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POLICY REPORT

PRIVATIZATION OF ENVIRONMENTALLY CRITICAL SPACES

A CASE OF URBAN FORESTS

NOVEMBER 2018

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Background

Pakistan in the recent years has come to terms with several unexpected natural disasters. These events were inimical to infrastructure and livelihoods. Thousands of people have been injured, displaced and killed because of unforeseen floods, droughts, and cyclones. Such natural hazards are a stark reminder of the fact that Pakistan is one of the most vulnerable countries to the effects of climate change. According to the Global Climate Risk Index, Pakistan is ranked 33rd overall on the index and 8th on the list of 10 countries most affected by climate change from 1998 to 2017.[1]

A report by the United Nations Environment Programme avers the increasing population to be putting extreme pressure on the environment. It states that urban areas are being affected more. Contributing factors include an increasing population concentration, meaning higher population density, agglomeration economies and higher energy usage in these areas. In Pakistan, majority of the energy generated is through thermal power plants. Resultantly, the average temperature in Pakistan is rising due to higher greenhouse gases' emissions. Atmospheric concentration of carbon dioxide, the major greenhouse gas, has risen from 280 ppm in 1750 to 410 ppm in 2018. Other greenhouse gases, such as methane and nitrous oxide, have also recorded a rise in their atmospheric concentrations.[2]

Additionally, forest loss has halved over the past 30 years according to the 2015 Global Forest Resources Assessment. Between 1990 and 2015, global forest area declined by 3%, but the rate of loss has halved between the 1990s and the past decade.[3] This is indicative of people using the available resources more responsibly and sustainably because of awareness regarding deforestation and its consequences. However, the rate of deforestation in Pakistan during the last decade of the previous century was greater than other countries in the same income group. It is indicative that economic growth will not help Pakistan grow out its environmental problems and so effective policy and private initiatives need to be introduced.

Forests provide clean water, sequester and store carbon, provide timber and non-timber forest products. Forests are a valuable habitat for animal and plants species as well. Tropical forests, while

[1] David Eckstein, Global Climate Risk Index 2019, German Watch, [November 27, 2018]; Retrieved: December 13, 2018, https://www.germanwatch.org/en/cri

[2] Rebecca Lindsey, National Oceanic and Atmospheric Administration, [August 1, 2018]; Retrieved: December, 5 2018 https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide

[3] Global Forest Resource Assessment 2015, Food and Agriculture Organization of the United Nations http://www.fao.org/3/a-i4808e.pdf

covering only 15% of the global land area, contain over 50% of land animals and plants. The area of land covered by forest and trees is therefore an important indicator of a country's environmental condition.

Over the years, the phenomenon of urbanization has picked up pace and seems to be gaining impetus. According to the 2018 Revision of World Urbanization Prospects, by 2050, 68 percent of the world population is expected to reside in urban areas. Many economists, such as William Alonso (1968) Luisito Bertinelli (2002), Duncan Black (2004), and international organizations, The World Bank (2009), have unanimously harmonized the strong nexus between urbanization and growth. Urbanization leads wealth creation and opportunities leading to prosperity through development of the socio-economic spheres. However, despite its benefits, urbanization, if unplanned, may entail some serious costs towards the living standards of its citizens and the urban area's environment. Environment is one of the pillars of sustainable development. It is therefore crucial to have a well devised framework for urbanization management, to effectively minimize adverse impact on the environment.

Cities have to play a greater role in climate change mitigation. The reason behind is their greater contribution in emissions of greenhouse gases, and deforestation; along with degradation in urban environment impacting health and economic wellbeing of the larger population residing in urban centers. Similarly, Pakistani cities are contributing to the country's economic growth at the cost of environmental degradation. An analysis of Pakistan's environment was conducted by the Asian Development Bank, which identifies pollution and waste management as two pressing concerns within the country. The report dubs both issues to be linked with urbanization and being generated by cities specifically. Pollution has increased over the years due to growing energy consumption and a consequent dependence on fossil fuels. This coupled with the increasing number of vehicles emitting hazardous fumes has led to deterioration of air quality. Industries create problems in both domains. In Pakistan, safe methods of waste disposal are not implemented which leads to contamination of air and water. Another environmental concern for Pakistan is biodiversity. During the last century, Pakistan has lost several species of flora and fauna.[4]

