Green Productivity and Tree Plantation: A Case Study of Rawalpindi And Islamabad

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DEDICATION

This research is dedicated to my beloved grandparents and my parents whose love, affection, encouragement and prayers made me able to get such success.

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"IN THE NAME OF ALLAH, THE MOST BENEFICIENT AND THE MOST MERCIFUL"

I express thanks to Almighty for enabling me to complete this work within given time period.

I bow before His compassionate endowment. All the respect of His last Prophet (S.A.W.W) for enlightening with essence of faith in Allah covering all His kindness and mercy upon us.

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Abstract

The urbanization and crucial influence of man in the natural setup is causing numerous difficulties. In the current era of modernization, human activities are disturbing the ecosystem, like industrialization, emissions of toxic gasses, causing several diseases. To tackle these problems Green Productivity is a tool to help and maintain a balance between needs and supply of products or services and maintain the environment. In the current study, two different areas were selected from the twin cities named: Sadiqabad, Rawalpindi and Bahria Town, Islamabad. Sadiqabad, Rawalpindi is a dense urban area with less or no trees and vegetation while the Bahria Town, Islamabad has lush green plantation and Margalla Hills Forest in the vicinity. This ground reality makes both locations best to justify the concept of green productivity. For this purpose, total 20 water samples (i.e., 10 from each site with triplication) were collected and physiochemical properties were analyzed including temperature of water, TDS, pH, alkalinity, hardness and chloride ion. The results from Bahria Town, Islamabad were significant ($p>0.5$) while results from Sadiqabad, Rawalpindi were evidently opposite. Environmental parameters from past 10 years (2010-2020) including rainfall, maximum temperature and minimum temperature were analyzed and found increasing trend in temperature. Moreover, the rainfall pattern was also uncertain. A public survey was conduct in the study areas to identify the socioeconomic status and to found awareness and interest level for tree plantation. Interviewees were from diverse background. In the study area of Bahria Town, Islamabad disease frequency was low, temperature was relatively tolerable, people were relatively polite, lesser noise pollution and lush green vegetation was found. Furthermore, in Sadiqabad, Rawalpindi few trees were found, temperature was relatively high, high noise pollution, people were usually suffering from lungs diseases and asthma etc. people had relatively rough behavior. However, inhabitants of both study areas showed great interest and considered dire need for tree planation. The current study proved a prominent distinction about the impact and need of green productivity via green infrastructure and plantation. Green productivity has become need of the modern urban planning and sustainable development.

Keywords: Green productivity, Green infrastructure, Tree plantation

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LIST OF ABBREVIATIONS

WHO	World Health Organization
GI	Green Infrastructure
GP	Green Productivity
APO	Asian Productivity Organization
NEQs	National Environmental Quality Standards
PCRWR	Pakistan Council OF Research in Water Resources
PSLM	Pakistan Social and Living Standards Measurement Survey
TDS	Total Dissolved Solids
EU	European Union
UN	United Nations
VOCs	Volatile Organic Hydrocarbons
NO	Nitrogen oxides
PMFC	Plant Microbial Fuel Cell

CHAPTER 1:

INTRODUCTION

1.1 Background Information

The urbanization and crucial influence of humans in the natural environment creates numerous problems. In the current era of modernization, human activities disrupt the ecosystem, such as industrialization, toxic gas emissions, causing various diseases (Opoku & Boachie, 2020). As increase in human population the needs of humans also in increasing trend, in recent decades have resulted in serious environmental problems. These are causing depletion in natural resources. In many parts of the world, water crisis has become one of the serious problems. Scarcity of water and the deterioration of quality lead to environmental problems around the world (Shaheen *et al.*, 2019). Due to increase in domestic demands, the rapid development and expansion of industries are causing high energy consumption. Our ecosystem and environment are in danger due to excessive use of chemical pesticides and fertilizers in agriculture. Methane, carbon dioxide and other greenhouse gases are produced by industries and the combustion of natural or energy resources. Improper waste treatment also produces greenhouse gas (Ali *et al.,* 2019). To address these problems, Green Productivity is a tool to promote development and sustainability (Ahmed, 2020). Green productivity (GP) is an approach for concurrently betterment for productive efficiency and environmental performance for socio-economic advancement that leads to a sustained progress in the living standards of human (APO, 2018). The Asian Productivity Organization (APO) first ever coined the term Green Productivity. According to the APO, this is a strategy to improve productivity and environmental performance for global socio-economic development. It is the application of best suited management systems, techniques and technologies to yield responsible environment friendly services and products. To do this, this concept was based on the premise of integration improvement from productivity to advancement and environmental fortification, where output efficiency delivers the structure for sustained wellbeing and progress, furthermore, conservation of environment gives the basis for continuous growth (Maciel & Freitas, 2019).

In other words, finding a management solution in harmony with nature for community or organizational development is green productivity. For example, plant trees in urban areas to mitigate rainwater problem and utilize it (Carlyle-Moses *et al.*, 2020). Likewise, implementation of green productivity based green infrastructure is a trendy endorsed way for reducing air pollution. Green walls, street, green roofs, park trees, and other means of introducing vegetation into the urban landscape are examples of green productivity (Hewitt *et al.*, 2020). Economic and social development in a society is socioeconomic development. It can be assessing by measuring life expectancy, employment ratio, literacy and GDP (Russo *et al.*, 2019).

Reduce damages like; exposure to heat and pollen, ultraviolet radiation, resilience recovery, stress reduction, air pollution, mental health, and clinical outcomes, building capabilities such as birth rate, energetic life and weightiness status is the practical approach to green productivity through tree plantation, especially in urban areas (Wolf *et al.*, 2020). With regard to urban tree planting services, green productivity is becoming a broader aspect of the development in terms of both conservation and conservation (Mussinelli *et al*., 2020).

Greening the city has several advantages, both on an economic, social and health level. On an economic level, we are thinking of agglomeration economies, lower infrastructure and operating costs and reduced congestion costs. From a social point of view, job creation, poverty reduction and improved equality, as well as improved quality of life (such as safer roads and more cohesion in the community) can be seen as benefits of the green economy in the city. Most of the environmental benefits usually lie within these social and economic gains. Additional environmental benefits include, for example, reduced emissions, which has a positive impact on public health. Another environmental benefit is that a green economy can offer opportunities for improving ecosystems within built-up areas (Rutkowska and Sulich, 2020).

Several jobs in fields can be generated by greening urban vicinities: 1) renewable energy; 2) waste management and recycling, 3) peri-urban and urban green agriculture, 4) green construction; and 5) public transport. The ecofriendly green productivity-based service sector will mostly be more urbanized areas than the green production or primary sector. Nevertheless, there will also be a number of green high-tech production clusters close to or even within the urban core. This is due to knowledge spillovers from universities and research laboratories - which are almost always situated within the urban core (Ram *et al.*, 2020).

Several advanced countries have also initiated to focus on green productivity as the main practical way of employment creation. The German Alliance for Work and Environment launched a program in 2001 to adapt more than 300,000 apartments, through improved insulation of roofs, windows and walls, as well as improved heating and ventilation systems and the installation of renewable equipment and energy. In the period 2001-2006, the program created about 140,000 new jobs and reduced annual emissions from buildings by about 2%. The program has received US $ 5 billion of government grants, which has subsequently boosted an investment of approximately US $ 20 billion. About US $ 4 billion of this was realized through appraisal. The Adaptation Program has become one of the main features of the German government's strategy to reduce CO_2 emissions by 40%. Converting existing buildings offers many older cities job opportunities. Higher environmental standards for construction works can also provide more employment (Onubi *et al.,* 2020).

What is perhaps most fascinating here is that through (certain) green building and adaptation projects one can have the opportunity to initiate a transition and have buildings transformed from traditional consumer components to active producing components. In this way, buildings are not only given a consuming function, but also a production function - think of the production of food, water, energy and other resources or even the establishment of spaces with concept of green productivity (Shurrab *et al.,* 2019).

More trees and greenery present in the public space of a city center, the residents use these spaces more often and frequently. The research also concluded that related to local inhabitants, people incarnate closer to green areas enjoy fewer green spaces, (1) show stronger emotions of attachment, (2) know their neighbors better, (3) have more interactions, and (4) enjoy more social life. They showed that children living in greener areas are more resistant to stress; have a reduced risk of behavioral disorders, anxiety and depression; and experience a higher self-esteem. Green space, of course, also stimulates social interaction between children. Other important properties of green cities are also considered as part of the quality of life, such as: pedestrian opportunities, public green spaces, cycling infrastructure and recreational facilities. In emerging states this may partially be the association between cities based on green productivity and cities with high living quality standards (Douglas *et al.,* 2017).

The adequate governance is necessary in the transition to a green economy. For cities, this requires coordinated policies at national, regional and local levels. These are strategic planning processes carried out by policy makers, including the participation of a number of external stakeholders. They examined the effectiveness of government coordination, both vertically across different levels of government and horizontally within municipal governments, as well as the skills and capabilities that exist in cities today. Here are some findings: Almost all cities (95%) in the survey have (or are developing) some form of green strategy. Strategic plans are usually formulated through a strategic urban development plan (48%), while another 10% of cities have sector-specific action plans for the green strategy. Only a few cities (5%) report having a legally binding city plan to guide their global approach to green policy (Ilyas *et al.,* 2020).

Cities in general have a wide range of external stakeholders (the external stakeholders) in the development of green policy. The majority of cities state that the involvement of a wide range of stakeholders, especially civil society organizations (71%), the general public (68%), provincial or regional governments (64%), business and industry association (63%) and NGOs (61%), is necessary (Vargas-Hernández, 2020).

In present world cities see their green agendas most supported by the regional level and least by supranational governments. Almost half of the cities see the regional level as 'supportive' or 'very supportive'. Slightly fewer cities (43%) see the national policy level as supportive. Almost across the board, cities see international policy frameworks as "least supportive" and only one in four cities see supranational frameworks as "supportive." National government is more often seen as supportive in cities in middle and low-income countries. Asian cities also report more often to receive support from national governments. Cities rate their capabilities fairly highly across a wide range of green economy sectors (the majority of cities rate capabilities in all of the listed sectors as either 'good' or 'excellent'). Four-fifths of cities rate its capabilities as 'good' or 'excellent' when it comes to urban planning, while three-quarters do so in IT sectors. Least often reported are capacities for surveillance / enforcement and innovation-based economic development (Vuola *et al.,* 2020).

Planning and regulation are the most common policy tool for urban development in more complex and mature political environments. In such cases, planning and regulation can range from strategic and land-use planning to building regulations and environmental regulations. In addition to achieving the desired environmental results, regulation and planning can also contribute to green initiatives and create a demand for green products at different levels (Biber *et al.,* 2018).

In Pakistan, the government considers seriously the matters of climate change, environment and tree plantation. The internationally hailed and acknowledged “Ten Billion Tree Tsunami Program” launched by Pakistani government on 2nd September, 2018 documented by Ministry of Climate Change, Government of Pakistan. There are very few studies on the green steps taken by the Government. In this study, tree plantation is discussed with respect to green productivity which can increase public participation in tree plantation and can improve more the global impact of Pakistan and environmental conservation output. For the study twin cities, Islamabad and Rawalpindi were selected as study location because both cities have difference in socio-economic situation, greenery, pollution level and living standards even situated side by side. These cities were best suited to justify the study rationale.

1.2 Problem Statement

In the world of spatial planning, the global climate crisis is a topic that is rife the interest today. Features of climate change are expected greater exposure; prolonged droughts, heat waves, increase in the frequency and intensity of peak showers and floods also economic and human health crises etc (Ahmed, 2020). Climate change has different consequences for each area. For the urban areas, the effects of climate change can be described as a greater chance of flooding, flooding due to extreme rainfall, drought and heat retention in built-up areas and rising heat stress in extremely hot summers (Salimi, 2020). The climate effects and the associated climate adaptation differ per urban area. Or the climate effects cause damage or nuisance is determined by the properties of the buildings, the presence of public green spaces and water features and the condition of the sewer system (Ortiz *et. al.,* 2020). In urban areas, it will be especially vulnerable to the increasing risk of flooding and heat stress the urban area has many paved areas and there are a lot of buildings, which means that rainwater heavy showers cannot go away (Pour *et. al.,* 2020). Outside the cities if precipitation penetrates into the ground or evaporates, only ten percent drains over the surface. In the cities this is often more than eighty percent, depending on the paved surface (Hua et. al., 2020). The heat stress can arise because cities are increasingly densely built up and public spaces and gardens are increasingly being paved, so that the city will retain more heat (Gargiulo and Zucaro, 2020).

Because the climate changes are uncertain, it is difficult for the urban area that how can prepare for the effects of the change. That is why there are calls for measures that be robust, flexible and resilient (Hurlimann *et. al.,* 2020). Robust means that the measures must be able to withstand extremes. Flexible means that the measures must be adjusted can be up to change and resilient means that measures can cause any harm restored (Sharifi, 2020). There are different types of workable measures as options. Green productivity has cheap, flexible measures can be taken in the short term, these are installation measures, this could include adapting buildings, for example, insulation and construction of green roofs and the adaptation of paving for water storage, for example. Other measures are system adjustments. This could include the construction of parks, green streets, ponds, water features or the construction of so-called "green infrastructure". These measures are large, and they have a positive effect on the quality of life in the city (Ronchi *et. al.,* 2020). Green productivity-based structures as a means of climate adaptation and can be used to store water and limit heat problems in urban areas (Liu *et. al.*, 2020).

Operative development and governance between various managerial ranks needs eminence statistics to educate and create awareness among inhabitant of urban areas and endorse behavioral alteration. Moreover, certain cities are major hubs for consumers, possibly worthy to the manufacturers and providers of ecofriendly services and products, statistics is also a vital protocol to effect decision and choice of consumer. But buyer inclinations, in advanced and emerging nations, are not always ecofriendly and productively green. For instance, very populated urbanized areas are not at all times accepted in many areas of the Europe, United Kingdom and the North American tendency towards suburbanization is also difficult to label as green (Mealy and Teytelboym, 2020).

The active communication and statistics about the possible wellbeing of a more environmentally friendly lifestyle in cities can enable consumers to make informed decisions. In Munich, for example, new residents receive an information package about green mobility options. The use of such tools can also influence the behavior of companies, as the Indian city of Surat, one of Gujarat's 21 largest industrial centers, has shown. A combination of information and regulatory tools are used to force textile companies to reduce water pollution. A large company reduced pollution by 90 percent, energy consumption by 40 percent and the use of chemicals by 85 percent (Cao *et al.,* 2020).

The information alone is not enough to change behavioral patterns. Information must be supplemented with incentives that lead to lasting change. This can partially limit adaptation costs for businesses and inhabitants. For instance, businesses and employees may experience higher costs in brown businesses when urban areas move from industrial structures to model of green productivity. Policymakers need to recompense for these short-term losses. In addition to given that straight monetary inducements, metropolitan governing bodies also offer community facilities - such as training and education for employees, industrial development and green productivity-based development. Such amenities not only lessen the expenses for businesses to initiate the green and ecofriendly transition, but likewise change the business atmosphere to an environment based on the norm of green productivity (Guo *et al.,* 2017).

