefits not only the environment, but also the local residents that rely on these resources for a living.

5.7.5 Sustainable solutions/NBS are economic friendly

Table 5.17: Sustainable solutions/NBS are economic friendly

Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	13	3.1	3.1	3.1
Disagree	20	4.8	4.8	7.9
Neutral	84	20.0	20.0	27.9
Agree	140	33.3	33.3	61.2
Strongly Agree	163	38.8	38.8	100.0

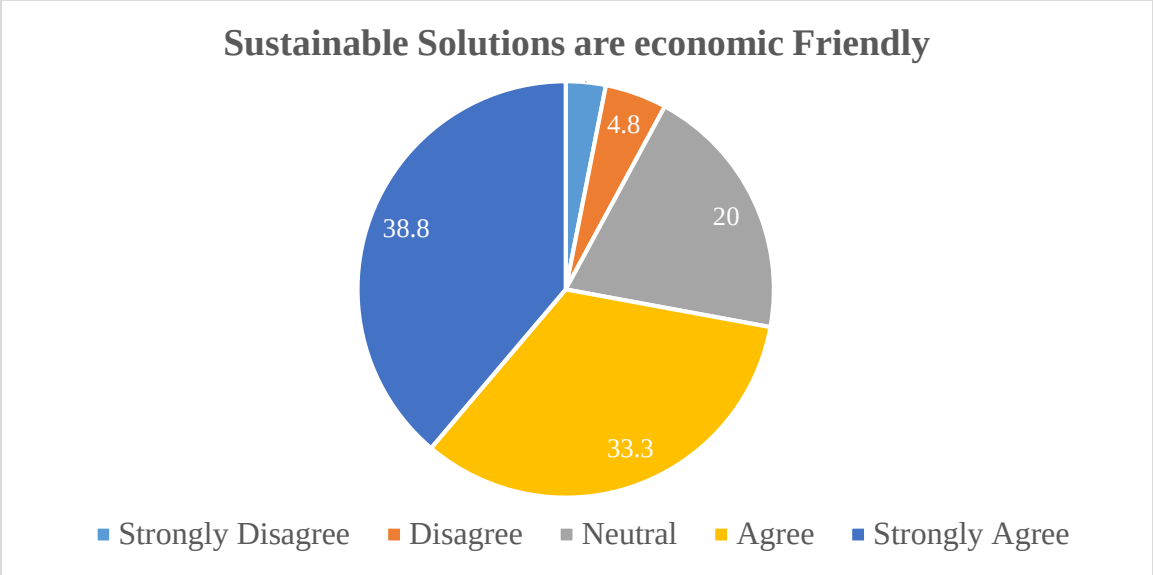

Figure 5.14: Sustainable Solutions are economic friendly (Public Perception)

40% of the residents strongly agree that NBS provides sustainable solutions and is economic friendly. Green infrastructure initiatives, can assist reduce storm water runoff and flooding. Not only do these projects improve the environment, but they also save towns money by eliminating the need for expensive traditional infrastructure renovations.

NBS can help local economies flourish by producing green jobs and encouraging economic activity. Investing in urban green spaces and natural habitat restoration, for example, can attract tourists, increase property values, and benefit local businesses.

Habitat destruction is a primary threat to the continued survival of species

Table 5.18: Habitat destruction is a primary threat to the continued survival of species

Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	10	2.4	2.4	2.4
Disagree	18	4.3	4.3	6.7
Neutral	73	17.4	17.4	24.0
Agree	145	34.5	34.5	58.6
Strongly Agree	174	41.4	41.4	100.0

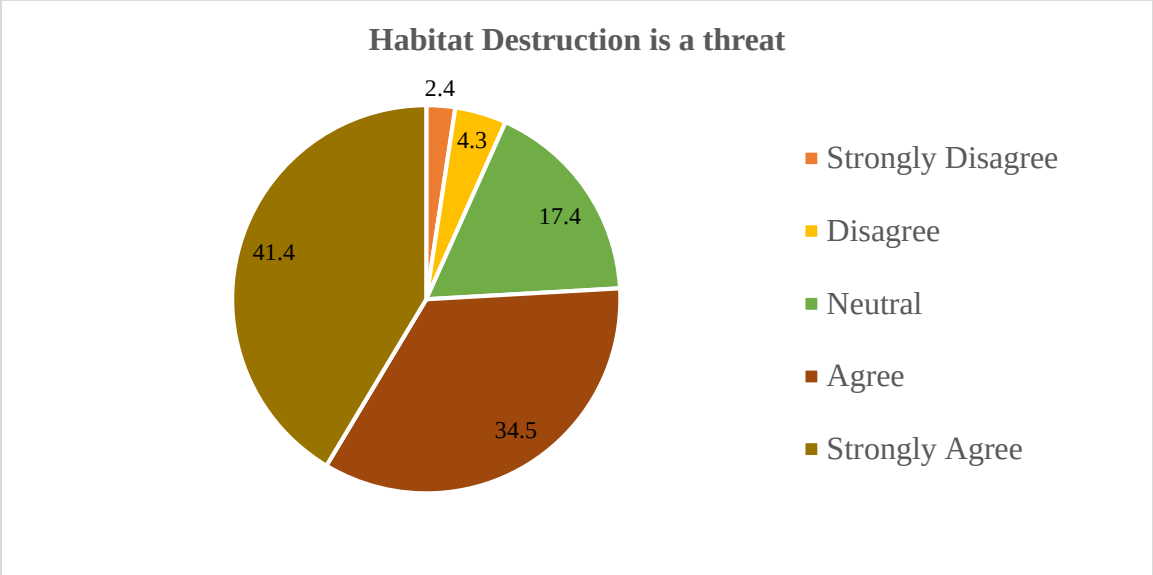

Figure 5.15: Habitat destruction is a primary threat to the continued survival of species

40% of the people strongly agree that Habitat destruction is a primary threat to the continued survival of species. Deforestation is one of the leading causes of habitat destruction. Trees provide essential habitat for countless species, from insects to mammals. When forests are cut down to make way for agriculture or development, these species lose their homes and food sources. This loss of habitat can have devastating effects on wildlife populations, leading to declines in numbers and even extinction. Urban development is another major cause of habitat destruction.