In this context, 11th Sustainable Development Goal, under United Nations agenda, stands for making cities more-safe, resilient and sustainable. Consequently, efforts are being made globally to endorse urban development models that focus on investing in green infrastructure such as forests, wetlands and other green spaces. In 2008, the Trust for Public Land Center for City Park Excellence published a report claiming that Philadelphia, experienced $16 million in annual public cost savings as a result of storm

[4] Country Environment Analysis, Asian Development Bank, December, 2008; [Retrieved: December 14, 2018] https://www.adb.org/sites/default/files/institutional-document/32193/country-environment-analysis.pdf

water management and air pollution reduction through trees and vegetation in urban parks.[5] One such effort of establishing green urban spaces goes with the name of 'Urban Forestry'. Urban Forestry focuses on managing individual as well as group of trees for economic, social and physiologic well-being of urban dwellers (Grey and Deneke, 1986). We further discuss the idea in this policy brief and assess the viability of establishing such green spaces within urban centers in Pakistan.

Introduction

Ecological devastation has become a serious problem locally and globally. Environmental degradation arose primarily from exploitation and construction of cities and industrial institutions with non-biological materials. Humans have since ignored the rules of nature, biodiversity and coexistence.

Against an international standard of 25%, forest in Pakistan only covers 5% of its land area. With a 0.03 hectare per capita forest cover, Pakistan ranks 171 on the forest cover index out of 190 countries. Its total forest area of 4.34 million hectare can be segregated into 3.44 million hectare state-owned forest land and 0.88 million hectare under private ownership. [6]

Pakistan on average has lost around 27,000 hectares of forest land due to deforestation. Expanding cities are cutting their green cover to create more space for infrastructure development, with corresponding dust and smoke extracting higher health costs from lower income segments.

One of the measures of environmental health, now being considered globally, is the restoration of ecosystems indigenous to each region. It is done through restoration of native and multi-strata forests following an ecological method. These experimental reforestation projects, based on ecological studies, have so far been conducted at 550 locations throughout Japan and in Southeast Asia, South America, and China. These urban forests have proven effective in restoring and maintaining global environments, including disaster prevention and carbon dioxide (CO_2) absorption.

These forests retain ground water in addition to absorbing rain water, thus rehabilitating the ground water table over time. They attract birds and insects, produce native fruits and improve air quality.

[5] Trust for Public Land, *Philadelphia Park Value Report*, June 08, 2008; [Retrieved: December 06, 2018] https://www.tpl.org/philadelphia-park-value-report

[6] Forest area (% of land area), Food and Agriculture Organization; [Retrieved: December 06, 2018] http://www.fao.org/faostat/en/#data/RL/metadata

Compared to a conventional plantation, these forests grow ten times faster, are hundred times more bio-diverse, and have 30 times more green surface area. Additionally, the entire process is organic.

Under Corporate Social Responsibility (CSR) initiatives, companies in Armenia, Japan, Malaysia, South Korea, Thailand, United States and others are financing urban forestry projects. These forests are grown primarily on vacant factory sites, parks, around urban infrastructures and roadside.

As per CSR guidelines of Securities Exchange Commission of Pakistan (SECP), companies in Pakistan can engage in climate change activities to fulfill their CSR obligations. This framework includes forestry as one of the core areas for climate change initiatives. However, companies mostly prefer engaging in energy conservation and earth day celebrations as their contribution under CSR initiatives. For effective contribution, companies have to increase their participation in more sustainable initiatives that benefit society on a continuous basis. Initiatives such as urban forestry help curb the rising problem of environmentally critical property within urban centers. Green belts, parks, botanical gardens, horticulture lands and cultivation area around agriculture research departments are all such examples where private sector can be engaged to promote conservation of green spaces.