Pakistan has become now bearer of one of the biggest tree plantations drives in the world. Above mentioned discussion should be implementing in term of green productivity in Pakistan to curb climate change and socio-economic development. Just tree plantation campaigns can improve environment but with green productivity socio-economic development process will also gain boost in the country. Furthermore, Islamabad and Rawalpindi (the twin cities) having different socioeconomic and micro climatic situations are suitable to justify the green productivity scenario.

1.3 Research Question

The question: “Does green productivity really impact the urban landscape?” need to be justified and main focused of the current study to find satisfactory answer for this question so that the concept of green productivity can be coined confidently before the concern stakeholders.

1.4 Objectives of Study

Keeping in view the green productivity importance current study has been planned with the following objectives.

- To study the practicality of green productivity in urban landscape

- To identify and analyze the impact of green productivity over a period of 10 years (2010-2020), providing baseline information to NGO's, policy makers, public and academia in order to endorse and implement green productivity concept in Pakistan.

1.5 Significance of Study

Climate adaptation is now becoming increasingly important (Van den *et. al*, 2013). Climate adaptation is about dealing with and partially reducing the risks those the climate changes possess. In the green productivity infrastructure and spatial planning (Ministry of Infrastructure and Environment, 2012b) creates space for safety, a sustainable water supply and a climate-proof urban planning as national interest with spatial measures in its urban areas can respond to the changing climate and become resilient. Urban areas can prepare for climate change with each new adaptation and investment in the built environment to take climate adaptation directly into account (Ligtvoet *et al.*, 2011). Rawalpindi and Islamabad are neighbor cities and have very distinctive climatic situation due to population pressure difference and vegetation. Both cities are facing climate change and for the sustainable urban development and socio-economic wellbeing this study is a benchmark for the policy makers and administrative authorities.

1.6 Dissertation Structure

The Chapter 1 deal with introduction, purpose, objectives and scope of study. Chapter 2 comprises on the review of literature. Chapter 3 describes the material and methodology. Chapter 4 is about the result and discussion and last chapter deals with conclusion and recommendations.

CHAPTER 2

LITERATURE REVIEW

Changes in worldwide environment driven by anthropogenic exercises, particularly the consuming of petroleum products and deforestation, have been continuously expanding and are projected to increase. Expanding level of carbon dioxide in air and temperature will have critical ramifications for future production of food, security, quality and supply chain (Trebicki, 2020). Mitra and Zaman (2020) emphasized that; one of the alarming issues of the current world is the fast increase of human populace because of which lack of assets as far as food, space, work and other essential requirements have sprung up.

Increase in population generally implies increase in metropolitan population. According to the projections by UN, increase in population of rural areas has decreased globally, but the world can expect to add close to 1.5 billion urbanites in the next 15 years, and 3 billion by 2050. How the world will fulfill challenge of development with sustainability will be closely related to this phenomenon reported by Ritchie (2018). Mohsin (2019) found that; Growth in economy closely linked to consumption of energy. 13.5% consumption of energy consumption has increased. Furthermore, the increase in emission of carbon dioxide and per capita consumption of energy has also observed. Results of study uncover that urbanization and energy utilization are the significant drivers of CO2 discharges in both timeframes, while exchange plays out the inverse. Additionally, a one-way connection exists from urbanization and its square to fossil fuel byproducts. This obviously demonstrates that urbanization causes natural degradation. In this way, strategies to handle energy destitution and furthermore make it clean, limit metropolitan peculiarities and improve reasonable development were suggested by Nathaniel (2019).

Doimo *et. al.,* (2020) found that expanding urbanization, stationary ways of life, virtualization of social connections, unreliable business, environmental change and extraordinary conditions like the Covid-19 lockdown prompted an acceleration of stress and uneasiness in the worldwide populace. Stress is one of the main sources of non-transmittable disease (NCD, for example, metabolic, oncological, immunological, cardiovascular and mental problems. Both in Europe and around the world, NCD are expanding their frequency and mortality, thus quantifies for pressure recuperation and advancement of sound ways of life have become essential for general wellbeing. Wolf *et. al.,* (2020) reported that concept of green productivity or green infrastructure decrease harm like; air contamination, radiations, exposure of heat, and dust, reestablishes limits; reclamation, mental wellness, stress decrease, and clinical results, develop limits as birth results, dynamic living, and weight status by means of tree plantation especially in urban areas. Green productivity initiatives via plantation of trees give great support to general wellbeing of public and time in contact with green areas appears to have a "wellbeing reward". Regardless of whether and how much management of plantation can better to this is still ineffectively explored. There is the need to all the more likely investigation causal connections between characteristics of plantation, kind of interactions, recurrence and "dose" of meetings, responses of an individual and requirements and prosperity impacts to expand profits by green productivity based activities reported by Doimo *et. al.,* (2020).

Sun *et al.,* (2020) reported that roofs make up 20-25% of New York's urban area also gave an estimate of 16% for Greater London. In the Netherlands, 14% of the surface is built on in very urban environment. Roofs thus form a considerable part of the paved surface of a city, which has a great influence on, among other things, water management and the microclimate in the city. At the moment only a small part of the suitable roofs and facades are covered with vegetation. Li *et al.,* (2019) investigated for an entire catchment area in Athens, Georgia, what effect green roofs would have on the proportion of paved surface. They found that 54% of the area was paved, 16% of which was roofs. They found the highest proportion of impermeable surface (54-78%) in commercial areas in the inner city, the lowest (35-45%) in residential areas.

Francis and Jensen (2017) reported that if only flat roofs on commercial and government buildings were to be greened, then a decrease to approximately 50% paved surface would be possible. There are so few buildings with a flat roof in residential areas that this would only make a difference by a few percent. If all roofs were to be greened, the total share of paved surface in the catchment area would be 15-20% lower.

Green facades are another quite unusual green element in cities. Only facades with climbing plants that grow up from the ground are a bit better known. Currently, 1-2% of suitable walls in Berlin are covered with vegetation. In total, there is approximately 0.01 km^2 of wall area for every 0.1 km^2 of urban area in England (Knaus & Haase, 2020).

Köhler and Kaiser (2019) reported that for the green types of lawn, street trees and park, the green volume, and thus their share in the urban area, is usually much higher than that of green roofs and facades, so that they have a major effect. In Amsterdam, for example, 5.4% of the surface area is park and park, and only 0.04% of the surface is green roof.

Vaz Monteiro *et al.*, (2017) reported the effect of greenery at ground level was so great that it can be measured directly, for example the lowering of the UHI effect. However, due to the usually still low percentages of green roofs, hardly any measurement data is available about the effects of green roofs on a neighborhood and city scale. The data available is almost all derived from models, which extrapolate the values of individual green roofs. In modeling studies, many authors opt for a relatively high proportion of green roofs in cities in their calculations.

Versini *et al.*, (2020) considered a city with 50% of its roofs green. They modeled the situation in which all flat roofs of a neighborhood are greened. This does give a good picture of the potential effects of green roof and facade, but in reality, these kinds of percentages are not achieved anywhere at city level, possibly locally at neighborhood level.

Air consists of a variety of components, some of which are harmful. Nitrogen oxides (NO) and volatile organic hydrocarbons (VOCs) from traffic and industry in particular can lead to the formation of ozone and smog under the influence of sunlight. This has a strong negative effect on health, with peak loads in particular being harmful. Green spaces can be used in the city in two ways to improve air quality: around highly polluted places to absorb local peak emissions, and regionally to reduce background values (Viecco *et al.*, 2018).

The effect of greenery on the content of gaseous air pollutants is complex. Depending on the type, plants can absorb these substances through their stomata or in the wax layer on the leaves. In addition, many plants also produce volatile organic compounds themselves. In addition, planting types such as trees or parks act as a windbreak (P. Du et al., 2018). Since the wind plays a very important role in mixing and diluting polluted air with the cleaner air from higher layers, the windshield effect often overshadows absorption by the vegetation. A dense avenue tree planting in a street can create the “green tunnel effect”, as a result of which the air under the trees is dirtier than without plants. Air pollution can also rain out and be broken down into the ground (Tang & Zheng, 2019).

Greenery also indirectly contributes to cleaner air, because it reduces the need for air conditioning. Temperature: Insulation of buildings because green elements such as green roofs, spaces and facades have an insulating effect on buildings. As a result, less air pollution is produced by power plants. Urban green reduces the urban heat Island effect less smog is formed at lower temperatures. Greenery shading parking spaces also reduces the emission of volatile substances. Cooler cars evaporate less volatile substances, and when the car air conditioning is not on, they use less fuel (Zhao *et al.*, 2018).

Zhang and He, (2021) reported that the purification capacity of a specific plant species depends on the leaf surface. Based on their leaf surface and the needles that are also present in winter, it can be predicted that conifers have a greater cleaning capacity than deciduous trees. Deciduous trees do have a higher absorption capacity for gases. Azeñas *et al.*, (2018) provided a comprehensive overview of the available knowledge about the uptake and release of volatile substances. In general, there is a difference between wet and dry deposition: rain and dew drop on leaves increase the surface area, as does the deposition rate of various pollutants.

Gourdji (2018) measured the NO_2 uptake capacity of 217 plant species, between which differences of up to 600 times were measured. The Sedum that is used on extensive roofs probably has a low absorption capacity for NO, and the thin substrate layer also contributes little. As a result, extensive roofs are less effective than intensive roofs, which can be compared to urban forests in their composition of plant species and substrate. 19 m_2 extensive green roofs have the same cleaning capacity as an average tree. However, installing a green roof is much more expensive than planting a tree.

Sulich *et al.*, (2020) found that yet it cannot be estimated whether a green economy will generate or eliminate net employments in the extended term. After all, the demand and supply of laborer always tends to adapt to the prevailing conditions on the labor market. In a well-functioning labor market in the long term, for instance, the augmented demand for labor in one segment will exert ascending pressure on the prevailing hourly income, so that labor in other sectors will be displaced. Job creation in greener sectors will therefore displace job demand elsewhere. So, while jobs in the (greener) segment can increase in the extended term, service in the entire labor market cannot. However, in the short term and with certain policy tools against unemployment, the effect of net employment will probably be greater.

Jansma and Heck (2021) reported that there is an increasing and significant strategy focused on peri-urban and urban farming. Green metropolitan farming can (1) reprocess urban solid waste and wastewater, (2) lessen transport charges, ensure the (3) conservation of biodiversity and wetlands and (4) create inspired use of green spaces. Results from state statistics and domestic studies proposed that “up to two-thirds of metropolitan area and vicinities of urban areas in emerging nations are involved in farming”. Urban agriculture is also a much-discussed topic in developed countries.

Waste and recycling activities are also labor intensive. Lunag *et al.,* (2021) estimated that in developing countries approximately 15 million individuals are involved in collection of waste for their living. For example, in the city of Dhaka in Bangladesh a scheme to generate fertilizer from organic leftover has assisted to provide 400 new employments in collection of waste and 800 new employments in the making of fertilizer. Labors gather 700 tons of organic remaining per day to get up to 50,000 tons of compost per year. A project for the collection and reprocessing of plastic leftover has contributed to an improvement of the environmental situation and created work and income for the local population in Ouagadougou, Burkina Faso. The city can also be an engine for the recycling of valuable materials (such as cobalt, gold, etc.), this process is called "urban mining". The city is seen here as a modern mine from which metals can be extracted, such as by recycling and shredding mobile phones, computers and all other products containing raw materials; we will discuss this further in the case studies.

Amano *et al.,* (2018) studied those green spaces in urbanized areas offers an exclusive chance to recover quality of air. The trees in the city of Chicago provide air purification worth US 9.2 million dollars. The long-lasting wellbeing is projected to be extra twice the price. Figures such as these will of course always remain arbitrary or vague. Several public health services are experiencing problems related to the lifestyle of urban residents. Physical inactivity is estimated to account for 3.3 percent of all deaths worldwide and for 19 million life years adjusted for disability (DALYs). Green urban transport (promoting walking and cycling) is an exclusive occasion to associate physical motion with reduced discharge of pollution. In Europe in 1999 more than 30 percent of journeys were by car, journeys not more than 3 km, and around partial still for journeys not more than 5 km. Theoretically, these could easily be replaced by bicycle rides.

Mueller *et al.,* (2018) also confirmed the benefits of an ambitious cycling policy in cities. They argued that if all European cities were to copy the Copenhagen bicycle model (where 26 percent of journeys are made by bicycle), this would save nearly 10,000 live in addition to creating 76,000 jobs. This was calculated by the World Health Organization. The same study argues that the economic gains are enormous. After all, the job creation of 76,000 jobs only concerns direct jobs, such as people who work in bicycle shops or who carry out repairs. It is not about, for example, extra jobs in the tourism sector. For Brussels, specifically, a decent bicycle rack could create 156 jobs and save as many as 12 lives.

Nieuwenhuijsen *et al.,* (2017) concluded that it is no concurrence that urban areas with (1) a long practice of spatial development, (2) convincing community conveyance policies and (3) an emphasis on community green spaces are amongst the fittest around the globe. Among the 100 largest cities in the United States (US), Portland was number one to meet the Healthy People goals. Among Canadian cities Vancouver is the first while the cities of Munich and Copenhagen can be found in the top ten of the safest and healthiest in Europe, and in Australia healthiest and safest city is Melbourne.

Enssle and Kabisch, (2020) found that green cities and vegetation represent a range of ecosystem services with significant welfare effects. A study by Toronto's Greenbelt estimated the value of the ecosystem services at CA $ 2.6 billion per year, an average of about CA $ 3,500 per hectare. Ecosystem services continue to play a vital role as a measure to reduce risks associated with climate change. In tropical urbanized places such as Jakarta, flood risks have drastically amplified due to local deforestation. The 2007 city floods affected 60 percent of the city region, killing 80 people and forcing more than 400,000 residents to leave their homes. The 2005 floods in Mumbai, which killed more than 1,000 people and left the city completely paralyzed for almost five days (Revi, 2008), are also linked to a lack of protection of the Mithi River.

Zhang, (2020) reported that full cost pricing (internalization of external environmental costs), either in the form of taxes or with user rights, is essential to encourage companies to adopt a greener policy. Complete budget estimating measures have proven their success in handling requirement for water, food, energy and other needs and are finding a growing number of implementations in the metropolitan context. In the United States, several cities have newly presented impact taxes to cover the costs of supplementary infrastructure (such as roads, telecommunications, or schools, which were required by new developments). Impact loads can also help avoid negative rebound effects. In addition, revenues from environmental taxes can be used to reduce labor costs, thus providing an impetus for job creation.

Jayasooriya *et al.,* (2017) calculated the effect of different types of green on the air quality in cities using the UFORE model. In an urban environment, most of the capture of gaseous air pollution (NO_2, SO_2) is realized by the urban trees and shrubs, with the large trees in particular having a great effect. Planting a hedge of Juniperus around all walls, or all flat roofs (20% of the roofs) with a grass roof each yields slightly more than 10% higher cleaning capacity. All roofs fitted with a grass roof yield an approximately 20-25% higher cleaning capacity.

Besir and Cuce (2018) concluded that green roofs and facades cannot replace trees and shrubs at ground level, because the same cleaning capacity is not achieved even when all roofs and facades are greened. But it is interesting as a supplement to the greenery at ground level. These model calculations also show that the same area of intensive green roof with shrubs captures about twice as much gaseous air pollution as an extensive grass roof.