5.8 Cumulative average frequency

Rising temperatures, changing rainfall patterns, and extreme weather events can disrupt ecosystems and force animals to migrate or adapt to new conditions. Conservation efforts must take these factors into account to ensure the long-term survival of vulnerable species. Additionally, pollution, such as plastic waste in oceans and toxic chemicals in waterways, can have devastating effects on wildlife health. Contaminants can bio accumulate in food chains, leading to widespread illness and population declines. Addressing pollution requires comprehensive strategies at the local, national, and global levels. In response to these environmental challenges, wildlife protection factors play a crucial role in ensuring the well-being of animal populations. Conservation organizations work to establish protected areas, implement sustainable management practices, and rescue and rehabilitate injured or orphaned animals. Public awareness campaigns

educate communities about the importance of wildlife conservation and promote responsible behavior towards animals.

Table 5.19: Descriptive Statistics

Indicators	N	Minimum	Maximum	Mean	Std. Deviation
Environmental Factors Average	420	2.00	5.67	3.9579	.50437
Wildlife Protection Factors Average	420	1.75	5.00	4.0482	.65240
Social Factors Average	420	1.67	5.00	4.1382	.68800
Economic Factors Average	420	1.00	5.00	4.0159	.73798

Mean of all indicators selected and interviewed from the general public clearly indicates that most of the people are in the favor of Nature Based Solutions as values for all of them are above 3.5. However, values for social factors are observed at highest which indicates its importance among population.

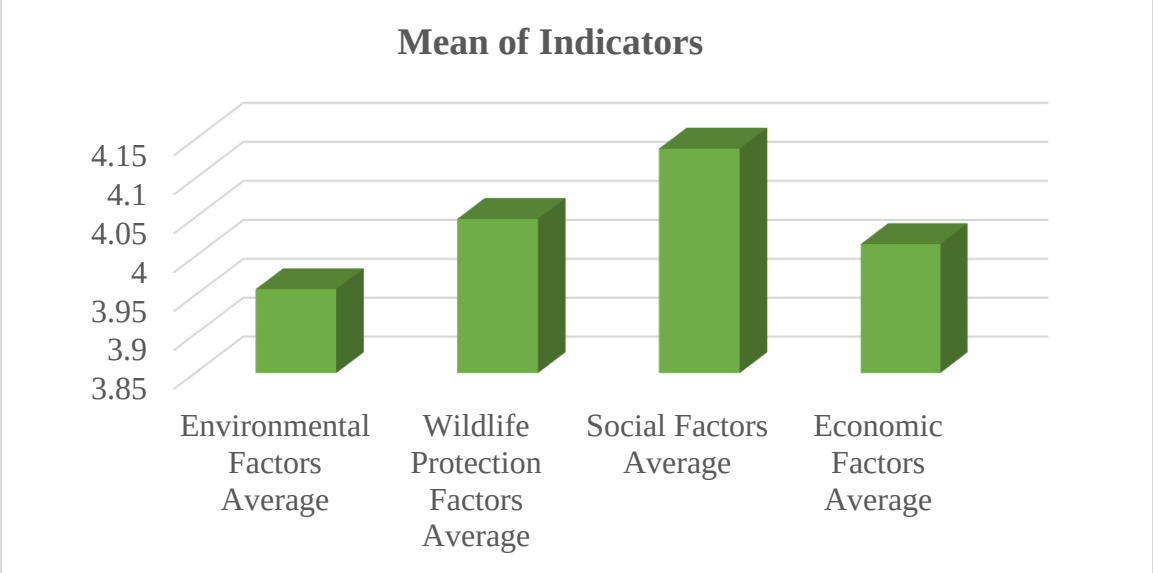

Figure 5.16: Average of Factors

Environmental Factors average is the average of the public responses for the questions related to Environmental Nature Based Solutions (EnvNbS) and their perception about its adoption to solve the problems of daily life. Higher values (3-5) indicate that more than 70% public is in favor of Nature Based Solutions for environmental problem.

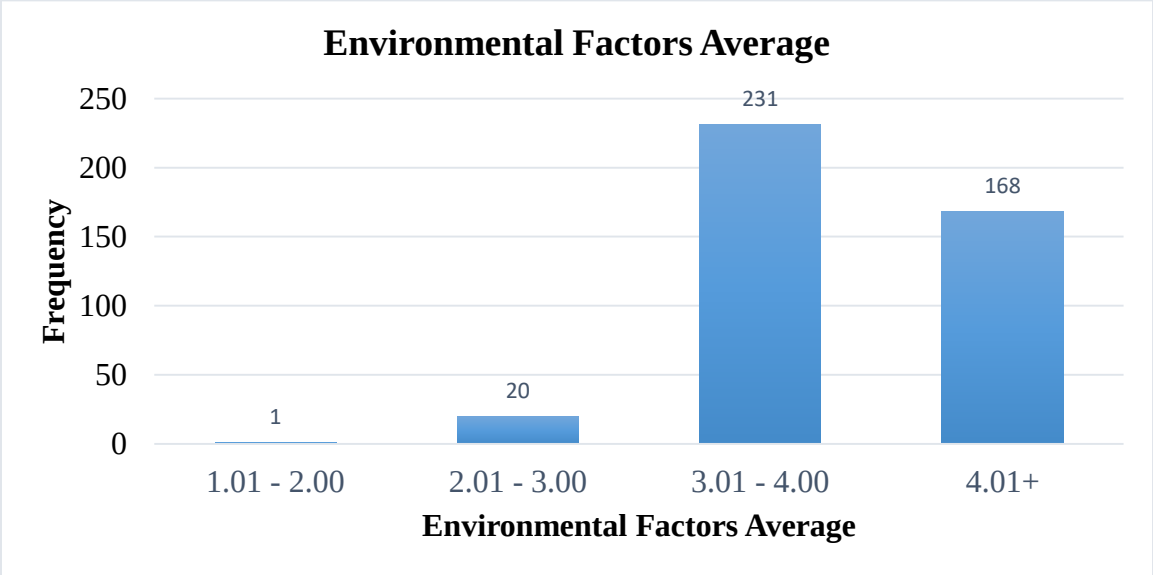

Figure 5.17: Environmental Factors Average

Social Factors average is the average of the public responses for the questions related to Social Nature Based Solutions and their perception about its adoption to solve the problems of daily life. Higher values (3-5) indicate that more than 70% public is in favor of Nature Based Solutions for Social problem.