A Miyawaki Method for growing urban forest is based on growing local species of a combination of canopy trees, trees and shrubs for a fast vertical forest growth. It can be grown on a plot size of 100 m^2, with a plant density of 320-350. With its natural selection loci, the plants grow much faster than they do in conventional methods of plantation. These plants require a 2-year maintenance period, after which they become self-sustained.

The *2018 Revision of World Urbanization Prospects* estimates that 68 percent of the world population will reside in urban areas by 2050. Many economists have concurred on the strong nexus between urbanization and growth, whereby urbanization has been linked to prosperity, wealth generation and socio-economic transformation in general. However, despite its manifold benefits, the byproduct of urbanization has manifested in terms of severe environmental degradation that harms the very core of sustainable development.

Since the 1990s, the world has witnessed an influx of urban dwellers, with absolute numbers significantly increasing from 2.3 billion in 1990 to 4 billion by 2015; with a yearly average of 57 million in 1990 to 2000 to 77 million between the years 2010 to 2015.[7] As of 2018, 55 percent of the global population currently resides in urban settlements. A host of factors have contributed to this

[7] World Cities Report 2016, United Nations Human Settlements Programme, July 2016; [Retrieved: December 8, 2018] http://wcr.unhabitat.org/wp-content/uploads/sites/16/2016/05/Chapter-1-WCR-2016.pdf

phenomenon, the most apparent being the economic opportunities and recreation that urban areas tend to provide coupled with the increase in population pressures (UN, 2018). Historically speaking urbanization has been associated with wide ranging economic and social transformations that have assisted in poverty reduction, increasing literacy, increasing life expectancies and lowering fertility rates. However the dangers of unplanned urbanization threaten sustainable development by having a profound impact on economic and social development as well as environmental protection. Specifically focusing on the third pillar that is the environment, it is crucial that well thought out management of urbanization - inclusive of urban green spaces - be in place to hinder any possibilities of environmental degradation.

City administrations have increasingly found themselves concerned with the struggle they face in coping with the environmental pressures that have ensued following rapid population growth and by extension rapid urbanization. The challenge has also been recognized by the United Nations in their Sustainable Development Goals, where SDG 11 specifically calls for efforts in "making human settlements and cities more safe, resilient and sustainable.' Following this, globally a trend has emerged where city planners are pushing to adopt an urban development model that involves investing greatly in 'green infrastructure' i.e. investing more in forests, wetlands as well as other green spaces. When integrated into urban planning and management, trees or green spaces in general may serve as valuable assets in transforming cities into more resilient as well as sustainable assets.

Oftentimes urban settlements have been considered as the major consumers of natural resources subsequently causing direct as well as indirect damage to the environment. Rapid urbanization has greatly been linked to environmental degradation as well as depletion of the natural ecosystem coupled with an alarming loss of vital ecosystem services. City development typically requires conversion of forests and agricultural land coupled with the reclamation of wetlands for urban infrastructure and other associated uses leading to widespread removal of vegetation that acts as a major support system for the urban ecosystem. To elaborate a little further, urban development processes involve extensive exploitation of natural resources, the most prevalent being deforestation, which has led to an irreversible loss of vital ecosystem functions (Ichimura, 2003). With public attention increasingly drawn towards greater evidence of urban growth unsustainability of urban growth, demand for new urban models is rising. Such model should be capable of making ecosystems sustainable whilst taking care of the growing demands of the burgeoning population.

The vast amount of deforestation that ensued due to rapid urbanization can be attested by the fact that that the Global Forest Resources Assessment revealed that the global forest area seems to have decreased from 31.6 percent of global land area to 30.6 percent between the years 1990 to 2015. Rapid deforestation has brought with itself a host of environmental challenges that range from an increase in

natural disasters to rising global temperatures that bring forth a host of challenges. Containing the rapid decline in forest area is vital for making communities resilient as well as harboring the biodiversity of the region, its particularly urban settings that require urban green spaces the most to make them more sustainable and livable. The solution for greening urban settlements lies in the concept of urban or peri-urban forestry, which refers to the *management of urban forests to ensure the optimal contribution to the economic, sociological and physiological wellbeing of urban forests*. Urban forests in simple terms refer to all the trees that are present within the compounds of urban lands or a built environment; these usually include a mix of planted as well as naturally regenerated trees. By extension the main task of urban forestry is to make the trees functional as well as compatible with the harsh urban environment.