Besir and Cuce, (2018) reported that the green space in the city has several interactions with gaseous air pollution: it absorbs polluting gases from its leaves, it produces gaseous substances itself and it blocks the wind, which reduces pollution concentrations by mixing. Greenery cools the city, which limits smog formation. The effect on the air composition is difficult to demonstrate for all types of urban greenery. In models, the effect is positive, but small in relation to the amount of pollution produced. The choice of species and placement makes it possible to optimize the effect of urban greenery, for example by minimizing the wind-blocking effect.

Hossain *et al.*, (2019) found that extensive green roofs and facade greenery differ from other types of green, because they do not form a wind block. Together with intensive green roofs, they can prevent the formation of combustion gases for heating (-1%) and cooling (-6%) of houses, due to their insulating effect. The type-specific effect is therefore good, compared to other greenery, but the overall effect remains limited. All roofs fitted with a grass roof will increase the cleaning capacity of the urban green by 20-25%.

Viecco *et al.,* (2018) concluded that in the past, attention for the dust-catching capacity of greenery was focused on the number of heavy metals, such as lead, that could be captured with it. Nowadays, however, attention has shifted to particulate matter, with a particle size of up to 10 µm. The reason for this is the adverse effects these particles have on health, because they can be inhaled deep into the lungs. Zivkovic *et al.,* (2018) reported that in the Netherlands, approximately more than 2,300-3500 people die each year as a result of exposure to peak concentrations of particulate matter, and more than 12,000-24,000 people die as a result of exposure during their lifetime.

Qin *et al.,* (2018) found that the plants have several effects on the concentration of particulate matter in the air. Plants retain the dust on their leaves and branches, but also block the wind, which has an even greater effect on the dust concentration in the air. Planting can be used locally to capture peak production of particulate matter, or regionally, to reduce the background values. It is especially important for local applications to prevent blocking of the wind. plants only remove 1% of the particulate matter present from the air. It is more effective for coarser dust particles, but they are less harmful to health than fine dust. (Sysoeva and Aksenov, (2020) also assumed that the effect of urban green on air quality is of the order of a few percent reductions. However, some authors differ. According to Tomson *et al.,* (2021), the reduction of particulate matter due to greenery in street canyons (street flanked by tall buildings) could be as much as 60%.

Hörmann *et al.,* (2017) reported that the purification capacity of specific species depends on the leaf surface. On the basis of their leaf surface and the needles that are also present in winter, it can be predicted that conifers have a greater cleaning capacity than hardwood. A list with data on the species-specific cleaning capacity for fine dust of trees and shrubs, based on the leaf characteristics was compiled.

Vieira *et al.,* (2018) found that due to greater volume of trees and shrubs have a greater purification capacity than herbs. This means that an intensive green roof will have a higher purification capacity than an extensive green roof. The study showed that the same area of intensive green roof with shrubs captures 5 times as much fine dust as an extensive grass roof. Planting a Juniperus hedge around all buildings in the city has 1.5 times the purification capacity of providing 20% of the roofs with a grass roof.

When planting for this purpose, it is important to ensure that the planting is porous but contiguous. This ensures that the wind passes through it instead of around it, and as much leaf surface as possible comes into contact with the polluted air. When using facade greenery, it is good to ensure that it can reach a height of 5-7 m. At this height there is a particulate matter peak, which is caused by passing trucks. To reduce the regional background concentration, it is good to plant landscape elements with trees in the vicinity of cities (Graça *et al.*, 2018).

Silvennoinen *et al.*, (2017) found that problems with rainwater drainage often arise in cities. In a natural situation, rainwater does not flow over the surface, but is absorbed by the soil, thereby replenishing the groundwater. Some of the rain remains on the surface of the greenery and evaporates again, reducing the amount that reaches the soil depending on the type of planting. Over time, the water in the soil is partly absorbed by plants and evaporated. In cities, however, a large part of the surface consists of pavement, in which the water cannot sink but flows off superficially. It is usually drained through sewers or flows out of the city through waterways.

García Soler *et al.,* (2018) reported that if there is no extra space for greenery at ground level, roofs and facades can also be planted to improve the water management in the area. Two effects are important here: plants evaporate water and can store water. Facades hardly store any water, but they do contribute to evaporation. It was mentioned an evaporation rate of 200 l / m^2 during a growing season for a planter in Berlin. Facades can be combined with a water storage tank in the building, which, for example, collects water from the roof and makes it available for the facade planting.

Green roofs do have an effect on both evaporation and water storage. In practice, the greatest effect appears to lie in the share of the total amount of rainwater per year that is intercepted by green roofs before it goes to the rainwater discharge. How well a green roof absorbs peaks in rainfall turns out to be variable. Various authors found - depending on the local rainfall pattern and the type of roof - retention of 25 to 100% of the water that falls on the roof, with green roofs with 10 cm substrate usually scoring around 70% of the annual total discharge (Gillefalk *et al.,* 2021)

Meilvang, (2021) investigated the effect of green roofs on the drainage of an entire urban catchment area in Athens, Georgia. The effect appears to be greatest for fairly small showers. If there is a shower of 12.7 mm, greening all flat roofs results in a 19% reduction in the volume of the run-off water, and greening all roofs for a 37% reduction. This is especially noticeable by the less high peak in the water discharge, hardly any delayed discharge. With a rainfall of 79.2 mm, green flat roofs only reduce the run-off by 3.6%, and greening all roofs results in a reduction of 7.6%.

Dai *et al.,* (2018) reported that in the Netherlands, showers of this magnitude occur on average once every 20 years. It was concluded that green roofs alone are not sufficient as a measure to process rainwater. But a combination of green roofs with technical measures for collecting and cleaning water is cheaper than applying centralized technical measures only.

Motasim, (2018) modeled the water balance in a residential area. They found that in order to restore the natural water balance, 30% of the roofs should be provided with a green roof, combined with wadis, in which the water from these roofs can sink into the soil. The wadis are necessary to keep the water in the area and to restore the groundwater level.

Moosavi *et al.,* (2020) found that the non-paved surfaces in the city, including urban green, are important for good water management in the urban soil, to prevent problems with rainwater drainage, and for cooling by evaporation. Green roofs have a significant capacity for water retention and evaporation. They can handle a very large part of the rain that falls throughout the year. Green facades only contribute to water management through evaporation. By greening 30% of the roofs (plus construction of wadis), the natural water balance of residential areas can be restored. This is a practically feasible and economically valuable effect.

Boas Berg *et al.,* (2020) reported that there are several properties of green roofs and environmental factors that affect the retention of rainfall peaks. These are the same factors that are responsible for the total annual retention. The situation of the roof at the start of the storm plays a big role: the more the roof was already saturated with water, the less water will be retained from a new storm because the size of the measured showers, the types of roofs and the initial situation of the roofs varied greatly, the measured retention times and volumes also differ greatly.

Raimondi and Becciu, (2021) concluded that green roofs and other forms of lowering the percentage of paved surface make a good contribution to absorbing smaller showers. Technical measures such as collection basins are more suitable for absorbing the peak of major showers (which occur less than once every 2 years). However, by lowering the percentage of paved surface, one not only achieves a reduction in peak discharge. It also (partly) restores the natural hydrology of an area.

Nazif *et al.,* (2021) reported that urban green is valuable for absorbing rainfall peaks, because water can sink into the unpaved surface and the plants evaporate it. Green roofs and facades also evaporate, and roofs have a temporary collection capacity for rainwater, which can be optimized in the design if desired. This means that extra temporary storage capacity for water can be realized in the city, without taking up additional space at ground level. This works well for small and medium-sized showers, but with large showers, the storage capacity of green roofs is insufficient.

Yu *et al.,* (2020) found that the Urban Heat Island effect (UHI) is the fact that the temperature in cities is higher than in the surrounding countryside, especially the peak temperatures on hot days. This is especially the case in the Urban Canopy Layer, the lowest layer of air that extends to the roofs of buildings, which is strongly influenced by processes on a micro scale.

Leal Filho *et al.,* (2018) investigated that this effect is a problem especially on hot summer days, as people's health and work productivity suffer from high temperatures. The adverse effects are especially noticeable above 27.7 ° C ambient temperature. To counter this, air conditioning is often used, which entails costs and energy consumption. In the Netherlands, it is on average 2.3 ° C warmer in cities on summer days than in the countryside, but the temperature difference can reach up to 5.3 ° C (with the 5% highest peaks being omitted). In half of the cities where the measurements were taken, it was uncomfortably warm on average 7 days a year, but in peak Rotterdam it was 15 days a year.

Yang *et al.,* (2018) found that the cause of the UHI effect lies in the different ways in which materials react to solar radiation. Buildings and paving absorb a large part of the solar radiation and convert it into sensible heat. Plants reflect some of the solar radiation and use absorbed radiation for photosynthesis and evaporation of water. In addition, the large 3-D surface of the planting releases its heat to the air more easily than a smooth paved surface, so that the heat is transported upwards more quickly with the rising air. Due to these effects, it is cooler above plants than above pavement. In addition, trees and shrubs cast shade, making it cooler under and next to the plants. This effect depends on the amount of leaf, which is represented by the Leaf Area Index (LAI). In calculation models, a tree with a LAI of 1 (= 1 layer of leaf between sun and measuring equipment) gave a cooling of 0.5 ° C and with a LAI of 5 a cooling of 1.1 ° C.

Cao *et al.,* (2019) estimated that the effect of green roofs in cities can be as much as 3 °C cooling. However, they indicate that the use of green roofs can have some undesirable side effects. For example, evaporation increases the humidity, which gives a higher perceived temperature. Also, by lowering the temperature, the air currents above the city can change, which in specific cases can result in a lower mixing of the warm, dirty city air with clean, cool air from outside.

Kim *et al.,* (2017) found in satellite measurements at the city of Chicago, that an increase in the albedo by 0.2 decreases the local ambient temperature by approximately 1 degree. The same temperature drop can also be achieved by increasing the NDVI (photosynthetic activity on a surface) by 7%. The maximum cooling that can be achieved with rising the albedo was 3.1 °C, the maximum cooling with the help of vegetation at 6.5 °C. In both cases, the highest value that was actually measured in Chicago was taken as the maximum, not the theoretical maximum. For a cooling effect, the NDVI must be at least 0.35, and the green roofs (including a semi-intensive roof) in the measurements all had a lower NDVI. The measured temperature drop was only 0.1 °C. Grass at ground level does have a higher NDVI; this type of planting may be denser or may have a better water supply, resulting in more photosynthesis. Street trees and fallow overgrown areas also have a high NDVI with associated cooling. When looking at individual buildings, the local cooling effect of reflective roofs is sometimes much greater, in one example 5 °C cooling was caused by an increase of 0.16 in the albedo.

Shih, (2017) found that a green roof reduces the peak radiation (of absorbed solar heat) by 70% compared to a conventional roof, and the average radiation by 52%. A white roof had an even stronger effect on the deterioration of the appearance. For areas of high irradiance, the use of white or reflective roof is the cheaper effective solution for this limitation of the appearance of buildings than green roofs. However, reflective roofs have only one function, while green roofs have many. Now there is little literature about the effect of green facades on the neighborhood or city scale. On a building scale, there are indications that facades can also contribute to the reduction of the Urban Heat Island. A green-covered wall on a hot summer day was more than 10 °C cooler than an uncovered wall.

Galdies and Lau, (2020) The effect of green roofs and facades on the ambient temperature is usually measured at a small distance from the roof or facade and compared with a non-green roof or facade. In this way, a very large cooling effect can be measured. However, this cannot simply be translated into a temperature drop at greater distances. It was measured using satellite images that greening a roof only provided 0.1 °C of cooling. It was measured the cooling effect at different heights above a green roof in Hong Kong: average 5.2 °C on the roof, 0.7 °C at 10 cm above, and no measurable cooling on 1.6 m above the roof.

Yu *et al.,* (2018) reported that surfaces and air do not react in the same way to the factors that increase and decrease the temperature. Especially during the day, there can be a significant difference between surface temperature and air temperature. This is the reason that the effects of a green roof on the building insulation are greater than the effects on the UHI: the first works via the roof temperature, the second via the air temperature.

H. Du *et al.,* (2017) found that no comparative measurements were known of the effect on the air temperature of different types of green roofs. Theoretically, an intensive green roof (high evaporation due to good water supply and large green volume) should have a greater cooling effect than an extensive green roof (low plants that evaporate little during drought). The air in a park is usually cooler than in the rest of the city, which can save up to 3 °C. Even in a small park of 40 by 60 m a decrease in temperature was already found, and in a park of 100 m^2 a decrease of 0.8 - 1.3 °C was measured. Moreover, an effect on the size of parks; for the most consistent and best cooling, a park of 3 ha or more was needed. Not only were the measured parks themselves cooler, but the effect extended to their immediate surroundings, for a very large park up to 1 km away. It was also reported this cooling distance for a park of 0.6 km^2.

Aram *et al.,* (2019) found that the size of the area affected also depends on the surrounding buildings; in high-rise buildings, the air mixes less and the cooled area is smaller. It was also reported that in a Toronto model, peak temperatures dropped to 2 ° C when 50% of the roofs were overgrown. They modeled the effect of different amounts of greenery in a high-rise district in Hong Kong. Trees were more effective for street-level cooling than grass; for 1 °C cooling, the tree-covered surface should be at least around 30%. Cooling at street level with plants work better between lower buildings (20 m) than between higher (60 m).

Shada BV *et al.,* (2018) studied that in the Netherlands, it was measured how much the UHI effect decreased, depending on the percentage of greenery in a block of 600 by 600 m around the weather station (at neighborhood level). Every 20% more greenery resulted in a 1 degree drop in temperature, on the hottest summer days. The cooling effect of surrounding greenery was more pronounced at street level (in "urban canyons") than at roof level. The large amount of water in Dutch cities has a cooling effect for part of the day, because it warms up slowly. But it also cools down slowly, so it can increase the UHI effect at night. The level of the UHI effect does not appear to be very much related to the size of a city, but it does correlate with the population density: if it increases by 3000 people / km2, the UHI effect will increase by 1°C on the hottest summer days.

Buccolieri *et al.,* (2018) looked at the effect of roof and facade greenery on the temperature peaks in "street canyons", the space between tall buildings. Vegetated roofs and facades were able to lower the temperature by 2-4 °C in the London model. According to their model, facade green has a greater effect on the temperature in the canyon than roof green, but the roof green has a greater effect on the temperature of the city as a whole. Green roof plus facade provided the strongest cooling to the city.

Dadvand and Nieuwenhuijsen, (2019) found that green roof and facade have an insulating effect on buildings. This creates a pleasant living environment, but also reduces the energy requirement for heat and cooling. A lot of measurements have been taken, especially on green roofs. Insulation is one of the effects of green roof and facade, with which the owners and users of a building can save money and recoup the construction of the greenery. However, it is less easy to calculate than with an inorganic insulation material, because the insulation factor does not remain constant. This varies with the content of water and air in the substrate: the insulating effect is often greater in summer than in winter.

Bevilacqua *et al.,* (2018) reported that the average energy saving was 1%, but the cooling saving was 6%, and the cooling saving during hot summer days was 25%. This makes the construction an especially interesting alternative for locations that must be kept cool with an air conditioning system.