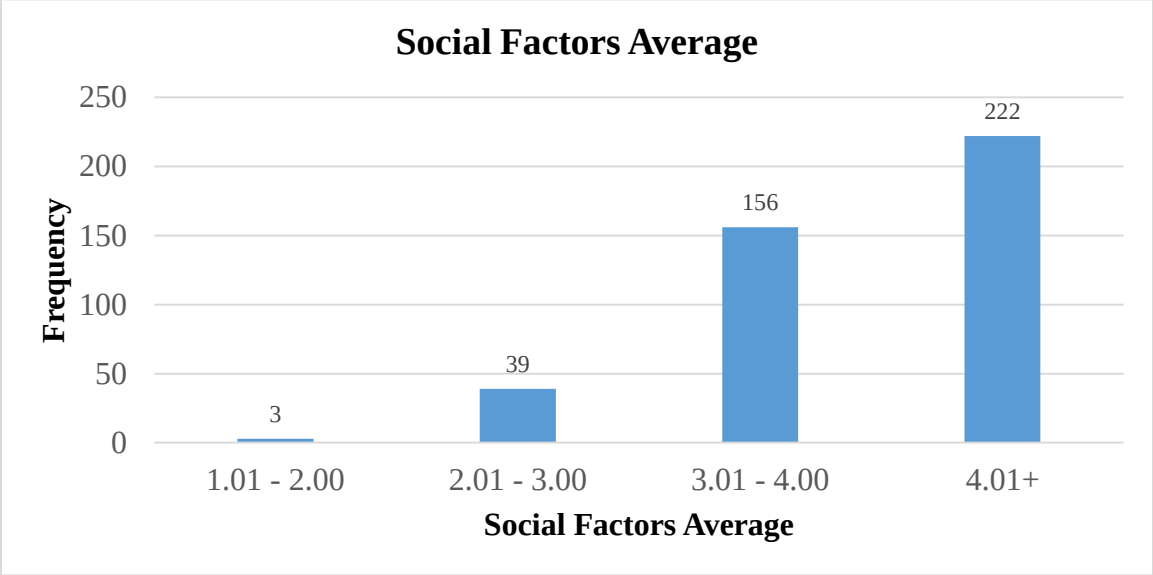

Figure 5.18: Social Factors Average Index

Wildlife Protection Factors average is the average of the public responses for the questions related to Wildlife Protection Nature Based Solutions and their perception about its adoption to solve the problems of daily life. Higher values (3-5) indicate that more than 70% public is in favor of Nature Based Solutions for Wildlife problem.

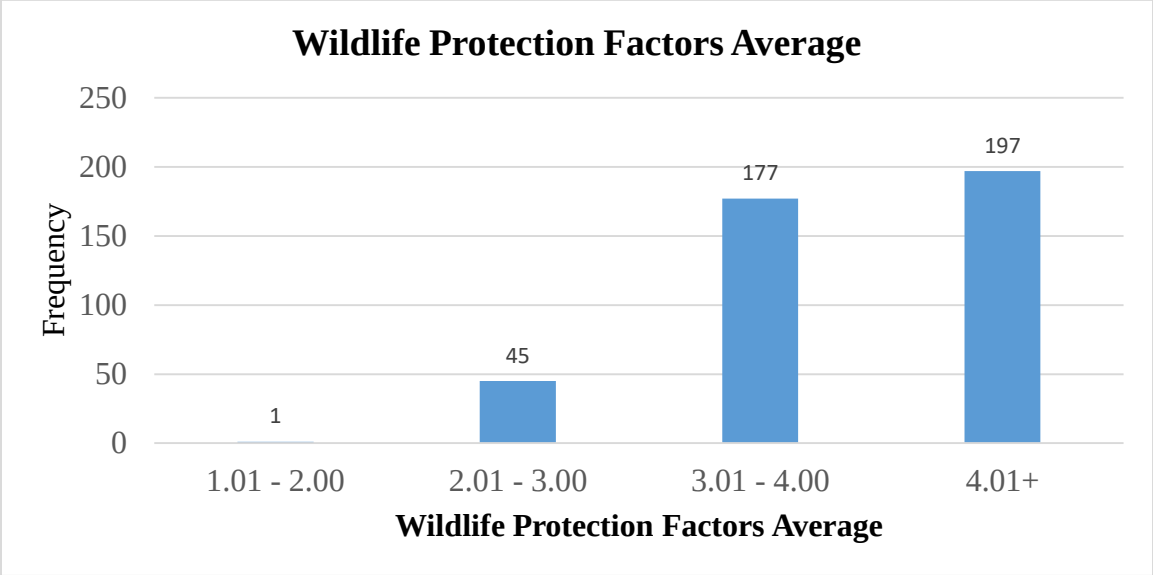

Figure 5.19: Wildlife Protection Factors Average Index

Economic Factors Average values indicate public perception about the NBS and their economic impacts. Results show that majority of public responded above 3, which means that majority believe that NBS are economic friendly and can solve real time economic problems.

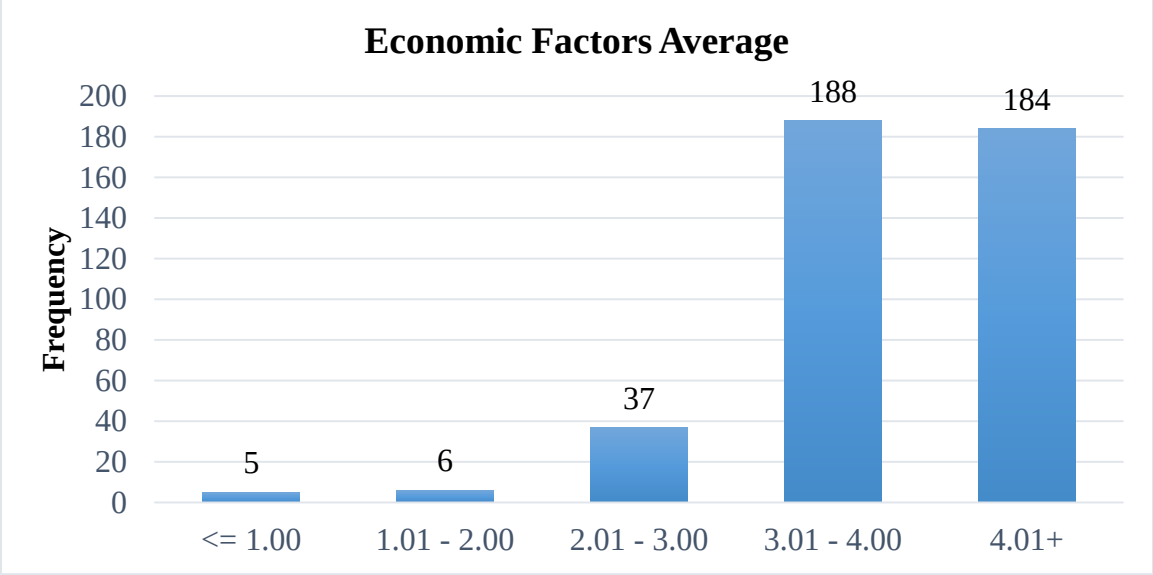

Figure 5.20: Economic Factor Average

Cumulative average for all factors of NBS including Environmental, Social, Economic and Wildlife indicate the strength of NBS factors and their impacts for solving the daily based problems. High values in results show that most of the public perception and inclination is in favor of Nature Based Solutions (NBS) and there is a dire need to opt Nature Based Solutions at smaller to larger scale.