More often when it comes to urban forests, they are much admired for their aesthetic and mostly overlooked for their ecosystem functions. Usually unaware of these services, urban planners tend to place a low priority and subsequently allocate low budgetary resources to it. It is no secret that forests and trees in general make vital contributions to the planet as well as the people, some of these contributions include, conserving the biodiversity, bolstering livelihoods, providing clean air and water as well as mitigating the effects of climate change. The livelihoods coupled with food security for much of the world's poorest depends upon vibrant trees and forests where studies have suggested that forests contribute to 20 percent of income to the livelihoods of the poor households in the developing regions of the world. Another significant contribution of forests is there ability in mitigating the effects of climate change, as stressed by the Paris Climate Agreement 2015, forests have been deemed as a vital instrument in in determining the greenhouse gas (GHG) accumulation in the atmosphere, deforestation has been deemed as the second major contributor to climate change and accounts for nearly 20 percent of all GHG emissions. Forests act as major carbon sinks with the capacity of absorbing roughly 2 billion tons of carbon dioxide (a greenhouse gas) each year. This makes effective forest management fundamental in strengthening the adaptive capacities as well as resilience of communities to climate related natural disasters (FAO, 2018).

It is these significant contributions of forests that have led them to be referred several times in the Sustainable Development Goals (SDGs). In particular SDG 15 (Life on Land) places forests and mountains at the core of sustainability of terrestrial ecosystems. Two of the targets of SDG 15 specifically focus on sustainable forest management, which includes urban forest management as well. Forests particularly in urban as well as peri-urban environments, if managed well can make fundamental contributions to planning as well as management of sustainable and resilient landscapes. Some specific contributions of urban forests include the socioeconomic and environmental resilience of cities, which is achieved through the ability of these forests in mitigating climate change, reducing energy costs, poverty as well as malnutrition and providing ecosystem services (FAO, 2016).

The newfound interest in urban forestry has led to several methodologies being formulated that would not only assist in increasing forest cover but also assist in reclaiming the environmentally degraded land as a result of rapid urbanization. A methodology that has specifically stood out in the global arena due to its high success rate is a method formulated by a Japanese botanist, Professor Akira Miyawaki, who has grown 40 million trees around the globe and won the Blue Planet Prize. Miyawaki was successful in formulating a reforestation method that would allow rejuvenating of environmentally degraded lands through growing of a self-sustaining forest in a short period of time. The methodology has even been picked up and was successful in even Pakistan where environmental issues are not dealt with due diligence.

The study aims to understand the needs of the program specific to Pakistan. An impact assessment of urban forests and the possibility of returning Pakistan's forest cover to its indigenous value particularly by adopting the principles of the Miyawaki Method. The study also aims to evaluate the program efficiency and cost incurred to elaborate whether such urban forests projects will be feasible locally or not.

Literature Review

The year 1976 marked the conception of the United Nations Human Settlements Programme UN-Habitat, where cities were first given the title of the 'emerging future'. One of the major outcomes that materialized from this venture was the Vancouver Declaration that urged the international community to commit to adopting policies that assisted in alleviating the unfortunate conditions that were associated with uncontrolled urbanization. Though urbanization does allow communities to expand and is a key factor in socio-economic development, urbanization often has a host of challenges associated with it. The key challenge being lack of environmental sustainability, which has greatly stagnated the wellbeing of the general public. Some of the environmental challenges that urbanization has produced include urban heat island (UHI) effects, storm water runoff, lack of clean drinking water and air pollution (UN, 2016). Over the recent decades urban trees have been given significant importance, with literature terming urban trees as integral in enhancing the environmental quality of the cities around the world. Recent studies have begun to enumerate the range of benefits that urban forestry has brought along with it which have embraced the wider economic and social dimensions and have highlighted their capacity in mitigating much of the climate related predicaments faced by the urban community.