Ran and Tang, (2017) reported that research has been done on a "green mantle" for buildings. In this method, climbing plants grow on a climbing support along the facades and above the roof of a building. This is actually a combination of a green roof and a green facade, with the advantage that this technique can also be used for roofs with a low load-bearing capacity. This resulted in a reduction of the summer peak temperatures in the building by up to 3.1 ° C. Moreover, the green facades also insulate well against summer heat. The maximum temperature difference between a sunlit wall with and without green facade panels was 16 °C. The green facade also delayed the transfer of heat from outside to inside the building by several hours. The moisture content of the medium and the distribution of moisture in the panels turned out to be an important factor in the insulation value.

In addition to the wall temperature of different types of green facades and decrease in wind speed was studied by Maiolo *et al.,* (2020). The temperature remained almost constant (on a cool day) as the green facade was approached closer and closer from a distance of 1 m. It was only cooler in the substrate layer of facade panels. In all cases, the wind speed only decreased between the foliage of the plants. Facade panels appear to have a higher insulation value than climbing plants or planters, especially because an extra air cavity, substrate and load-bearing layers have been applied to the facade.

Walters and Stoelzle Midden, (2018) concluded that green roofs and facades are regularly used for food production. In third world countries and for about 20% of Westerners, saving on food expenditure is the main reason. Only 75% of gardeners have a vegetable garden for fun because vegetable gardening is a fun outdoor activity. Some vegetable gardeners find it a good fit for an environmentally friendly lifestyle, or they need food autonomy and control over the way food is produced.

Wright *et al.,* (2021) reported that the most traditional form of food production on roofs and facades is the use of fruit-bearing climbing plants and espalier fruit along walls. This method produces food with an efficient use of space. In addition, many fruits benefit from the warmer microclimate in front of a (south) wall, which means that the growing season is shifted, and fruits also ripen in climates that are a bit too cold. Now there is great interest in using roofs for food production. This is already happening on the roofs of restaurants in the USA and Japan, where herbs and vegetables are grown and sometimes even bees are kept for their own honey. This development is also underway in the Netherlands. It is often used just as much for its environmentally friendly and / or innovative appearance as for its production. Roof vegetable gardens are also being laid out for communal use. Many of these projects also have a social component: they offer the unemployed labor and cheap vegetables or want to strengthen ties in the community.

H. Farhangi *et al.,* (2020) reported that not much research has yet been done into the effects that large-scale rooftop food production can have on the other ecosystem benefits. For example, the use of fertilizers can cause deterioration in the quality of the water run-off from the roof. Local food production appears to be beneficial for the environment, because fewer transport kilometers have to be made. But potting soil and fertilizers, for example, must be supplied, and production may be less efficient than in large-scale agriculture and horticulture. An example calculation: Amsterdam has approximately 800,000 inhabitants, and 40 km2 of roofs are available for greening. According to the WHO, 1 hectare of land can feed about 6 people. This means that, even if all suitable roofs were fully used for food production, the roofs would only be able to produce 3% of the necessary food for Amsterdam. Now roofs will not quickly be used to grow fodder maize, grain or sugar beets, but rather for crops for human fresh consumption such as vegetables, fruit and herbs. As a rule of thumb, a vegetable garden of 40-50 m 2 can provide one person with vegetables, fruit and herbs. Then the 40 km2 roofs could serve up to 1 million people and make Amsterdam self-sufficient in this area. The production capacity of roofs is therefore not negligible. But whether a roof is set up as a vegetable garden is the choice of the owner.

Shafique *et al.,* (2020) found that the green roofs can contribute to energy production. This provides for part of the residents' energy needs, and also gives them the opportunity to become more energy autonomous. The most well-known way of energy production on green roofs is with solar cells (photovoltaic panels). These types of panels are known to operate less efficiently at high temperatures. It saves 0.25 - 0.5% yield for every degree Celsius above 25 °C ambient temperature. On hot summer days, when a panel could supply an above-average amount of power, this is inhibited on a conventional roof by the high ambient temperature, which can reach up to 70 °C. It is much cooler just above a green roof than above a conventional roof. As a result, the panels supply more power. The combination of green roof - solar panels has the pleasant side effect that the shade of the solar panels creates a greater variation in living conditions on the roof, which benefits biodiversity.

Guan and Yu, (2021) described a second way in which a green roof could contribute to energy production in the future is by designing the roof as a Plant Microbial Fuel Cell (PMFC). In this process, microorganisms generate electricity in the substrate of a green roof, fed by the substances that the plants on the roof secrete in their roots. This system has not yet been tested in practice, but it has been tested on a laboratory scale. A precondition for this is that it only works with plants that grow in wet or swampy soil, a type that is rarely found on green roofs until now. It is expected that, after optimization, an output of 3.2 W / m2 green roof could be achieved, which could, for example, cover 1/3 of the electricity needs of a household. An advantage of this power production system is that it also provides most of the other ecosystem benefits of green roofs.

Manso *et al.,* (2021) found that green roofs and facades affect human health in different ways. Some of the aforementioned physical effects play a role in this, such as lowering peak temperatures in the summer, cleaner air and soundproofing. In addition, the presence of greenery has a direct effect on well-being. Greenery exerts this influence on people through observable properties, such as the ornamental value, scent, changes during the seasons and the animal life that is attracted by the greenery. A number of positive effects can also be caused by the aspect “green space view” alone.

Sen and Guchhait, (2021) examined which aspects of roof and facade greenery are found attractive. Not all attractive elements of greenery - such as naturalness - apply to roof and facade greenery, as this will by definition be located in a human-dominated environment. But within urban green there is a difference in appreciation between neglected and well-maintained greenery. Well-maintained greenery is more appreciated and provides a greater sense of security than neglected greenery. Furthermore, there is a preference for low, neatly arranged greenery over randomly placed greenery and for well-growing plants over languishing vegetation. Many weeds have a negative effect, and an increased proportion of flowers in the vegetation have a positive effect on the valuation. White found in a survey in England that an ivy facade was most appreciated, followed by a pasture-mixed roof. The other roof types tested were a mowed grass roof, “brown” (local natural vegetation, such as on a vacant lot) and sedum roof.

FAO (2014) stated that the green economy, the urban green space (trees, parks etc.) makes a beneficial input to human livelihood, through the marketable and marketed products and enterprises based on tree plantations, and the generation of income and new jobs, while preserving biodiversity, and keeping up and creating urban tree plantations biological system administrations on an economical premise, all related are in reference of changing climate. The green productivity opens new aspects for development and work in the urban green spaces. Singhal. V. *et. al.*, (2014) describes the green space is beneficial for the employees that are working in their office feels comfortable if green space is present. The loose their tensions, work efficiently and remain cool state of mind. Trees present along or inside the area of office can minimize the energy cost. As proof for the staggering effects of air contamination on human wellbeing keeps on expanding, improving urban air quality has gotten quite possibly one of the most critical issues confronting policy creators around the world. There are technical evidences, that presents the green infrastructure (GI) is a mutually advantageous solution for urban air contamination, decreasing the concentration of contamination without limiting the traffic and other causes of pollution reported by Hewitt *et. al.*, (2020).

The Communication on green infrastructure and productivity from the European Commission describes green infrastructure as a tool that delivers environmental, economic and social benefits through natural solutions and helps us to value the benefits nature brings to human society and mobilize investment to maintain and enhance those benefits reported by Grellier (2017). Liquete *et. al.*, described (2015) in other words, it is a network of natural and semi-natural areas and green spaces that provides ecosystem services that promote human well-being and quality of life. Green productivity can offer many useful functions and benefits within one spatial area. These functions can have an environmental dimension (e.g., conservation of biodiversity or adaptation to climate change), a social dimension (e.g., providing for water runoff or green space) or an economic dimension (e.g., job creation or enhancing the value of real estate). What makes green productivity and infrastructure attractive is that, unlike solutions based on gray infrastructure (concrete based), which usually fulfills one function (such as discharge or transport), it can offer a solution to several problems at the same time. Traditional gray infrastructure remains indispensable, but can often be reinforced with natural solutions of green productivity reported by Langemeyer (2020).

Van Oijstaeijen *et. al.*, (2020) stated with an example; green productivity can enhance too much rainwater ending up in sewers and ultimately lakes, streams and rivers, based on the natural retention and absorption capacity of soils and vegetation. The benefits that green infrastructure can offer in this regard include broader carbon storage potential, better air quality, reduction of heat islands in urban areas, expansion of wildlife habitats and more space for recreation. Green spaces also contribute to the ethnic and historical sites by making places recognizable and help determine the appearance of cities and urban agglomerations where people live and work. Study shows that solutions based on green productivity are cheaper than gray infrastructure (concrete based) solutions and have numerous side effects that benefit local economies, the social fabric and the wider environment reported by Nieuwenhuijsen (2021).

According to a study conducted by (Yuliani et al., 2020) there are also elements of green infrastructure for which this does not apply. Management of underground natural water channels such as green roofs, for example, often has a clear function, and there are benchmarks to measure their efficiency. The business case for green productivity and infrastructure can also seem problematic, although as mentioned, these solutions not only offer many advantages, but are often also cheaper, more robust and more sustainable. Designers should therefore no longer rely on gray solutions such as dikes and pipelines for flooding issues, but should first look at the benefits that the restoration of flood plains or wetlands can bring reported by (Meerow, 2020).

(Alves et al., 2020) found that green infrastructure is the foundation of the EU's policy for biodiversity, but for the protection of biodiversity it is more than just a tool. It can impact prominently to the execution of objectives of Union policy related to development of regional and rural areas, disaster risk management, agriculture, environment, forestry and the climate change. The importance of green infrastructure is also recognized in other areas of European policymaking, notably in the Seventh Environment Action Program (7th EAP), Regional Policy 2014–2020, the Water Framework Directive, the Nitrates Directive and the Floods Directive and the EU Adaptation Strategy to climate change. All these initiatives will hopefully lead to strengthening the use of green infrastructure as a policy tool and to practical solutions at the local level reported by Krämer (2020).

Bowen & Lynch (2017) found that; urban areas are usually hotter than the rural areas. The houses made of stones and bricks, boulevards and squares trap a lot of heat and release it slowly. It is studied that the temperature was 5 to 10 times higher in the middle of the city during the nights of summer than the green spaces. This happens also occurs in smaller towns and rural areas. Gashu and Egziabher (2019) reported that; due to many causes it is important to avoid and reduce higher heat in metropolitan areas. It is really harmful for human lives especially people from older age group, children and patients of heart diseases. Alves *et. al.*, (2019) described, heat waves cost human lives: each degree that the temperature rises further during a warmth wave is reflected in death toll. In the warmer time period stretches of 2003 and 2006, for instance, somewhere in the range of 1000 and 2200 a greater number of individuals just died in the Netherlands than in a usual year. This worries individuals who in any case might have lived any longer, as per research. Moreover, work profitability diminishes during warmer periods of year, there are negative ramifications for development, quality of water and so on. By evaporating water, green vegetation helps to lower the temperature in an urban area. Thus, the direct rise in temperature of air and infrastructure reduces to much extent. Where a roof made of bitumen can heat up to 70 degrees in the scorching sun, a roof designed with grasses, mosses and plants will not get warmer than 32 degrees in the same conditions, provided that sufficient water is available reported by (Cascone, 2019).

Ferreira *et. al.*, (2020) found that greenery beautifies the environment, furnishes constructions and raises the attraction of the area, developing an improved business environment for both inhabitants and companies. With green business parks, the metropolitans offer information intensive companies a working site that international faculty and clienteles like to stay. Furthermore, an urban area with more green spaces also offers more eye-catching and healthier living surroundings, making it calmer for businesses to hold staff. (Du Toit *et al.*, 2018) reported that; trees provide shadow. In the shadow of trees, the rise in temperature observed much lesser as experienced by people, provided there is also sufficient ventilation. Shade thus helps prevent from stress of heat. Due to the evaporation and shadow, green places and parks in the urban vicinity keep the temperature lower which can be measured away from the green space.

Beaugeard *et. al.*, (2020) quoted that; 'enjoying nature in your surroundings, educational institutes or work and business places that is also imaginable in the urban vicinity via green infrastructure". More and more nature are discovering the city, turning the city into its own ecosystem with a diverse range of animal and plant biodiversity. The selection of tree species depends upon the geography and climatic zone of the urban area. A city with green spaces i.e., parks, gardens, street and roadsides with thick lush green flowery and grassy vegetation and small water ducts attracts beautiful birds, fireflies, butterflies and many other beautiful animals. Roofs and facades decorated with green vegetation and plants also play an important role to the natural significance reported by (Lepczyk *et al.*, 2017).

Villaseñor *et. al.*, (2020) found, by applying biological supervision in government and private green spaces, residents, organizations and the municipal government can play important role in the protection of unique and imperiled species, for example, wild honeybees. These unique kinds require not just a standard grassy lawn; they incline toward a diverse biotope with numerous local plants. A particularly common city likewise gives a climate wherein youngsters and grown-ups can wonder about the rich variety of metropolitan biodiversity. Pauleit *et. al.*, (2019) found; green infrastructure is a promising concept when developing multifunctional green space systems to address major challenges of urbanization such as increasing social cohesion, promoting the transition to a green economy, adaptation to climate change and conservation of biodiversity.

Abhijith *et. al.*, (2017) reported; tree plantation based green productivity initiatives can play a significant role in mitigating urban air pollution. Air quality changes in local built environments due to vegetation are assessed. Low-level hedges improve air quality in street canyons unlike high-level trees. Green walls and roofs are effective to reduce pollution in streets/open roads. Prior design of green infrastructure should be performed for improving air quality. APO (2014) reported Pakistan's status in the respective domain. Most green productivity activities were carried out for energy efficiency, audits and conservation for industry and buildings. Lack of energy audits for other 28sectors (e.g., agriculture and SMEs), green productivity implementation carried out under different names, e.g., green growth, clean production, green economy, climate change adaptations, ecosystem restorations, waste minimization. Green productivity activities scattered, poorly reported/documented, without any coordinated mechanisms.

Ünüvar, (2019) found that three things are very important when we talk about financing a green economy. Mainly attaining a full overview of the present economic situation in way of possible profits. This investigation often has to be centered on the local and global contrast with cities of similar size. In addition, metropolitan administrations must introduce many types of collaboration with native industries and civil society organizations. If urban areas develop a policy for commitment, act in a transparent manner and do not lose sight of the importance of profit on investment for private bodies, then there is a lot of scope for stimulating private wealth. Third, vertical and horizontal linkages are essential. Corporations and alliances ensure inter-urban collaboration and local / worldwide contribution within many native government policy and strategy platforms. Numerous of the green productivity ventures are within the reach of metropolitan governments, who can use public or corporate / reserved capitals for the preliminary investments. For example, the huge cost of the new metropolitan railway setup is being paid by the urban railway company, the MTR Corporation, which is capitalizing on the property potential of its stops and stations as share of a combined railway ownership expansion model. Corporate funds are also used for initial investments in Paris and London. For example, the rental of city bikes is paid for by companies in exchange for advertising space. Once the initial investment is made, these projects generate a steady stream of income that can be reinvested. Some projects do not even require an initial capital investment because they depend on legal regulations, such as the green construction programs in Berlin or Austin.