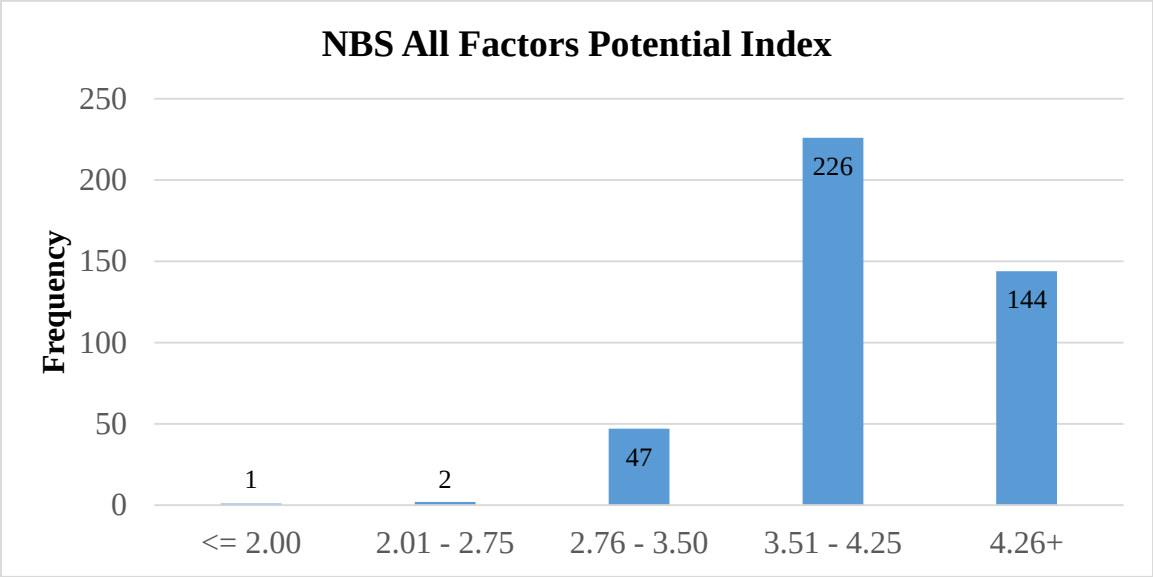

Figure 5.21: NBS All factors Potential Index

CHAPTER 6: STAKEHOLDER NBS ASSESSMENT

6.1 Stakeholder NBS Assessment

Nature-Based Solutions (NbS) are increasingly recognized as a vital component of sustainable urban development, offering ecological, social, and economic benefits. In the context of implementing NbS, key stakeholders such as government departments, development authorities, and environmental agencies play a crucial role in integrating these solutions into development plans, policies, and regulations. This thesis focuses on a comprehensive stakeholder assessment involving several pivotal organizations to understand their contributions, challenges, and recommendations related to NbS. Detailed interviews were conducted with officials from the following entities: Lahore Development Authority (LDA), Architecture Department, Provincial Disaster Management Authority (PDMA), Punjab, Environment Protection Agency (EPA), Punjab, Punjab Housing and Town Planning Agency (PHATA), Punjab Central Business District Development Authority, Pakistan Environmental Protection Agency (PEPA), Punjab Wildlife & Parks Department, Federal Government Employees Housing Authority (FGEHA), Gujranwala Development Authority (GDA), Ministry of Climate Change, Parks & Horticulture, and Ravi River Urban Development Authority (RUDA). These interviews aimed to delve into how these departments are contributing to the adoption and integration of NbS, the significant challenges they face in this endeavor, and their suggestions for enhancing the effective implementation of NbS to maximize their benefits. By examining these aspects, this research provides valuable insights into the current state and potential of NbS in urban planning and development, paving the way for more effective and widespread adoption of these solutions.

The list of institutes is created here.

Table 6.1: List of Institutes

Sr. No.	Name of Institutes
1	Lahore Development Authority (LDA)
2	Architecture Department
3	Provincial Disaster Management Authority (PDMA), Punjab
4	Environment Protection Agency (EPA), Punjab

Sr. No.	Name of Institutes
5	Punjab Housing and Town Planning Agency (PHATA)
6	Punjab Central Business District Development Authority
7	Pakistan Environmental Protection Agency (PEPA)
8	Punjab Wildlife & Parks Department
9	Federal Government Employees Housing Authority (FGEHA)
10	Gujranwala Development Authority (GDA)
11	Ministry of Climate Change
12	Parks & Horticulture Authority (PHA)
13	Ravi River Urban Development Authority (RUDA)

6.2 Thematic Analysis: An Overview

Thematic analysis is a qualitative research method used to identify, analyze, and report patterns or themes within data. This approach is particularly useful for examining complex, nuanced data sets, as it allows researchers to distill large amounts of information into meaningful categories that capture key aspects of the research question. The process involves several steps, beginning with familiarization with the data, followed by generating initial codes that represent important features of the data. These codes are then grouped into potential themes, which are reviewed, defined, and named. The final step involves producing a detailed analysis that illustrates how these themes relate to the research question and contribute to the overall understanding of the subject. In this thesis, thematic analysis was employed to systematically analyze the responses from interviews with key stakeholders, providing a structured and insightful examination of their perspectives on Nature-Based Solutions (NbS). This method facilitated the identification of recurring themes related to contributions, challenges, and recommendations for the implementation of NbS, offering a comprehensive understanding of the data collected.

6.3 Thematic Analysis:

6.3.1 Organizational Bye-Laws/Rules/Regulations Support to NBS:

Analysis:

Themes Identified:

1. **Supportive Regulations and Practices**
    - **Detailed Support (Building and Zoning Regulations)**: Several responses mention specific regulations such as LDA's Building & Zoning Regulations, Landuse Rules, and Private Housing Scheme Rules that support NBS through various measures like roof-top gardening, solar system installation, green areas, and rainwater harvesting (Responses 1, 2, 6, 12, 16, 18).
    - **General Support**: Some responses indicate a general support for environment-friendly practices and sustainable development, even if not explicitly termed as NBS (Responses 2, 3, 5, 8, 18).
2. **Implementation Challenges and Need for Improvement**
    - **Weak Implementation**: A theme highlighting that while regulations exist, their implementation is weak and needs strengthening (Responses 14, 15).
    - **Need for Amendments**: The need for amendments in current regulations to better support NBS is mentioned (Response 11).
3. **Partial or Indirect Support**
    - **Partial Support**: Responses suggest that while there is some support for NBS, it is not comprehensive or is focused on specific aspects like housing schemes or greenery (Responses 7, 14, 15, 17).
    - **Indirect Support through Sustainable Practices**: Some organizations follow local authority regulations for green spaces and other planning parameters, indirectly supporting NBS (Response 17, 18).
4. **Lack of Support**

- **No Support**: A significant number of responses indicate that current regulations do not support NBS at all or there is a lack of specific regulations addressing NBS (Responses 4, 9, 10, 13).