Time and time again environmental economic literature has revealed the ability of trees in acting as major sinks for carbon dioxide (CO_2) and by extension forests have been termed as 'carbon sinks' that puts forward the idea that urban forests may be integral in sequestering carbon content in urban

settings. In the US alone, urban forests tend to capture around 23 million tons of carbon each year (Ordonez et al, 2010). As per the IPCC Report (2014), the cumulative emission of carbon dioxide that have largely determined the global mean surface warming with multiple lines of evidence pointing towards a strong and almost consistent relationship between CO_2 emissions and the projected global temperature that leads to a phenomenon known as climate change.

Human influence on climate change has become more evident, recent anthropogenic emissions of the GHGs have been the highest in history where carbon emissions from fossil fuel combustion have accounted for 78 percent of total GHG emissions. Anthropogenic GHGs have significantly increased since the pre-industrial era owing to economic and population growth that have acted as the largest drivers of carbon content. From the year 1750 to 2018, the atmospheric concentration of carbon dioxide has risen from 280 ppm to 410 ppm. One of the options that IPCC suggests in lowering the carbon content is enhancing the biological carbon sequestration and storage capacity; increase in urban forests being a viable option.

The intensity of climate change has been long lamented upon; extreme weather patterns and devastating natural disasters have impacted millions around the globe. In the lieu of the adversities that climate change brought with itself, the international community was compelled to sign the Paris Agreement in 2015 that obligated 195 nations to stabilize atmospheric CO_2 concentrations and rigorously pursue efforts to keep global temperatures below 2 degrees Celsius. It is this very commitment coupled with the targets specified by SDG 13 that compels nations to prioritize the mitigation as well as the adaptation of climate change, urban forestry here may play a key role in assisting countries in stabilizing the carbon content in their atmospheres as well as make cities more resilient towards the effects of climate change. It should be greatly emphasized that though urban areas only occupy 2 percent of the earth's surface area, they have been responsible for contributing to almost 70 percent of global carbon dioxide emissions and other GHGs. Deforestation coupled with forest degradation has been found to contribute 6 to 17 percent to anthropogenic carbon emissions.

McPherson and Simpson (1999) explain that urban forests alter the atmospheric content through two channels; firstly the intake of CO_2 through photosynthesis make trees a significant storage site or tend to assist in sequestering CO_2 and secondly trees around buildings tend to reduce the demand for air conditioning and heating thus reducing energy demands that translate into lower emissions associated with electric power. Explaining the concept of carbon sequestration; they elucidate that this refers to the annual storage of carbon dioxide in above as well as below ground biomass over the period of one growing season. Zhao et al (2010), revealed that for the case of Hangzhou, a metropolitan area in China, urban forests through sequestration were responsible for annually offsetting 18.57 percent of the amount of carbon emitted by the industrial enterprises in the area and were capable of storing 1.75

times the carbon content that were emitted by the industrial energy uses within the city. Though it has been proven that given the higher tree density of rural forests, they tend to sequester twice the amount of carbon than urban forests can, however since urban trees grow faster than the rural ones, they sequester more carbon on a per-tree basis. Another point worth mentioning here is that though rapidly growing trees do tend to sequester more carbon dioxide, this advantage tends to be lost if the trees die young and it may be useful to invest in slow growing yet long lived trees for urban plantation to have a sustained carbon sequestration process. Secondly survival of urban trees is paramount in influencing the long-term sequestration process whereby it has been noticed that loss rates for residential as well as street trees ranged from 10 to 30 percent within a span of 5 years.