Joshi and Dhar, (2020) reported that investing in education and training is another priority at city level in both developing and developed countries. Green technology training and skills training is needed for employees and potential employees to ensure they have access to "green employment". Finally, Table 6 shows some UK examples of necessary training for carbon neutral jobs. These were developed by the Institute for Public Policy Research to illustrate the nature and extent of the additional training that will be required to achieve a transition to a carbon neutral economy.

Geng *et al.,* (2019) concluded addressing the energy needs of existing buildings is a priority for cities. In addition, urban green building strategies also focus on more efficient use of other resources such as water and materials. Three main green building strategies are distinguished: (1) design, (2) materials and technology and (3) behavior-related strategies. Passive design solutions to improve the environmental performance of buildings can guarantee the greatest cost-effectiveness, especially in developing countries. For example, coastal housing projects in Puerto Princesa (Philippines) are designed to reduce energy demand through more natural light, better ventilation and a cooling effect of the roof covering.

Groppi *et al.,* (2018) reported that in cities, the demand for energy is concentrated and - in a classic model - there is reliance on external energy sources. However, cities have the option to either (1) slow down energy distribution or (2) optimize its efficiency by lowering energy consumption and implementing green energy systems (district heating and heat energy installations). Rizhao, China has transformed itself into a "solar energy city", in the central districts 99 percent of households already use solar water heaters. In Freiburg, solar panels supply 1.1 percent of the city's electricity demand. A biomass plant and wind turbines provide a further 1.3 and 6 percent, respectively, of the city's energy needs.

Ding *et al.,* (2020) found that in Oslo and São Paulo, nearby hydroelectric systems are used to obtain a relatively high share of renewable energy. Wind and tidal energy are increasingly important sources of renewable energy for cities. Geothermal energy can also be used to provide cities with reliable, safe and cheap electricity. In Manila, 7 percent of electricity comes from geothermal sources. A decentralized energy system with district heating systems can provide heating and hot water in large urban complexes (such as hospitals, schools or universities) or residential areas. It can bring about a significant reduction in the total energy demand. Efficiency can be further improved with a combination of cogeneration and power generation systems. The district heating system in Copenhagen, for example, supplies 97 percent of the city with "waste heat".

Wang *et al.*, (2019) reported that cities consist mainly of buildings and infrastructure, they can still contain a significant portion of open space. Despite the continued growth, cities like Johannesburg, London and Delhi maintain large areas of green open space (parks, public gardens and private gardens), while other cities, such as Cairo, Tokyo or Mexico City have much less green space. Parks protected green space and gardens, street trees and landscaping provide vital ecosystem services, as green lungs absorb and filter air pollution, or they function as filters for wastewater. They also provide habitat for wildlife, as well as recreational benefits for city dwellers. As mentioned above, a study by Toronto's Greenbelt has shown that wetlands and forests can be seen as one of the most valuable assets in terms of ecosystem services such as carbon storage, habitat, water regulation and filtration systems, flood management and waste treatment.

Stessens *et al.*, (2017) found that the presence of green landscaped areas helps to regulate natural processes. Such as limiting local extreme temperatures, when the tree cover increases by ten percent, the energy consumption for cooling and heating reduces by five to ten percent. Vegetation and open space also play a role in reducing rainwater volumes. In this way, cities help to control the effects of heavy rains and are effective in helping to protect against flooding in coastal cities. New design strategies have been groundbreaking (1) for developing green roofs and facades on / on buildings, (2) for adding different natural (as opposed to man-made) spaces in cities, and (3) for decreasing of energy demand. Itabashi City in Tokyo, for example, promotes creepers as "green curtains" around public buildings and private homes to prevent buildings from overheating in summer and to reduce the use of air conditioning.

Liu and Jensen, (2018) studied that city need a significant transfer of water from the countryside to the city. Water leaks during transfer must therefore be prevented, which requires an appropriate policy. The upgrading and replacement of pipes has contributed to net savings of 20 percent on drinking water in many industrialized cities. Between 2000 and 2010 alone, Tokyo's new water system reduced water waste by 50 percent. The most effective mechanism for conscious water use is to charge for water per volume used. Many cities therefore have water meters installed and forgo simple taxes on access to water. One measure to maximize the usefulness of fresh water is its use in stages. Wastewater is recovered and can be used in another process where the quality requirements are less strict.

Meng and Hsu, (2019) found that to further reduce water consumption and provide alternatives to tap water, rainwater can be used as drinking and non-drinking water. Such services can only be performed in cities where there is a greater willingness to pay for water than in rural areas. To combat serious water shortages in Delhi, the city required rainwater collection and use for all buildings with a roof surface of more than 100 square meters and a plot of more than 1,000 square meters. It is estimated that 76.5 billion liters of water per year will become available for groundwater replenishment. If these estimates are correct, this would result in savings of US $ 16,000 per day. Tax incentives have also proven their success. Austin's (Texas) tax rebates for water recuperation save an estimated 8.7 liters of water per person per day for every unit in a household that has a rainwater recuperation system.

A city's food footprint has a major impact on its green credibility, especially when considering the energy consumption created by transporting food from remote locations to urban marketplaces. The food supply of European cities, for example, accounts for about 30 percent of their total ecological footprint. In general, urbanization is associated with a loss of nearby agricultural land and an increase in demand for finished food products from urban consumers. Significant reductions in the food footprints of major cities such as London and NYC have become increasingly evident in recent times, and there is also evidence that farmers' markets are re-establishing links between inner cities and regional agriculture. Other cities benefit from their location in the heart of rich agricultural landscapes, reducing the need for long food supply routes. In Milan, up to 40 percent of the daily produce is grown within a radius of four (travel) hours from the city reported by Tumpa *et al.,* (2019).

Lin *et al.,* (2017) found that about 15 to 20 percent of the world's food is produced in urban areas. The growing role of urban food production is a common feature of many global cities in developing countries. Estimates show that 35 percent of Nakuru, Kenya households were engaged in urban agriculture in 1998 and nearly half of Kampala, Uganda households in 2003. Successful urban agriculture projects are also spread across a number of western cities. They make use of communal gardens, roofs and unused urban spaces. In shrinking cities like Detroit, for example, some urban farms have been set up in some areas where there was very low development pressure on the land. In recent years, urban agriculture projects have been a priority in many cities.

Savini, (2019) reported that due to the high concentration of people and activities, cities have become centers of the "waste economy" (the so-called waste economy, which is opposed to a circular economy), which plays a dominant role within a city's ecological footprint. Yet cities are very resilient when it comes to finding green solutions that (1) reduce the total amount of waste, (2) increase recycling and (3) employ groundbreaking new forms of environmentally sound treatment of unavoidable waste. In large cities in developing countries, waste collection is often inadequate. In these cities there is sometimes a large workforce of mostly informal recyclers, such as the Zabbaleen in Cairo, who have implemented sophisticated reuse and recycling systems. These jobs, however, are usually not consistent with adequate work requirements. Also, green waste strategies (in this context) often fail to recognize the potential of these actors and implement expensive, technology-driven recycling models.

Basova *et al.,* (2019) concluded that recycling levels are around 50 percent in many European cities, while Copenhagen sends only 3 percent of waste to landfills. In 1991, a green exchange program ("cambio verde") was started in Curitiba, Brazil, which encourages people to exchange recyclable waste for fresh fruit and vegetables. These fruits and vegetables are in turn purchased by the city from local surpluses. Composting is also a critical component for greening the waste sector. Positive examples range from decentralized composting in Dhaka to urban food composting programs in San Francisco.

Summary

The urbanization and climate change are deteriorating the socioeconomic situation. There is an urgent need to implement green productive policy in town planning and sustainable use of resources. Tree plantation and green infrastructure are the part of town planning in the modern world. Many world’s leading and developing countries including Japan, Neither land, Germany, United States, England, Bangladesh, Nigeria, India, Brazil etc. are implementing green productivity in their cities and new development policies. Green productivity improves environment, health, energy conservation, food security and overall socioeconomic condition of the area. It’s the need of time to connect Pakistan’s Ten Billion Tree Tsunami Project with concept of green productivity to earn more benefits sustainably.

CHAPTER 3

MATERIAL AND METHODS

This chapter comprises on the details of adopted methodology to conduct this study and the tools which were used to collect data and its analysis.

3.1 Study Area

Tabular illustration of different parameters of study areas is given below.

Table 1- Details of Study Areas

Parameters	**Islamabad**	**Rawalpindi**
Coordinates	33°44′15″N 73°08′51″E	33°20′N 73°15′E
Area	1,165.50 km^2	5,286 km^2
Highest elevation	1,500 m (5,000 ft)	2,790 m (9,160 ft)
Lowest elevation	490 m (1,610 ft)	300 m (1,100 ft)
Population	2,006,572	5,405,633
Population Density	2,089/km^2	8,100/km^2
Distance between both selected study areas is just 16.6 km		
Source: Pakistan Population Census 2017		

As the objectives of the study described previously about to analyze the practicality of concept of green productivity, the study was conducted in two phases. In first phase random sampling of drinking water was done from Sadiqabad an area of Rawalpindi city (Figure 2) which is most densely populated area having less number of trees and plants and the other samples were collected from the Bahria town, Margalla hills, Islamabad (Figure 1) which has more lush green area having relatively more trees and plants. In the second phase a well-defined and well-prepared survey was carried out in above mentioned areas of Rawalpindi and Islamabad with the help of a questionnaire. The questionnaire was related to the personal information interest towards the trees, vegetation in urban areas and importance of forests near the residents and how the residents were willing to conserve their resources for their betterment and to improve the quality of life.

3.2 Sample Collection

Total 20 water samples were collected from both sides 10 from the Sadiqabad and 10 from Bahria town. Water samples were collected from the open public tap points from the above-mentioned areas which were not treated by any purification plant in order to find the best results. Before the collection of the drinking water, bottles containing samples were thoroughly rinsed with the distilled water to avoid contamination and then one litter water sample was collected after flush of water to receive the actual sample of water. Triplicate of 100 ml of each sample was taken in different plastic bottles and airtight caped (Khan *et al.*, 2013).

The meteorological data containing mean maximum temperature, mean minimum temperature and average annual rainfall was collected from the reliable meteorological sources for previous 10 years to study the impact of trees and the pollutants level found in the samples. In the second phase about 100 well prepared questionnaires were evaluated by the local dwellers of the locality of proposed study area of Rawalpindi and Islamabad. In this connection diversity was kept under consideration to find the best result of the study, from a common man to highly professional person, to collect their views and suggestions about the asked questions.