Summary of Thematic Analysis:

1. **Supportive Regulations and Practices**: Several professionals believe that their organization's regulations support NBS through specific guidelines and practices focused on sustainability, green areas, and eco-friendly initiatives.
2. **Implementation Challenges and Need for Improvement**: Even where supportive regulations exist, there is a common concern about the weak implementation and the need for further amendments to fully realize NBS goals.
3. **Partial or Indirect Support**: There is a recognition of partial support through existing regulations and practices, though it may not be comprehensive or directly focused on NBS.
4. **Lack of Support**: A notable portion of the responses indicates that there is no support or specific regulations for NBS, highlighting a gap that needs to be addressed.

Discussion:

The analysis reveals a mixed perception among professionals regarding the support for NBS in their organization's regulations. While some express strong support through detailed and specific measures, others highlight significant gaps and the need for better implementation and regulatory amendments.

6.4 Inclusion of NBS in Master Plan / Policy/Regulations

Themes Identified:

1. **Explicit Support for NBS**
    - **Integration with Sustainable Development Goals (SDGs)**: Some responses indicate that the master plans or policies integrate NBS within the broader context of achieving SDGs and sustainability (Responses 1, 2, 6, 17).
    - **Specific Policies and Standards**: There are specific mentions of standards and policies that incorporate NBS or related environmental concerns (Responses 20).

2. **General Acknowledgment with Implementation Concerns**
    - **Implementation Challenges**: A few responses acknowledge the inclusion of NBS but highlight concerns regarding its effective implementation (Responses 3, 12, 16).
    - **Partial or Minimal Concern**: Some responses suggest that while there is some consideration for NBS, it is not comprehensive or is minimal (Responses 5, 15, 17).
3. **Lack of Explicit Focus on NBS**
    - **No or Minimal Concern**: Several responses indicate that there is no significant focus or explicit concern for NBS in the master plans or policies (Responses 4, 7, 9, 11, 13, 14, 18).
4. **Indirect or Related Environmental Concerns**
    - **Disaster Risk Management**: One response mentions planning related to disaster risk management, which can be indirectly related to NBS (Response 19).

Summary of Thematic Analysis:

1. **Explicit Support for NBS**:
    - Some professionals recognize that their department's master plans or policies support NBS, particularly through integration with broader sustainability and environmental goals.
    - There are explicit policies and standards like the Punjab Environmental Quality Standards (PEQS) that mandate NBS or related environmental practices.
2. **General Acknowledgment with Implementation Concerns**:
    - While NBS is acknowledged in some policies, the primary concern is around effective implementation. There is recognition that master plans consider NBS to some extent but not comprehensively.
    - Some respondents note that policies exist but are minimal or partial in their concern for NBS.
3. **Lack of Explicit Focus on NBS**:

- A significant number of responses indicate a lack of explicit concern for NBS in their master plans or policies. These responses suggest that NBS is either not a priority or not considered in the existing plans.

4. **Indirect or Related Environmental Concerns**:
    - Planning efforts related to disaster risk management are noted, which could indirectly support NBS by promoting resilient and sustainable practices.

Conclusion:

The analysis reveals a mixed perception among professionals regarding the concern for NBS in their department's master plans or policies at the city level. While some express explicit support through integration with SDGs and specific environmental standards, others highlight significant gaps, minimal concern, or a lack of focus on NBS. Additionally, concerns about the implementation of NBS and its indirect consideration through related environmental planning are noted.

6.5 Challenges to Authority/department in implementing bylaws/policies/rules regarding NBS

Themes Identified:

1. **Weak Implementation and Enforcement**
    - **Weak Implementation of Rules/Policies**: Several responses highlight that the implementation of existing rules and policies is weak (Responses 1, 18, 24).
    - **Lack of Statutory Framework**: Some responses mention the absence of a strong statutory framework to support the implementation of NBS (Responses 17, 21).
2. **Capacity and Resource Constraints**
    - **Shortage of Qualified Staff and Resources**: Responses frequently mention the lack of qualified staff and necessary resources to implement NBS (Responses 2, 15, 16, 18, 20).
    - **Lack of Modern Technologies**: The absence of modern technologies is also noted as a significant challenge (Response 20).

3. **Lack of Awareness and Public Engagement**
    - **Public Awareness**: There is a recurring theme about the lack of awareness among the general public and stakeholders about NBS and its benefits (Responses 3, 6, 13, 22, 23, 24).
    - **Behavioral Change**: Changing user behaviors is perceived as a major hurdle (Response 13).
4. **Political and Institutional Challenges**
    - **Political Influence and Victimization**: Political involvement and victimization are cited as significant barriers (Responses 5, 12, 14).
    - **Corruption**: Corruption among town planners and other officials is noted (Response 14).
5. **Regulatory and Policy Gaps**
    - **Lack of Government Policy and Initiative**: Several responses point out the lack of strong government policies and initiatives supporting NBS (Responses 9, 10, 21, 22).
    - **Regulatory Approval Processes**: Challenges related to obtaining necessary approvals are mentioned (Response 7).
6. **Development Pressures and Economic Constraints**
    - **High Land Costs and Development Pressures**: The increasing demand for housing and the high cost of land in metropolitan areas are leading to the depletion of natural habitats (Response 8).
    - **Economic Priorities**: The prioritization of economic development over environmental concerns is noted (Response 22).

Summary of Thematic Analysis:

1. **Weak Implementation and Enforcement**:
    - The implementation of rules and policies related to NBS is generally weak, with a lack of a strong statutory framework to support enforcement.