Urbanization has long been associated with the ability to alter local climates. Some serious environmental and health challenges that urban centers face are due to the phenomenon known as urban heat islands (UHI), summer heat waves as well as the gradual warming of the climatic system. A common phenomenon experienced by many larger cities is that the temperatures at the heart of cities are noted to be higher than that of the surrounding areas; this is known as the Urban Heat Island (UHI) effect. Urban microclimates have been known to be a significant contributing factor to not only falling pedestrian health but they also have an impact on the energy usage of buildings, urban air equality and all round urban sustainability. It is for this very reason that urban microclimates have been receiving a lot of attention in the recent decades (Wang et al, 2015). Urban forests can again play a role in influencing local climates; Li et al (2015) assert that these forests tend to be critical in regulating the urban atmospheric environment by maintaining the urban thermal energy equilibrium. Their study further reveals that selecting the appropriate tree species that have a high cooling capacity must also be given high priority while trying to mitigate the effects of UHI. London's Climate Change Adaptation Strategy 2010 was launched to increase the quantity as well as the quality green spaces and vegetation in London, particularly in the hot spots of the city as a way to mitigate the effects of UHI, the strategy was to slowly increase the green spaces first by 5 percent in 2030 and then by another 5 percent by 2050 (FAO 2016). Studying the microclimates of streets with low and high percentage of canopy covers in the city of Melbourne, Sanusi et al (2016) concluded that areas with a higher percentage of canopy cover were found to have lower air temperature as well as lower solar radiation; the reduction in temperature in higher canopy regions was almost 2.1 degrees Celsius in comparison to 0.9 degrees Celsius reduction in air temperature in regions with lower percentage of canopy. Thus their study concluded that increasing tree canopy cover would be beneficial for suburban residential streets.

The energy saving characteristics of trees can be ascertained by the fact that simulations in three cities of the US revealed that three mature trees around an energy efficient home cut annual air conditioning demand by 25 to 43 percent and peak cooling demand by 12 to 23 percent. However it should be stressed that planting the wrong tree species and that too at a wrong location might actually lead to

increase in energy use. A study in the state of Dallas revealed that correctly positioned trees in the city area were estimated to reduce energy related costs from residential buildings by $8.93 million annually. It was also revealed that trees had the capacity to produce more than one million dollar worth of value by reducing the amount of carbon produced by fossil fuel power plants (State of Dallas Urban Forest, 2015).

Moving on from the climatic dimension of urban forestry, watershed management challenge is another component that needs to be addressed and can thoroughly be improved by the use of urban forests. Urban cities are responsible for 75 percent of industrial and residential water use. By 2025, 1.8 billion people will be living in absolute water scarcity and two-thirds of the world population will experience water-stress conditions. Forests are vital in mitigating this situation as they capture and store water and are crucial in providing drinking water for millions of people around the world. Elaborating on how forests tend to play a fundamental role in watershed management, forests tends to reduce the quantity of storm water runoff as well as pollutant loads that reach surface waters. The ability of trees in reducing storm water runoff is vital in improving watershed health through recharging ground water, improving the base flows in streams that would then hinder any probability of erosions and flooding as well as impede any pollutant that could get washed into streams. Forest capacity of absorbing or storing rainfall allows it to have a lower runoff coefficient than turf grass or an impervious cover, here the runoff coefficient refers to the proportion of rainfall that is converted to storm water runoff (Capiella et al, 2005).

As per the UN-Habitat, the two striking predicaments that tend to affect the urban settlements are both water related, one is the lack of access to clean drinking water and adequate sanitation and the second is the increase in water related diseases. It is particularly the urban poor that tend to suffer the most from the safe water predicament. An example is of Accra, a city in Ghana with 2.1 million inhabitants, where the urban poor have to pay 12 times more for a liter of water than their richer counterparts due to lack of access to safe drinking water in rural areas. For the case of China, the Chinese government's emphasis on urbanization has placed the economy in quite a dilemma with its limited water resources being vastly wasted. The government's reforms include having 60 percent of the population living in cities by 2020. Under the recent urbanization plan the remote regions have been facing a considerable competition from the developed cities of China for limited water resources. The rampant urbanization has come with a cost where agricultural runoff has contributed to more than half of China's water pollution and due to the large amounts of pesticide use. The unchecked development has resulted in a reduction in the wetlands by 9 percent in a little over a decade coupled with a strain on the groundwater resources. Another reason why urbanization has resulted in water scarcity is because of the increase in the demand for water in many indirect ways, due to income rises, Chinese have begun to

use a lot of water intensive products (Guli and Yampolsky, 2014). The urbanization agenda of the government poses a massive challenge to the country's scarce water resources.