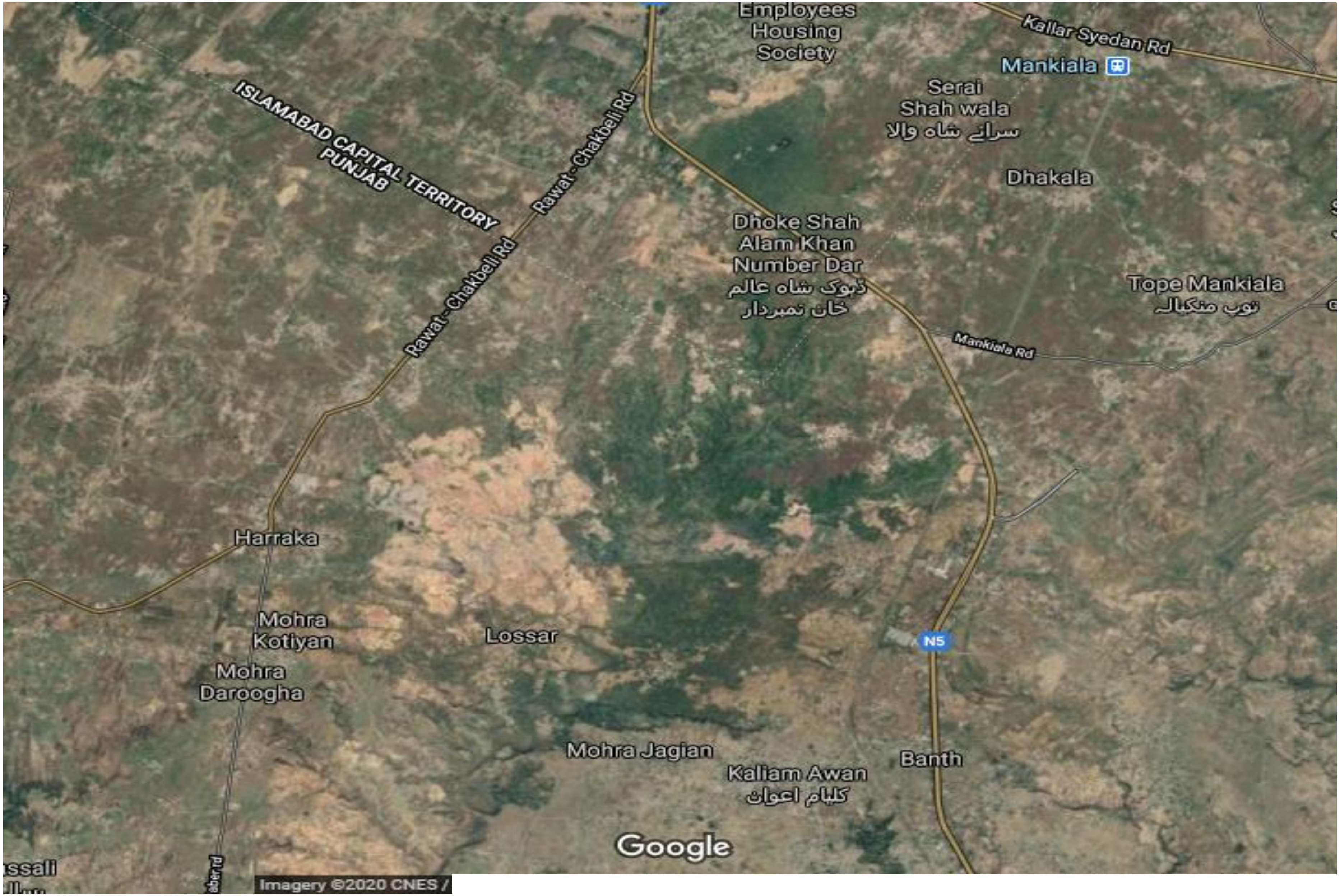

Figure 1: Bahria Town, Islamabad Source: Google Earth

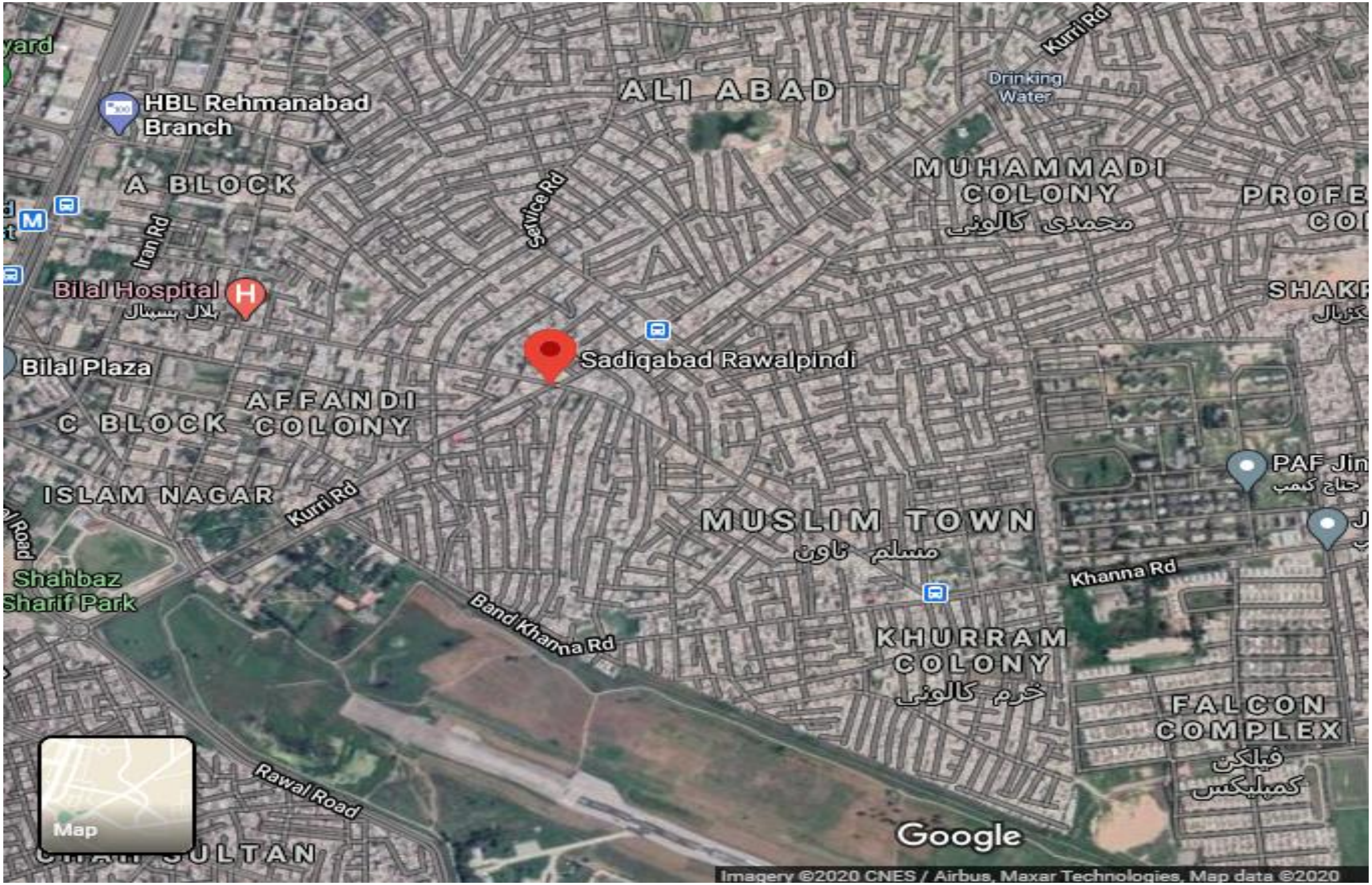

Figure 2: Sadiqabad, Rawalpindi Source: Google Earth

3.3 Sample Preservation and Transportation

The samples collected for analysis of heavy metal were stored in plastic bottles and transported to lab for analysis. No preserver or any chemical was added as per standard methods also followed by Abbas *et al.* in 2015.

3.4 Time for Sampling

The data was collected for analysis respectively from 15th November 2020 to 27th December 2020 in autumn season. The following characteristics were monitored according to standard methods.

Table: 2. Analytical methods adopted for different Physiochemical Parameters

Sr. No	Parameters	Analytical Procedure	Instrument
1.	pH	On Site	pH meter (model HI 98130 HANNA)
2.	TDS	Laboratory	Turbidity meter
3.	Chloride ion	Laboratory	Mohr Method
4.	Alkalinity	Laboratory	Computer aided titri-meter
5.	Total Hardness	Laboratory	EDTA Titration

3.5 Physical Parameters (On Site)

According to APHA 1998, to assess and analyze some of the water properties accurately the samples must be test on sample collection site mainly including pH, Temperature, Turbidity and Total Dissolved Solids.

3.5.1 pH

The pH meter (Figure 3) was used to measure the pH level of water samples. As per standard method of use, before testing the samples pH meter was normalized with three different solutions having pH level of 4.0, 7.0 and 10.0. The pH level of water samples was measured by dipping the probe of pH meter in each sample under study. Probe was washed with deionized water after each sample testing to get pure calculation without any impurity.

Figure 3. pH Meter (model HI 98130 HANNA)

3.5.2 Turbidity

The turbidity of water is like cloudiness appearance of water due to impurities which was calculated by standard turbidity meter (Figure. 4). After treatment of every sample with sample regulator and kept for 5 minutes inside the apparatus and noted the stable reading.

Figure 4. Turbidity Meter

3.5.3 Total Dissolved Solids (TDS)

TDS was calculated of water samples by standard method of vacuum filtration as prescribed by APHA. Water sample was taken in the glass fiber filter which was pre-weighed and was according to the size of apparatus before starting the filtration process. The filtered mass was collected on aluminum plate and kept for 23 hours at 100°C in an oven. The weight of filtered mass was done on electric balance. Furthermore, the gravimetric process was used to measure accurate values of TDS of collected samples (APHA 1998).

3.6 Analysis of Chemical Parameters

The water samples were tested for chemical analysis including alkalinity, chloride ion, hardness and bicarbonates.

3.6.1 Alkalinity

Alkalinity was measured with pH electrode and Computer Aided Titri-Meter (CAT). Alkalinity is about the concentration of $CaCO_3$ in water samples.

3.6.2 Total Hardness

Ethylene Diamine Tetraacettic Acid (EDTA) titration method was used to analyze the concentration of calcium, magnesium ions etc. to find out the hardiness of water samples.

3.6.3 Chloride Ion

Mohr method was used to find out the chloride ions in water samples. The samples were titrated with Silver Nitrate ($AgNO_3$).

3.6.4 Statistical Analysis

For the phase-1 of the study method related to physiochemical properties of water analysis of variance (ANOVA) was statistically used with Randomized Complete Block Design (RCBD) and 0.05 significant level was selected to compare parameters of both study sites. The mean of treatment was compared at 5% level of probability for multiple comparisons (Steel and Torrie, 1997).

ANOVA

ANOVA stands for analysis of variance. Like the t-test, this analysis compares means and is also used to test hypotheses. This test allows you to compare 2 or more groups or categories. The test measures the difference in two parts; the variance within the groups and the variance between the groups are compared. If one of the groups differs significantly in mean value, that results in a low P value for the entire test. If $P > 0.05$, then there is no difference between the means of the groups. If $P < 0.05$ there is a difference between the means of the different groups. The analysis technique was invented by British statistician and geneticist Ronald Aylmer Fisher in the 1920s – 1930s.

For the phase-2 study method related to survey regarding socioeconomic situation of the dwellers of the study areas, analyzed by using Microsoft Excel and Statistix 8.1 software. Statistix is statistical analysis software in field since 1985. Statistix offers powerful data manipulation tools, import/export support for Excel and text files, linear models (including linear regression, logistic regression, Poisson regression, and ANOVA), nonlinear regression, nonparametric tests, time series, association tests, survival analysis, quality control, power analysis, and more.

CHAPTER 4

RESULTS AND DISCUSSION

The results depicted variations after analysis of the twenty water samples collected from the selected study sites.

4.1 Physiochemical Parameter

The tap water samples collected from study areas were analyzed for physiochemical parameters such as pH, hardness, alkalinity and total dissolved solid on the spot as well as in laboratory according to standard methods recommended for analysis.

4.1.1 Temperature of Water

The deviation of temperature among water samples collected from both sites was minor. The maximum temperature was 34.5 degree centigrade while the minimum recorded temperature was 33.0 degree centigrade. The temperature was significantly higher of water samples collected from Sadiqabad, Rawalpindi. Moreover, the deviation in the temperature was recorded insignificant in study area of Islamabad. The results found similar to the study conducted by Coville *et. al.,* (2020) as they found the lower temperature of water in green infrastructure.

4.1.2 TDS (Total Dissolved Solid)

The prominent significance variance was observed during analysis of TDS levels in water samples collected from both sites. The unit of TDS is parts per million (ppm). A range of 421 to 936 ppm was observed in water samples from Sadiqabad, Rawalpindi whereas in Bahria town, Islamabad its range was from 339 ppm to 623 ppm. (Hancock et al., 2020) also found that dense vegetation holds the soil in roots which cause less erosion and eventually lesser TDS of water. The compression of result mentioned in Figure 5.

4.1.3 pH of Drinking Water

The results were significant ($p<0.05$). The analysis of pH in drinking water samples indicated that pH of samples collected from Bahria Town, Margalla, Islamabad had lower pH level than Sadiqabad, Rawalpindi where pH level was higher which is not suitable as healthy drinking water (Fwen Hoon *et al.*, 2020).

The results are comparatively similar to the study conducted by (Asadi *et al.*, 2019). They found the higher pH level in densely urbanized area and relatively lower pH level in tree covered areas.

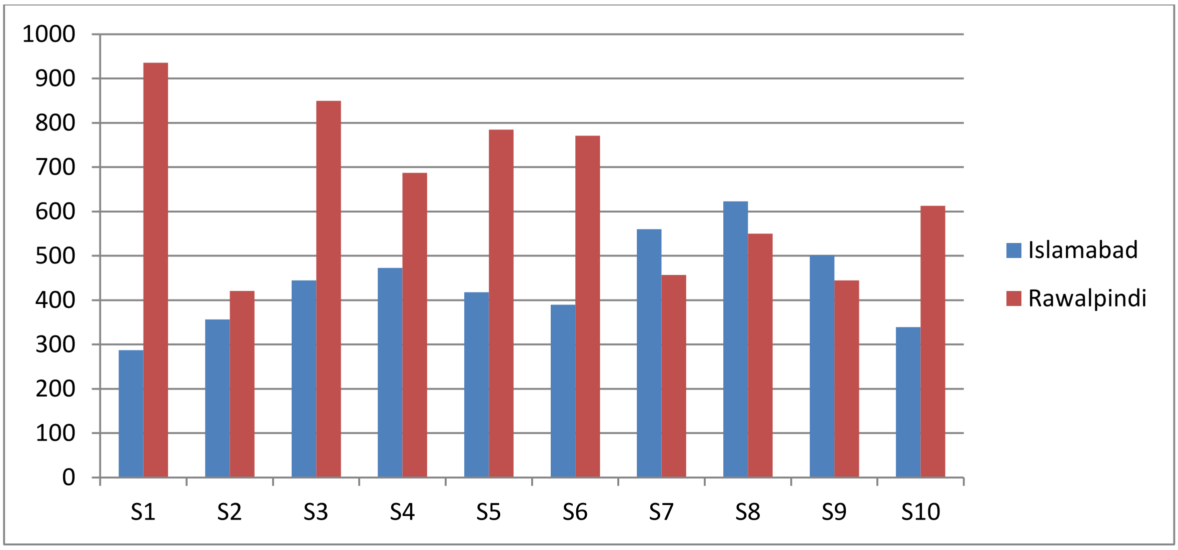

Figure 5: Comparison of TDS in Drinking Water samples
Source: Government Soil and Water Testing Laboratory

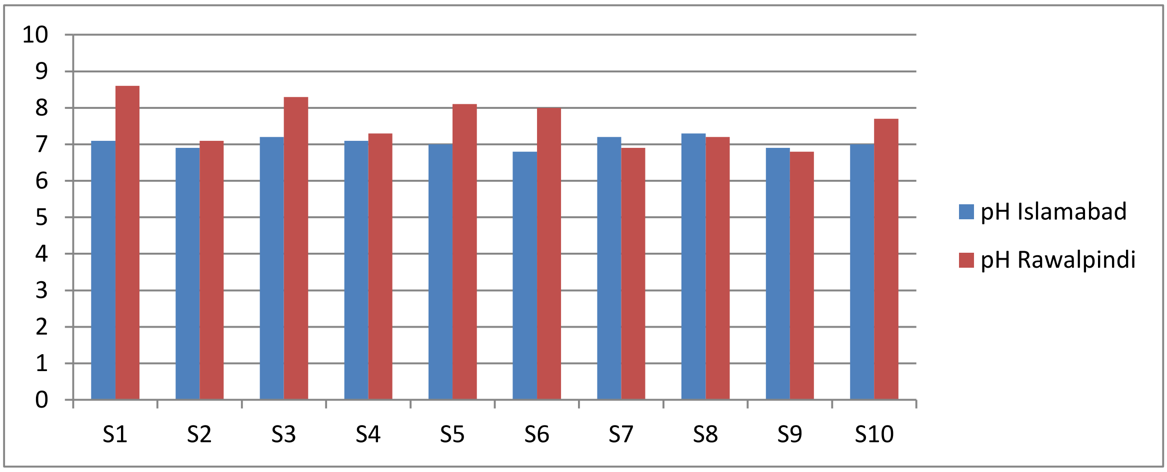

Figure 6: Comparison of pH in Drinking Water samples
Source: Government Soil and Water Testing Laboratory

4.1.4. Alkalinity

Alkalinity is the property which resists against making water more acidic. Alkalinity of water stables the acidity of water and to inhibit the reaction within metal contaminants. Contamination of carbonates and bicarbonates cause alkalinity in water. The analysis of alkalinity in drinking water samples indicated that alkalinity of samples collected from both study areas. The water samples from Bahria town, Islamabad depicted lower concentration of bicarbonates and carbonates. The findings of study are as same as Daud *et. al.*, concluded in their study regarding alkalinity level of drinking water in Islamabad, since 2017. Results are shown in Figure 7**.**

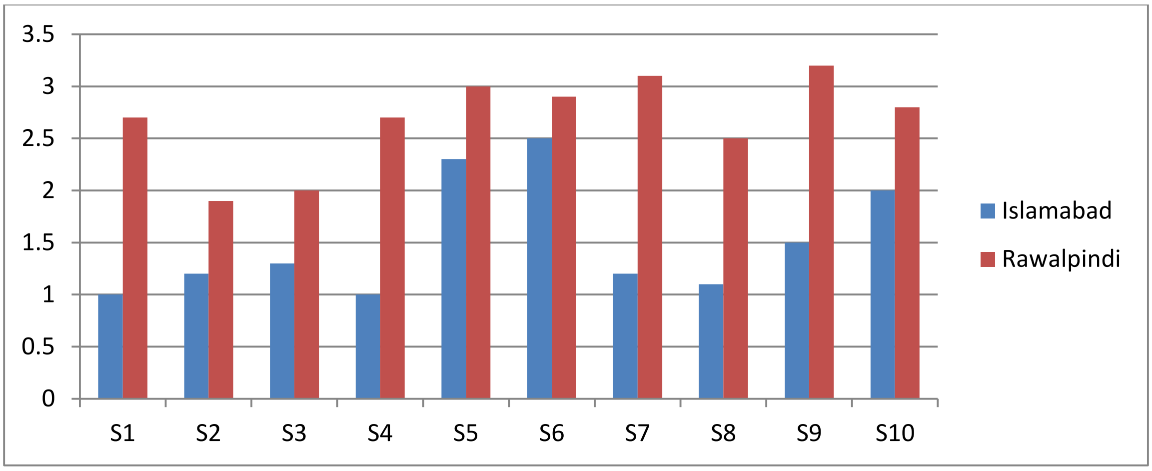

Figure 7: Comparison of Alkalinity causing bicarbonates in Drinking Water samples
Source: Government Soil and Water Testing Laboratory

4.1.5. Chloride Ion

Silver Nitrate ($AgNO_3$) titration method was used to analyze concentration of chloride ion in the water samples and the significant variance was observed. The water samples collected from Sadiqabad, Rawalpindi showed higher significant values of chloride ions, unsuitable for drinking. Whereas, water samples from Bahria Town showed lower level of chloride ions concentration. (Rakib *et al.*, 2020) also documented the same study results about higher chloride ions contamination in urban areas. The results have been mentioned in the Figure 8.