2. **Capacity and Resource Constraints**:
    - There is a significant shortage of qualified staff, resources, and modern technologies needed to effectively implement NBS.
3. **Lack of Awareness and Public Engagement**:
    - A major challenge is the lack of awareness among the general public and stakeholders about NBS, coupled with the difficulty in changing user behaviors to adopt more sustainable practices.
4. **Political and Institutional Challenges**:
    - Political influence, victimization, and corruption within institutions are significant barriers to the successful implementation of NBS.
5. **Regulatory and Policy Gaps**:
    - The absence of robust government policies and initiatives, as well as difficulties in navigating regulatory approval processes, hinder the implementation of NBS.
6. **Development Pressures and Economic Constraints**:
    - The high demand for housing and the associated economic pressures lead to the rapid depletion of natural habitats and a focus on economic development over environmental sustainability.

Conclusion:

The analysis reveals a range of challenges faced by authorities and departments in implementing bylaws regarding NBS. Key issues include weak implementation and enforcement, capacity and resource constraints, lack of awareness and public engagement, political and institutional challenges, regulatory and policy gaps, and development pressures. Addressing these challenges will require a comprehensive approach involving stronger policies, better resource allocation, increased public awareness, and reduced political interference.

6.6 Awareness campaign regarding NBS

Themes Identified:

1. **Active Engagement and Awareness Campaigns**

- **Public Campaigns and Drives**: Several responses indicate that their departments have organized public awareness campaigns, including public ads, notices, plantation drives, and campaigns like "Green Lahore" (Responses 1, 6, 12, 16, 20).
- **Workshops and Certifications**: Some responses mention organizing workshops and pursuing certifications (e.g., LEED) that promote awareness of NBS and sustainable solutions (Responses 2, 3).

2. **Lack of Awareness Campaigns**
   - **No Campaigns Organized**: A significant number of responses indicate that no awareness campaigns have been organized by their departments (Responses 4, 7, 8, 9, 10, 11, 13, 14, 15, 17, 18, 19).
3. **Uncertainty or Minimal Efforts**
   - **Uncertain Responses**: One response indicates uncertainty about whether any campaigns have been organized (Response 5).

Summary of Thematic Analysis:

1. **Active Engagement and Awareness Campaigns**:
   - **Public Campaigns and Drives**: Some departments are actively engaging in public awareness efforts through various channels such as public ads, notices, and plantation drives. Campaigns with specific names like "Green Lahore" are mentioned, indicating targeted efforts to raise awareness about NBS.
   - **Workshops and Certifications**: Other departments are focusing on in-house workshops and certifications like LEED to promote sustainable solutions and NBS among concerned bodies.
2. **Lack of Awareness Campaigns**:
   - **No Campaigns Organized**: The majority of responses indicate that their departments have not organized any awareness campaigns regarding NBS. This suggests a gap in efforts to raise awareness and educate the public or stakeholders about the importance and benefits of NBS.
3. **Uncertainty or Minimal Efforts**:

- **Uncertain Responses**: There is some uncertainty about whether any campaigns have been organized, reflecting either minimal efforts or a lack of communication within departments about such initiatives.

Conclusion:

The analysis reveals a mixed approach to organizing awareness campaigns regarding NBS. While some departments are actively engaging in various public awareness efforts and in-house initiatives, a significant number of departments have not organized any campaigns. This highlights the need for increased and more widespread efforts to raise awareness about NBS and promote sustainable practices among the public and stakeholders. Addressing this gap will require coordinated efforts and better communication within departments to ensure that awareness campaigns are prioritized and effectively implemented.

6.7 Suggestions for improvement of the implementation process of NBS in local context?

Themes Identified:

1. **Awareness and Education**
    - **Large-scale Awareness Campaigns**: Many responses emphasize the need for extensive awareness campaigns to educate the public, developers, and sponsors about the benefits of NBS (Responses 1, 3, 6, 8, 9, 12, 13, 17, 20).
    - **Seminars and Workshops**: Suggestions for organizing seminars and workshops to enhance understanding of NBS (Responses 2, 4, 8).
    - **Community-Based Awareness**: Highlighting the importance of community involvement and targeting different age groups (Responses 9, 8).
2. **Integration with Planning and Development**
    - **Incorporation into Planning Process**: Suggestions for integrating NBS measures into the planning process and local laws (Responses 4, 10, 18).
    - **Eco-Town Development**: Promoting the development of eco-towns and adopting international best practices (Response 7).

- **Vertical and Roof Planting**: Emphasizing specific NBS practices like roof planting, vertical development, and underground water tanks (Responses 15, 16).

3. **Legal and Policy Framework**
    - **Strong Legal Framework**: The need for a robust legal framework and enforcement of strong bylaws to protect the environment (Responses 6, 10, 11, 18, 20).
    - **Government Policies and Priorities**: Recommendations for government to prioritize NBS and environment in its policies (Responses 7, 17, 20).
4. **Resource Allocation and Technical Expertise**
    - **Financial and Technical Resources**: Suggestions for allocating financial resources, technical human resources, and modern technologies for the implementation of NBS (Responses 14, 18, 19).
    - **Qualified Technical Staff**: Emphasizing the need for relevant qualified technical staff to support NBS initiatives (Responses 11, 14).
5. **Stakeholder Involvement and Collaboration**
    - **Involvement of Local Stakeholders**: Including indigenous knowledge and local stakeholders in the planning and implementation process (Responses 6, 8).
    - **Collaboration with Academia and Private Sector**: Encouraging collaborations with academia and the private sector to find the best solutions for NBS (Response 8).

Summary of Thematic Analysis:

1. **Awareness and Education**:
    - There is a strong emphasis on the need for large-scale awareness campaigns, seminars, and workshops to educate various stakeholders about NBS. Community-based approaches and targeting different age groups are also suggested.
2. **Integration with Planning and Development**:

- Suggestions include integrating NBS measures into the planning process, promoting eco-town development, and adopting specific NBS practices like roof planting and vertical development.

3. **Legal and Policy Framework**:
    - The need for a robust legal framework and strong enforcement of environmental bylaws is highlighted. There are also calls for government policies to prioritize NBS and environmental sustainability.
4. **Resource Allocation and Technical Expertise**:
    - Allocating financial and technical resources, as well as employing qualified technical staff, are seen as crucial for the successful implementation of NBS. Modern technologies are also needed.
5. **Stakeholder Involvement and Collaboration**:
    - Involving local stakeholders, including indigenous knowledge, and fostering collaboration with academia and the private sector are recommended for finding and implementing the best NBS solutions.

Conclusion:

The analysis reveals a comprehensive set of suggestions for improving the implementation process of NBS in the local context. Key recommendations include extensive awareness and education campaigns, integrating NBS into planning and development, establishing a strong legal and policy framework, allocating necessary resources and technical expertise, and involving stakeholders in a collaborative approach. These measures collectively aim to enhance the understanding, adoption, and effectiveness of NBS practices for sustainable urban development.

CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

In conclusion, Nature-Based Solutions is indeed a revolutionary approach in the urban planning and housing sector and presents a viable option for sustainable growth amidst Pakistan's severe environmental crises. The mainstreaming and application of NBS into policies and practices are central steps for the urban planner or policymaker or developer who aspires to ensure a sustainable and resilient future housing in the country.

According to the discussed literature, NBS includes a range of practices such as green infrastructure, urban forestry, and cutting-edge sustainable water management systems and offers a host of innovative environmental and societal benefits. In particular, air and water quality improve, and the levels urban heat islands are reduced, and the overall health and well-being of people is enhanced. For instance, consider green roofs. Green roofs are not just vegetative layers on the top of structures; they are innovative eco-technologies on their own. By absorbing solar radiation, rough green function as urban cooling systems to counterbalance the prevalent heat islands in densely urbanized territories. They are excellent air purifiers, collecting and sequestering airborne pollutants and particulates while also providing a platform for urban agriculture. Educational programs and awareness campaigns will necessarily play a central role in promoting awareness of NBS.

In order to determine the extent to which NBS is used in various local development plans and policies in Pakistan, a thorough assessment of current documents and initiatives was carried out. This review include an examination of how NBS are referenced and integrated into these plans, as well as an evaluation of the level of implementation and real impact on the ground. Furthermore, the researcher connected with important stakeholders such as government officials, policymakers, community leaders, and environmental specialists to gain insights and perspectives on the application of NBS in local development. Understanding their experiences and

challenges allows us to acquire a better understanding of the constraints and opportunities to wider adoption of NBS in Pakistan. This research had underlined particular projects and efforts that have effectively integrated NBS. Different case studies yielded important insights and optimal approaches for subsequent planning and execution. These case studies can be used to pinpoint effective tactics, emphasize crucial elements of success, and demonstrate the real advantages that NBS can offer nearby communities.

To evaluate the potential of NBS the researcher considered the four themes incorporating NBS, that include environment, social, economic and wildlife. After consulting officials and local people, following conclusions are drawn

Natural-based solutions (NBS) are being more acknowledged as an important tool for tackling environmental issues. NBS has the potential to harness nature's power to give long-term solutions to concerns such as climate change, biodiversity loss, and water scarcity. Using nature-based approaches, we can not only safeguard the environment but also promote economic development and social well-being One of NBS's primary advantages is their capacity to deliver various benefits. It can help reducing air pollution, minimize the urban heat island effect, and increase biodiversity. Likewise, restoring wetlands can help to enhance water quality, defend against flooding, and provide recreational possibilities for locals.

According to the survey analysis, NBS have the potential to provide enormous socioeconomic advantages. It can lead to job creation, economic stimulation, and investment. Cities that prioritize nature-based approaches in urban design and development can increase their resistance to climate change, improve public health outcomes, and create more livable areas for citizens. Also, supporting sustainable agriculture practices like agroforestry and organic farming can assist to boost food security.

Through this research the researcher had tried to highlight the several institutional and local obstacles when it comes to the adoption of nature-based solutions (NBS) for sustainable urban development. For instance, towns may not have enough cash or resources to adequately undertake NBS programs. Second, there may be a breakdown

in coordination among various government agencies and parties involved in urban planning and development. Additionally, there may be opposition from citizens and companies who are unfamiliar with the benefits of NBS or are afraid to change their current habits. Zoning rules and land use policies may impede the incorporation of NBS into metropolitan areas. This may make it harder for planners and developers to implement green infrastructure.

Awareness campaigns and programs focused on explaining the myriad benefits of NBS and encouraging community-based efforts must be implemented. Urban forests and vast green spaces set up and managed in the apartment blocks are equally important to the survival of the housing industry in the long run. Additionally, integration of sustainable water management systems is critical for the survival of the housing sector. Rainwater harvesting systems are resilient installations that reduce the burden on fresh municipal water supplies in the process of preserving freshwater.

The more we delve into the economic prospects of NBS, it is apparent that not only are such environment-friendly practices beneficial to the environment—they also spark economic activities. Green technology and practice easily generate employment, leading to the revitalization of local economies through new job markets and industries. This makes NBS the ultimate pathfinder for the sustainable growth of the housing sector in Pakistan. It provides an opportunity for the development of improved livability, resilience, and environmental stewardship within urban developments. Therefore, there is an aura of urgency for all policymakers, urban planners, and parties involved to prioritize NBS as the cornerstone for the future development of urban housing. In doing so, Pakistan's future can have assured prosperity and sustainability.

Embracing NBS is not only a manner of addressing environmental issues, but it also promotes holistic societal well-being. From biodiversity conservation to climate change, water resource management, air quality improvement, and social welfare, the impact of NBS is enormous. It is the duty of every societal party, from policymakers to community representatives and the individual to institutionalize the potential of NBS for a more sustainable and viable tomorrow.

The scope of NBS, because of its ability to address multidimensional global challenges

such as urbanization, climate change, and eradication of poverty, is quite impactful. In realizing our full potential, collaboration and combined approach by the community is crucial at ensuring that nature-based solutions are integrated into the societal structure for resilient structures. Additionally, through NBS, the conservation of wildlife is seen as a possibility to correct the declining biodiversity trends. It is imperative that every nation and individual make concerted efforts to conserve wildlife through the incorporation of NBS.

Diversification of stakeholders is essential to facilitating the efficacy and optimization of NBS processes. Engaging a broad spectrum of partners, particularly varying government officials, non-governmental organizations, researchers and academia, and private enterprises, is vital. Such a holistic coordination is necessary for tracking, enforcing policies, pooling resources, and enhancing both methods of research and conservation. Ultimately, it is apparent that stakeholders must be channeled from a broad and well-represented background for NBS to be effective in the future. Engaging at both the local and international scales is also likely to stimulate NBS development and implementation of good practices and innovation that will expedite wildlife conservation. In the end, this collective effort and contribution will allow for the future of biodiversity and a safe coexistence between humanity and nature, as achieved relative to future generations.