The hydrological functions of urban woodland and trees have a significant role to play when it comes to sustaining water resources particularly drinking water resources. Open areas covered by trees often enable infiltration of rainwater and allow for the recharging of groundwater which would not be possible in an otherwise sealed urban area. Studies have attested to a clear inverse relationship between green spaces and surface runoff. Much of the studies have stressed that urban woodland in particular reduces surface run off and increases rainwater infiltration (Tyrvainen et al, 2005). With the water predicament hitting the poor the hardest, urban forests may actually provide a solution. Poor cities have also been associated with wastewater treatment challenges and could actually reuse wastewater for growing urban forests. Reusing city wastewater not only would recharge aquifers but would also assist in reducing the demand on scarce water reserves. The greatest potential of wastewater usage is in the arid zones in the developing countries much like Pakistan (Kuchelmeister, 2000).

The primary problem with storm water runoff is that as storm water flows over city streets it tends to collect debris, chemicals and sediments that seriously impair water quality. Urban areas by default tend to alter the land that they cover, these alterations then affect the hydrological cycle leading to excessive surface run off, reduced infiltration and greater amounts of non-point source pollution. The resulting urban hydrological cycle then greatly contributes to localized flooding potential and nearby water bodies tend to harbor more chemicals than nutrients (Peterson, 2010). Trees have the capacity to retain rainwater and hinder it from reaching the ground depending on the size of the tree, a single tree has the ability to store a 100 gallons of water, it has been estimated that urban forests can reduce annual run off by 2 to 7 percent. When trees are combined with other natural landscapes, studies have revealed that as much as 65 percent of storm water runoff can be reduced in residential developments. Through the collective action of leaves coupled with the absorbing as well as anchoring effects of the root system, trees also contribute towards soil stabilization and recharging of groundwater that all contribute towards a safer drinking water supply for the urban population. Thus this role of trees in storm water retention that greatly benefits municipal budget as well as public health makes planting and nurturing of trees through adequate urban forestry management vital in ensuring the resilience of the community (Fazio, 2010).

The increased infiltration of rainwater by trees is through their root systems as well as the soil conditions that result from leaf litter. Infiltration tests conducted across North Carolina concluded that a medium aged pine-mixed hardwood forest had an infiltration rate of 12.42 inches per hour however when the forest understory as well as the leaf litter was removed, the resultant infiltration rate was

reduced to 4.41 inches per hour. The interception of rainwater by forests that results in reduced storm water runoff is largely determined by branching structure as well as canopy density. The intercepted rainwater is either evaporated directly into the atmosphere, absorbed into the canopy surfaces or transmitted into the ground via the stem flow, which includes the branches and the stems of the trees. Urban forests in particular have been found to intercept 6 to 66 percent rainwater. Urban areas that are greatly characterized by local flooding may greatly benefit from the increased forest canopy cover to stabilize the urban hydrology cycle to prevent any sort of natural disasters from occurring (Capiella et al, 2005). Thus many communities have resorted to urban forestry as a means of sustaining water resources and disaster management, in Tokyo the Metropolitan Government Bureau of Waterworks has it in its mandate to manage the forest that is located in the upper reaches of the Tama River to assist in the preventing reservoir sedimentation, increasing the capacity in recharging water resources as well as in conserving the natural environment.