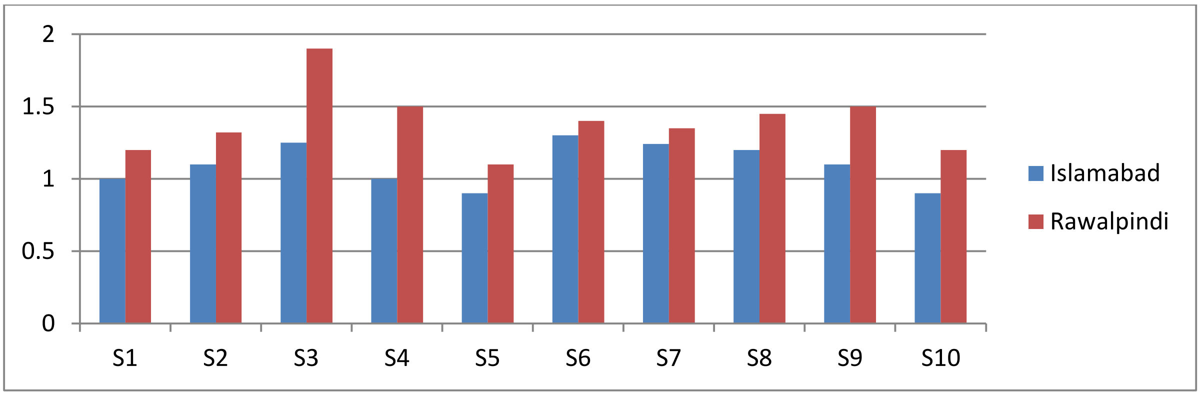

Figure 8: Comparison of Chloride Ions in Drinking Water samples
Source: Government Soil and Water Testing Laboratory

4.1.6. Hardness

Hardness of water samples depends upon concentration of magnesium (Mg^{+}) and calcium (Ca^{+}) ions. Results showed a prominent deviant in concentration said ions in water samples. Higher significant concentration values were found in water samples from Sadiqabad, Rawalpindi, a dense urban area while the water samples from Bahria town with much greenery showed healthy level for drinking water. Reyes *et. al.*, (2020) found the similar results of higher water hardness in densely urbanized area. Results are mentioned in the Figure 9.

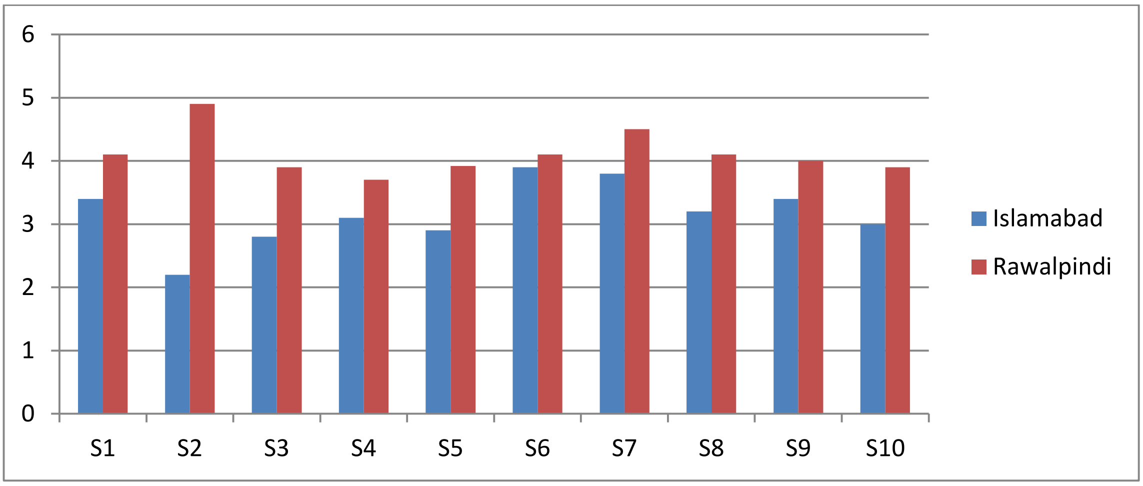

Figure 9: Comparison of Hardness in Drinking Water samples
Source: Government Soil and Water Testing Laboratory

4.2. Environmental Parameters

The data of environmental parameters (i.e., temperature, rainfall etc.) of previous 10 years from 2010 to 2020 including average annual rainfall mean maximum temperature and mean minimum temperature. This data was evaluated and analyze to justify the importance of green space and infrastructure. The 10 years data is mentioned in form of graphical figures for better understating.

4.2.1 Rainfall (mm)

Rainfall data of past 10 years from 2010 to 2020 was analyzed and observed that the rainiest years for Islamabad recorded were 2019 and 2020 about from 85.1 mm to 102.45 mm in the month of August respectively (Figure 10).

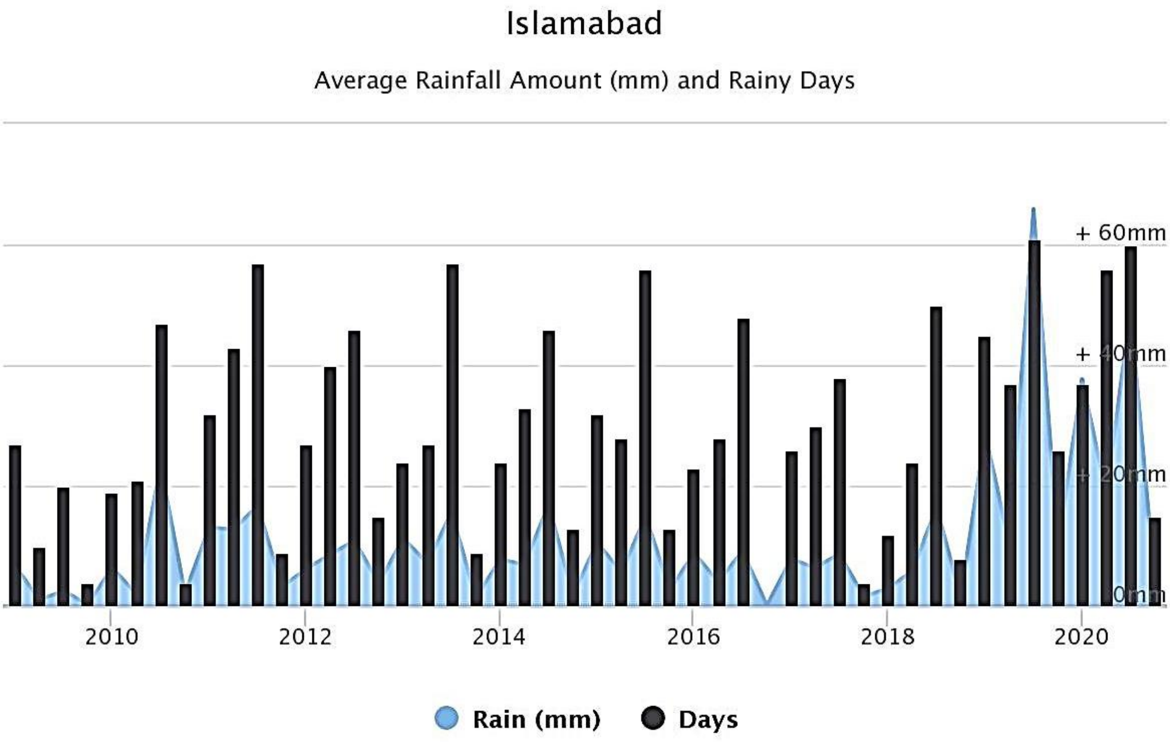

Figure 10 Source: Ministry of Climate Change Pakistan & World Weather Online

In the same years and same month, Rawalpindi received 63.85 mm in August 2019 and 78.08 mm in August 2020 (Figure 11). Since the Islamabad has more green spaces than Rawalpindi. Zabret and Šraj (2019) also documented the higher rainfall in the areas with tree plantation than the areas with no or lesser trees.

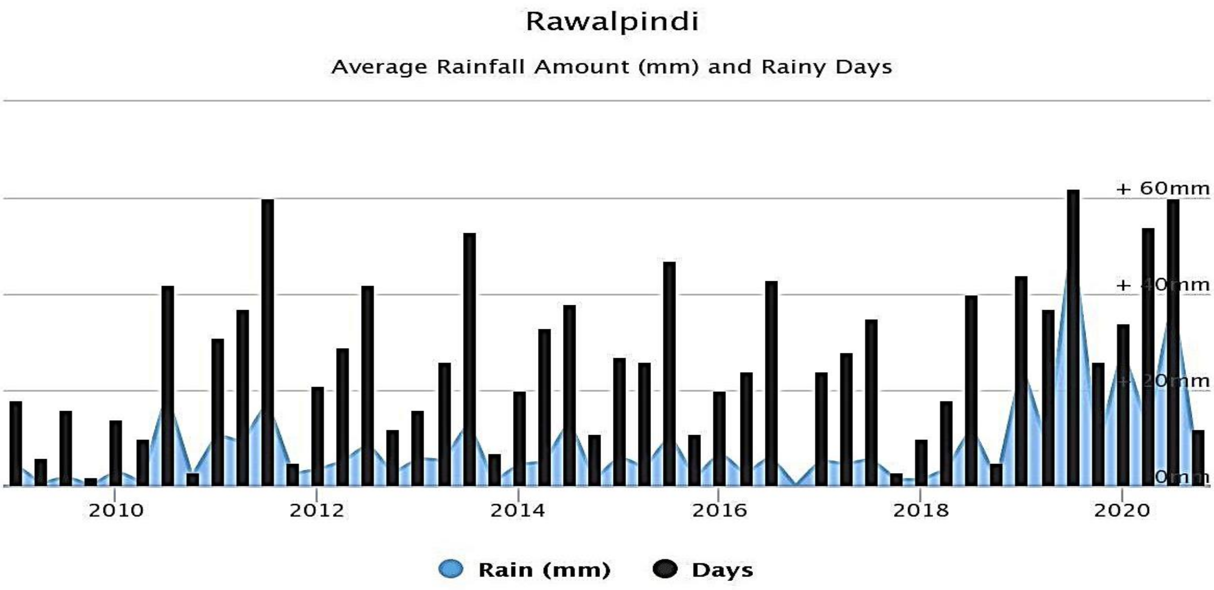

Figure 11 Source: Ministry of Climate Change Pakistan & World Weather Online

4.2.2 Max Temperature (ºC)

For 10 years the maximum temperature in Rawalpindi (Figure 12) and Islamabad (Figure 13) in months of June and July, year 2020 was recorded 41ºC, which is on trend to rise due to climate change. This is alarming and a natural call to plant more trees.

4.2.3 Min Temperature (ºC)

For 10 years the minimum temperature in Rawalpindi (Figure 12) and Islamabad (Figure 13) in month of January, year 2011 was recorded 5ºC. However, the minimum average temperature was 11 ºC.