7.2 Recommendations

i. Nature-based solutions are becoming a crucial instrument for addressing climate change and achieving 'net zero' ambitions and resilience. Nature-based solutions are gaining global recognition for their ability to cool cities, reduce energy demand, and manage flooding. Mainstreaming occurs through four pathways: recognizing its potential as a climate solution, investing to decrease climate risk, integrating climate action with other sustainability goals, and learning from practical experience.

ii. This research was an effort to explore that how nature-based solutions might help cities protect, repair, and prosper with nature as part of a global biodiversity agenda for the next decade. Four approaches are identified: regulating for 'no net loss' of biodiversity, creating co-governance frameworks for public-private finance, integrating biodiversity with

existing sustainability priorities, and incorporating biodiversity into urban growth and the built environment.

iii. Another area where nature-based solutions could significantly benefit the housing sector involves energy efficiency. One such advantage is the increasing use of larger windows and skylights in new constructions, harnessing natural light and reducing the need for artificial light and its expense.

iv. The reduced reliance on traditional sources of light and its consumption eventually leads to a lower emission of carbon since it requires minimal usage of electricity. Nature-based technologies like this one align with Pakistan's vision of cutting back on environmental rape.

v. Nature-based solutions, such as parks, rooftop gardens, and tree-lined roadways, enhance community spaces and promote wellbeing. To prevent gentrification and displacement of low-income people, solutions should prioritize social inclusion and address disparities. We identify three approaches to improve social inclusion: increasing community involvement, ensuring political commitment and policies that support inclusion, and pursuing social inclusion measures for health and wellbeing.

vi. In water management, permeable paving is propagated. This material facilitates the recharging of groundwater, as it effectively absorbs rainwater's vitality and thus manages the menace floods might pose. Consequently, such systems and rainwater harvesting could be useful for non-potable consumption. A non-potable use saves water and ultimately aligns with our strive for sustainable organic development. Similarly, proper waste disposal can reduce environmental hazards. Recycling, composting, and the use of biodegradable materials are encouraged in homesteads.

vii. Pakistan shall develop a safe technique for dealing with waste whose materials are reusable and recyclable. This approach serves as part of the circular economy, which targets zero waste of materials and conserving resources. The integration of more green spaces is prioritized. Greenery should be taken seriously and developed especially through the erection of new parks, gardens, or rooftop green spaces in multi-story houses. Aside from improved air quality and the environmental ancestral favors, greenery shall naturally be essential for people's mental wellness. Sustainable communities are encouraged here; thus,

these practices prepare residents for environmentally friendly living.

viii. Nature-based solutions can promote economic growth, employment, and quality of life. Nature-based solutions promote economic vitality and well-being while also creating new opportunities in cities. Mainstreaming for economic regeneration involves establishing investment partnerships, understanding their economic value, capitalizing on opportunities from other sustainability projects, and growing market demand for nature-based solutions.

ix. Nature-based solutions should be ingrained in Pakistan's sustainable policies and regulations to enforce the enactment nature-based policies as a vital painting to achieving sustainable housing. These avenues caution Pakistan to its industrial development while striving towards environmental conservation.

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ANNEXURE

Questionnaire No: ------

National University of Sciences and Technology (NUST), H-12, Islamabad, Pakistan

Understanding the Concept of NbS and Devising Suitable Nature-based Solutions for Sustainable Growth of Housing Sector in Pakistan

General Public Survey

(*The actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits are called Nature-based Solutions (NbS)*).

Note: The purpose of this research project is to examine the extent of use of NbS in National, Provincial and Local Development Plans & policies and devise suitable NbS for sustainable growth of the housing sector in Pakistan. This is a research project being conducted by a student of MS Urban and Regional Planning, National University of Science and Technology (NUST), Islamabad. Participation in this research study is voluntary, and you may withdraw at any time. The procedure involves filling out a survey that will take approximately 15 minutes. Your responses will be confidential, and we do not collect identifying information such as your name, email address, or IP address. The survey questions will be about your awareness regarding NbS . The results of this study will be used for scholarly and research purposes only. If you have any questions about the research study, please contact urbandesigners.pk@gmail.com

(i) Profile of the Respondent

1. Gender _____
2. What is your age? _____
3. What is your qualification? _____
4. What is your designation? _____
5. What is your household size? _____
6. What is your monthly income? _____
7. Are you a member of any environmental organizations?
   a. Yes b. No
8. Do you know about NbS?
   a. Yes b. No

(ii) Awareness regarding NbS

9. Please look at the following list of environmental issues that concern you the most.
   a. Air pollution
   b. Pollution of rivers and seas
   c. Flooding
   d. Litter
   e. Poor waste management (e.g. overuse of landfills)
   f. Exploiting resources
   g. Endangerment of wildlife species
   h. Overpopulation (of the earth by humans)

i. Health issues

10. Who do you think should have the main responsibility for implementing NBS?
    a. International organizations (e.g. the UN)
    b. The national government
    c. Local government
    d. Business and industry
    e. Environmental organizations/ lobby groups (e.g. Worldwide Fund for Nature)
    f. Individuals
    g. Other (please write in: _____)
11. Have you ever taken, or do you regularly take, any action out of concern for the environment?
    a. Yes
    b. No
    c. Don't Know
12. If yes, what did you do/ are you doing? _____
13. Please indicate how much you agree or disagree with the following statements about Nature Based Solution by ticking one box on each row:

Perception / Statement	**Strongly Agree** **1**	**Agree** **2**	**Neutral** **3**	**Disagree** **4**	**Strongly Disagree** **5**
Environment					
People should be made to reduce their energy consumption if it reduces climate change					
Human activities have no significant impact on global temperatures					
Planting a tree is also a type of NBS					
I should turn off the lights in my house when not in used					
The rain water can be stored and recycled					
Pollution from industry should be tackle in environment friendly way					
Economy					
The government should provide incentives for people to look after the environment					

Perception / Statement	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
Industry and business should be doing more to implement NBS					
Sustainable solutions/NBS are economic friendly					
Social					
I feel a moral duty to do something about climate change					
There is a park and open space available for social gatherings near my house					
Public spaces/Parks are a great source for social interaction & cultural cohesion					
Wildlife					
I have noticed the extinction of some species					
Habitat destruction is a primary threat to the continued survival of species					
Public parks should be designed to protect animal and plant species					
Sport hunting should not be encouraged in order to protect wildlife					

14. The following is a list of activities that you may do. For each one that you do regularly, please indicate your reason or reasons for doing so. Tick as many as you feel apply:

Activities	Convenience 1	To save money 2	To protect the environment 3	For my health 4	Habit 5	Moral Obligation 6	Any Other reason 7
Walk or cycle to work							
Use public transport							
Turn off lights I'm not using							

Activities	Convenience 1	To save money 2	To protect the environment 3	For my health 4	Habit 5	Moral Obligation 6	Any Other reason 7
Buy energy efficient bulbs							
Buy organic food							
Recycle glass							
Recycle other items							
Take part in campaign about an environmental issue							

15. If you have anything to add about the issues raised in this questionnaire or any comments about the questionnaire itself, please write them here: _____