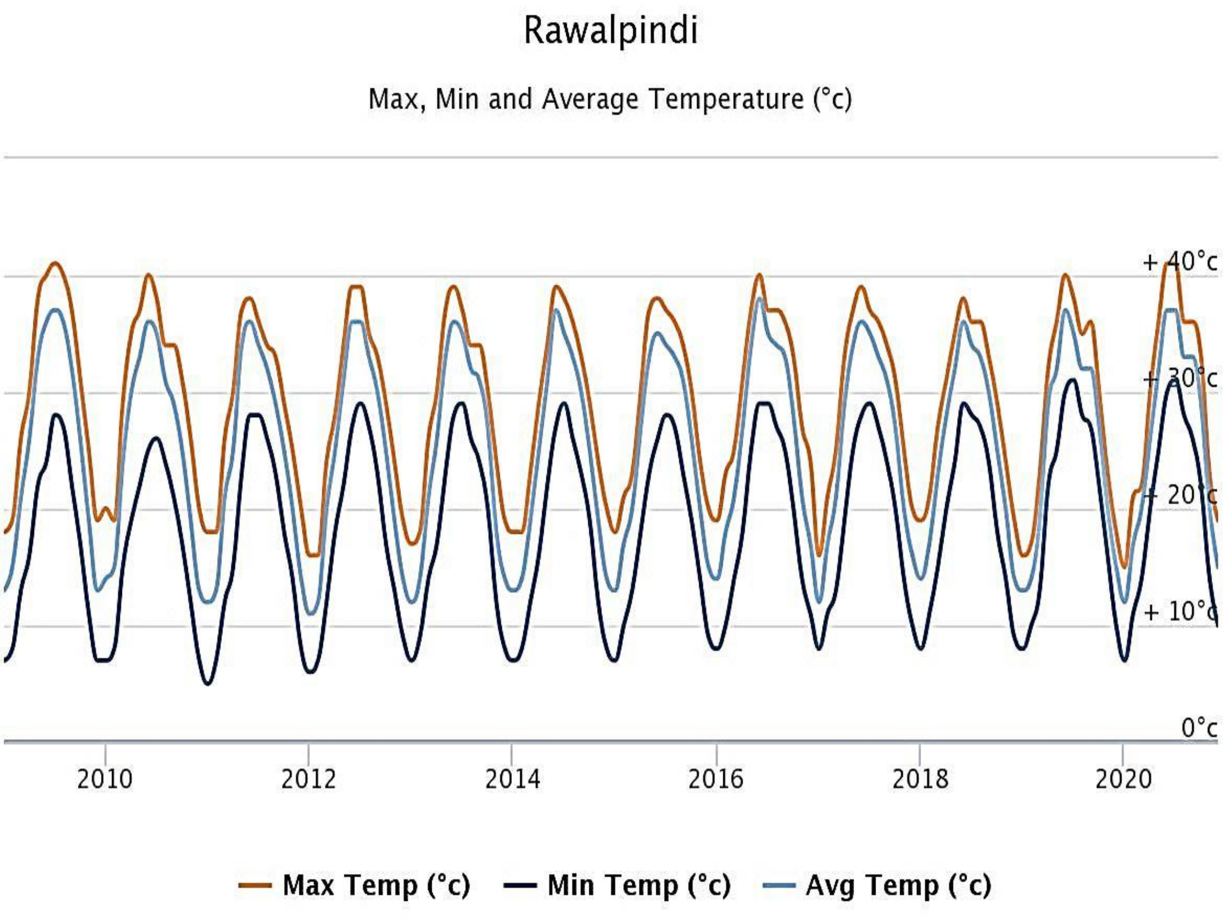

Figure 12 Source: Ministry of Climate Change Pakistan & World Weather Online

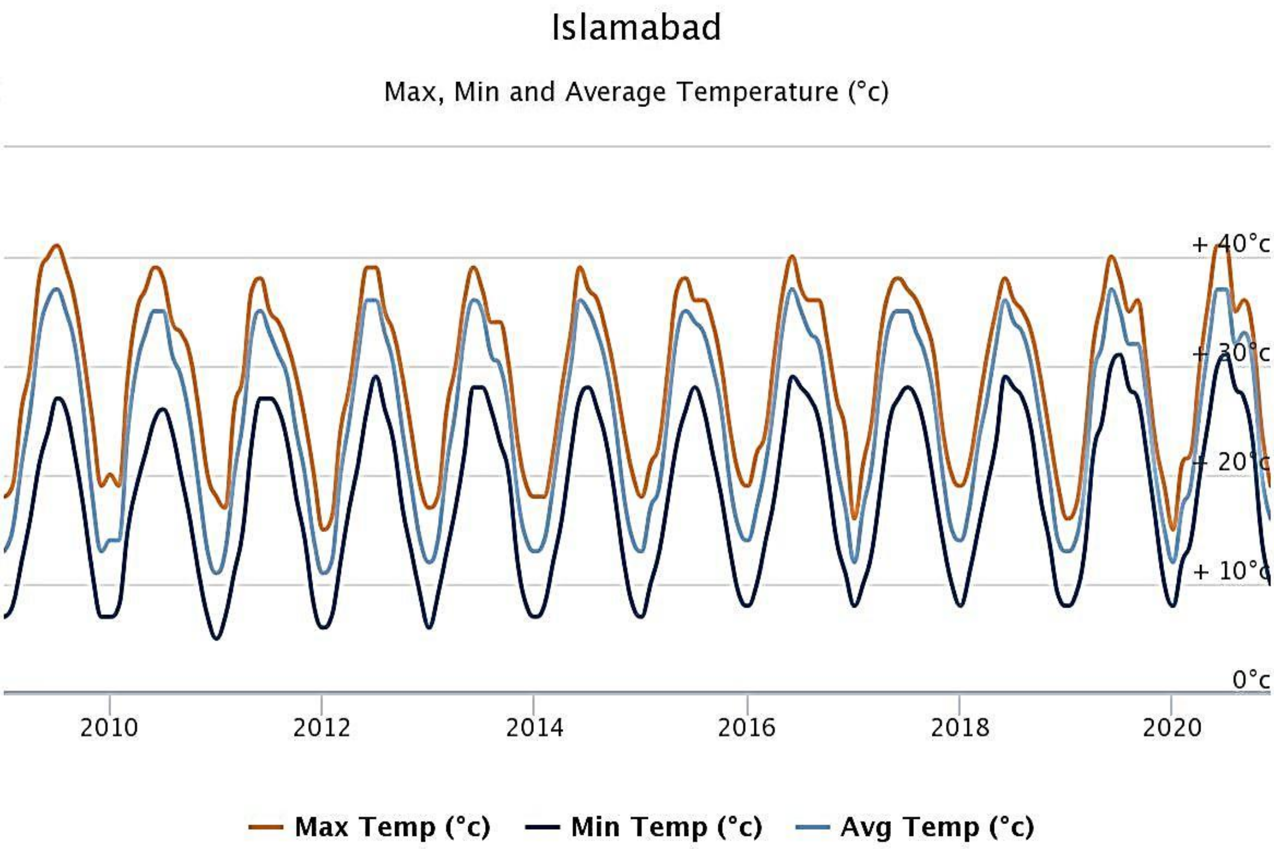

Figure 13 Source: Ministry of Climate Change Pakistan & World Weather Online

4.3. Survey

The phase-2 of methodology comprised on an interview survey. The primary purpose of the study was to understand the perception of inhabitants of both study areas regarding tree plantation and green infrastructure to explain it in term of green productivity. Experience and feedback added insight to the research questions posed in this study. By listening to and analyzing the experiences of these participants, valuable information was collected regarding their socioeconomic situation and willingness to live in a green productive environment.

In this section, the two research questions are discussed with supporting evidence, including both quotations and feedback from participants.

The results of this qualitative study are based on interviews of total 100 dwellers from both study areas i.e., 50 participants from Sadiqabad, Rawalpindi and 50 participants from Bahria Town, Margala Hills, Islamabad. All dwellers voluntarily participated in the study.

The participants were selected randomly in the study areas. The location coordinates of Sadiqabad, Rawalpindi are 33°20′N 73°15′E with highest elevation of 2,790 m (9,160 ft) and lowest elevation of 300 m (1,100 ft) while total area of Sadiqabad, Rawalpindi is 5,286 km^2 with 5,405,633 population having population density of 8,100/km^2. The study area of Bahria Town, Margala Hills, Islamabad has the location coordinates 33°44′15″N 73°08′51″E with highest elevation of 1,500 m (5,000 ft) and the lowest elevation of 490 m (1,610 ft) with the population of 2,006,572 heads having 2,089/km^2 population density.

Interview times varied and were scheduled at times conducive for all participants and the researcher. The researcher also took field notes during each interview. All interviews were conducted during the months of November and December 2020 in autumn season.

The part 1 of interview had a brief introduction about the purpose of the study, who would have access to the participant's responses, the participant's risks and rights, and when the interview data would be discarded. The intent was that the researcher would read each participant the introduction verbatim as part of the interview. The researcher orally improvised this introduction many times when talking with participants in order to get the initial interview protocol started in a timely and comfortable manner. The researcher felt comfortable hitting the major points outlined in the introduction and asking each participant, "Do you have any questions before we begin?" In both study areas most interview questions were asked exactly as they were written. However, the researcher often followed up the semi-structured questions with open-ended questions such as, "Why?" and "Can you tell me more?" This was the researcher's way to get at deeper meaning and richer understanding of the participant's experiences. In Sadiqabad, Rawalpindi, in the middle of the first interview, the researcher decided to add a question to the initial interview protocol. The question added was, "Would you like to live in a tree plantation or in a concrete jungle, which would you prefer? Why?" This question was added to get further feedback from participants about the overall value, or lack of value, that they believed they gained because of their awareness and experiences. All other participants from Sadiqabad, Rawalpindi were asked this question near the end of the interview.

Research Questions

1- What is the current socioeconomic situation of dwellers of study areas?
2- What impact of available green spaces and tree plantations they perceive?

Results:

Tree plantation and green spaces reduce the noise and air pollutions.

Green infrastructure offers a healthy living.

Green productivity ensures the energy consumption

Above mentioned outcomes answered the research questions in terms of both socioeconomic situation and better experience/awareness. Point 1 regarding reduction in air and noise pollutions directly induce a good impact on healthy life. Point 2 and 3 depicted the economic benefits in term of less expenditure on medical situation and electricity consumption, both are the decent socioeconomic benefits.

On question of medical expenditure, the participant 3 from Sadiqabad, Rawalpindi study area replied, “the annual expense of medication is around PKR 18000/-”. While the average calculated annual spent on medication is PKR 22800/- is the highest expense on medication from the study area of Sadiqabad, Rawalpindi. Meanwhile, in the study area of Islamabad the average annual expense on medication is PKR around PKR 6000/- the minimum calculated average was PKR 5400/- per annum expense on medication from the study area of Islamabad.

Similarly, the disease frequency was recorded highest from Rawalpindi study area. The participant number 39 from Rawalpindi study area, quoted; “the noise and air pollution due to heavy traffic is the main cause of unrest and diseases in the vicinity”. While the participant number 23 from the study area of Islamabad expressed his views; “We are living here with trees which is a blessing, Islamabad is green and silent which makes it one of the beautiful capitals in the world”.

It was observed during questioning that the dwellers of study area from Rawalpindi have lesser average per annum income than the study area of Islamabad which has the average earning per annum around PKR 720,000/-. It was observed in the study area of Rawalpindi that people were paying more electricity bills than dwellers of the study area of Islamabad. The highest average consumption of electricity was recorded in the study area of Rawalpindi which was PKR 94,500/- per annum based on usage of air conditions. Participant number 34 from the study area of Islamabad revealed that “due to highly vegetative area the use of air conditioner is not in peak”. While the participant number 13 from the study area of Rawalpindi said, “due to rise in temperature the use of air conditioner is inevitable”.

It was delightful to know that most of the participants from both study areas are aware about the importance of trees and green spaces and showed eagerness to plant more trees in their areas. The participant number 11 from the study area of the Rawalpindi replied, “I know the trees are important to reduce air and noise pollution and I’ll plant more trees if the government will provide me the plants”. For the better illustration, the results are also mentioned in the form of comparison of both study areas in the given Table. 3.

Table 3. Survey Results Comparison of Study Areas

Parameters	Sadiqabad (Rawalpindi)	Margala Hills (Islamabad)
Income of Interviewee	Average minimum 108000/- PKR per annum	Average minimum 720,000/- PKR per annum
Planting Practice	Below 50%	More than 50%
Satisfaction Regarding Plantation in Area	90%	91%
Money Spent on Electricity Bills	PKR 94,500/- per annum	PKR 16,800/- per annum
Disease Frequency	42%	Below 40%
Medical Expenses	Average PKR 22,800/- per annum	Average PKR 5400/- per annum
Dust and Noise Pollution	93% dwellers suffered	10% dwellers suffered

The data mentioned in the above table (Table 4.) showed that the people lived in Sadiqabad, Rawalpindi were become victim of these chronic diseases due to non-availability of clean water and polluted surroundings. Out of hundred interviewees, most of them were patient of cough and asthma. The other diseases were due to poor quality of water like, hepatitis, stomach diseases and diarrhea etc.

Table 4: The Disease Prevalence of Dwellers

Disease	Frequency
No disease	58
Chronic cough	13
Asthma	22
Lung irritation	2
Other	5

The presented results from interviews are evident and supportive to the rational of the study. The study area of Sadiqabad, Rawalpindi has very lesser green spaces and trees than the study area of Islamabad. The dwellers of the study area of Rawalpindi are more susceptible to suffering from chronic diseases, paying more on medication and energy consumption, living in the area having higher noise and air pollution than the study area of Islamabad which has more trees and green spaces.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Climate change has become a substantial threat to the environment, economy and health and lifestyle of inhabitants. Over last decades Asian countries make their and undergone sustainable development and urbanization programs with efficiently use of energy Water and air quality is degraded due to the emission of poisonous gases and liquid pollutants emerging form power plants, kilns and industries. The rising planet temperature from previous years is also alarming.

The present study was conducted in the area of Sadiaqabad, Rawalpindi and Barhria Town, Islamabad to analyze the impact of green spaces in green productivity for wellbeing of socioeconomic and environmental development. The twenty experiment samples were taken from random places within study areas both from Rawalpindi and Islamabad and analyzed by physiochemical parameters (temperature, TDS, pH, hardness, alkalinity and chloride ion) to assess the water quality under consideration of quality standard by introducing six treatments with three replications in RCBD layout as illustrated in methodology. Physiochemical parameters show the significant difference between the two sites and from previous ten years meteorological trend showed uncertainty about rainfall while maximum temperature is going up due to less plantation and cutting of existing tree cover.

It can be concluded that the water quality from both sites significantly differ from each other in term of chemical concentrations. Water samples collected from Sadiqabad, Rawalpindi depicted prominent contaminations in comparison with the samples collected from Bahria Town, Islamabad. Similarly, survey the qualitative part of the study showed also difference in the study areas. Information received from questionnaire survey from the site residents living in the Sadiqabad, Rawalpindi affected with many chronic diseases like; asthma, chronic cough, lung disease while those live surrounded with vegetation has no significant disease. Shortly urban tree plantation in term of green productivity enriched the area and have many beneficial compensations through their pay back strategy in a sense of climatically, economical and environment ailment.

5.2 Recommendations

As the quantitative and qualitative results are in support of our study, here are few recommendations that may help to the nation for health, economic and environmental betterment.

- People should have awareness about benefits of plantation and green productivity.
- Tree plantation drive should be organized with proper planning to boost green productivity and wellbeing of human health.
- Policy makers, NGOs and other authoritarian institutes should include and increase green spaces and green infrastructure to boost up productively green urban areas.
- On the bases of the analysis and results from the present study it is highly recommended to government to take immediate action to curb the situation on all managerial level and to educate the public to take practical steps for plantation in term of green productivity.

5.3. Limitation of Study

The study has the following boundaries based on practicality and resources:

- Both Islamabad and Rawalpindi were chosen and performed sampling for the study only in these cities. The expansion can be done to greater areas i.e., to other districts or province level to have further results.
- The collected samples of drinkable water were analyzed physio-chemicals characteristics in limited number both from selected areas of Islamabad and Rawalpindi, but other parameters can be chosen for more detailed study. Biological parameters were not included.
- Due to limitation of technical and financial resources, only selected areas of Islamabad and Rawalpindi were considered as study area, that study can be extended to other districts.

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Appendix – Survey Form

An Urban Forestry Campaign for City Dwellers

Tree Is Our Lifeline.

(Would You Vote It?)

Note: The questionnaire is divided in two parts (i) Personal information of participant (ii) Questions related to study's theme.

Please! Give the answers of all the following questions.

PART-I

Name: ____

Father Name: ____

Age: _______ Sex: ________ Profession: ______________________

Job Title/Designation: ____________________________________

Marital Status: Married/Unmarried

Residence: Urban/Rural

Address: ____

PART-II

Land holding: Yes/No

Area/Place (where land owned): ____________________________

How much land owned? ____________________________________

Do you know about urban forestry? Yes/No

Do you practice urban forestry on your farm? Yes/No

How much do you earn per month? Rs. ____________/-

How much you pay electricity bill per month? Rs. __________/-

Do you think that it's any kind of losing? Yes/No

How much trees do you have on your farm? _____________________

Do you feel any difference when you are in tree planted area and non-tree planted area? Yes/No

Have trees any importance near you? Yes/No

What kind of importance you want to give?

- Environmental importance
- Economic importance
- Important for Ecosystem
- Important for Landscaping

Are there trees planted in your home? Yes/No

How much trees planted in your home? ___________________________

Do you have any knowledge about state forest and their importance? Yes/No

Would you like, if you've a private forest? Yes/No

What kind of trees would you like to see in your surroundings?

(E.g. Fruit tree/Ornamental tree etc) _____________________________

If you are asked to decrease the pollution, then what will you do for it?

- Close the industries.
- Reduce the number of traffic.
- Stop deforestation.
- Increase tree plantation/Aforestation/Reforestation.

Are trees planted on the pathway from home to your job site or institution? Yes/No

Is there any effect on environment of tree cutting? Yes/No

What do you think about cutting of trees from city residential area?

- It is good for new infrastructure.
- It is bad for environment.

If you are offered millions of rupees for deforestation, would you like to accept it? Yes/No

If "No" then why?

____

Have you ever taken part in any kind of forest campaign? Yes/No

If you are requested to take part in a forest campaign, what would you like to reply: Yes/No

Do you think that Govt. Forest Department work efficiently? Yes/No

Do you have any knowledge about Govt. Forest Act? Yes/No

Do you think that Govt. Forest act or forest policy should be changed? Yes/No

Any suggestion for Govt. Forest Department:

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Do you want support from Govt.? Yes/No

If you are provided with

- Planting material
- Training/Guidance for tree raising.
- Share in profit as incentive.

Then do you like to raise trees on your farmland/land?

- Allocate some area of land only for trees.
- Raise trees on farm boundaries.
- Raise trees with crops/vegetables.

Please! Give any message for public awareness?

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THANKS A LOT! FOR BEING A PART OF THIS CAMPAIGN