The next environmental issue that has long been associated with rapid expansion of cities is the degradation and destruction of the natural ecosystem that has led to a loss in biodiversity. It would be an understatement to state that the provision of ecosystem services is vital for human wellbeing and consequently their degradation would translate into an exacerbation in the human-wildlife conflict. A significant amount of studies have revealed that unplanned urbanization is the leading cause of loss in biodiversity directly as well as indirectly. The direct impact on biodiversity is through loss in habitat as well as modified soils and other physical transformations that greatly deteriorate the living conditions for many species. The indirect impact manifests itself in the form changes in water bodies' nutrient composition as well as increase in the abiotic stressors that lead to a deterioration in the air quality, which negatively effects biodiversity as well. McDonald et al (2008) state that an urban growth amounting up to 10 percent in all eco-regions would lead to 80 percent of expected loss in species. Their analysis further suggests that 8 percent of the terrestrial vertebrae species on the IUCN Red list are largely on the list due to the effects of rapid urbanization, furthermore 28 of the 825 eco-regions have had one-third of their areas urbanized which have been homes to 213 terrestrial vertebrates. By 2030 urban land cover is expected to triple from what it was in 2000, greatly threatening the survival and very existence of habitats, particularly in highly bio diverse regions of the world. The threat to the terrestrial ecosystem has greatly been highlighted in the international community where SDG 15 calls for the protection, restoration as well as sustainable use of terrestrial ecosystem for achieving sustainable development at large.

Kowarik (2011) highlights the two main reasons for enhancing conservation activities in urban settings which include to allow enabling of ecosystem services that are associated with the urban nature and secondly to contribute to the conservation of biodiversity. As per Elmqyist et al (2016) urban forestry may very well assist in reversing the damages done to the biodiversity of regions as a consequence of

rapid urbanization, owing to their ability in sustaining biodiversity greatly. Rapid deceleration of biodiversity has become a hallmark of many urbanized areas, the reversal of which can only happen through an increase in urban green spaces. This has compelled many urban city planners in pushing for the promotion and preservation of biodiversity within urban areas through increased efforts towards urban forestry. The case of San Francisco reveals that the creation of urban parks has played a significant role in supporting a higher mean abundance of bees. Green parks, greenways and riparian buffers are essential in providing continuous corridors that allow for wildlife cover, paths for travel as well as food (McPherson, 2006). Coimbra, a highly urbanized municipal area in Portugal, has recognized urban green spaces as areas of huge ecological interest and fundamental in maintaining the environmental balance in any city thus initiating the Municipal Master Plan 2014 in which integrating urban green spaces in city planning has been deemed as an integral part of the plan. Studies have revealed that urban forest in the area have truly led to conservation of the native plant taxa of a high ecological value (Goddard et al, 2010) (Barrico et al, 2017).

When it comes to urban biodiversity the most heavily debated topic is the type of native species to use, which includes exotic, native or indigenous tree species. Worldwide different scenarios have played out for different plant species planted in urban settings, an analysis of 1200 street trees in Eastern Cape, South Africa revealed that native trees helped native birds thrive but at is the same time it was found that exotic tree species were crucial for the survival of parasitic mistletoes which provided a habitat for invertebrates. Thus ecological analysis is vital in deciding what tree species to plant (Livesley et al, 2016). It is worth mentioning that the rise in interest in enhancing as well as maintaining forests within urban landscapes is not only limited to their inherent value in biodiversity conservation but also because of the tangible societal benefits that are associated with their conservation which include enhanced mental health and wellbeing.

Owing to the above discussion there is no denying the fact that adequate urban forestry is essential in not only sustaining the rapidly deteriorating ecosystem but also in general realizing the goals of sustainable development, which would allow cities in general to be more sustainable as well as livable. One of the main objectives of urban forest management is to provide for optimal as well as sustainable benefits for the current as well as the future generations; this requires that managers have an adequate understanding of the current resources and the ongoing changes in it to guide these resources to a desired future state. As per Miller (1997), formally urban forestry is defined as the '*art, science as well as the technology of managing trees and forest resources in and around urban community ecosystems for the economic, psychological, sociological as well as the aesthetic benefits that trees provide a society*.' Historically urban forestry dates back to the ancient Greek and the Roman empires where an interest in protecting the surrounding woodlands for utilitarian as well as economic benefits was quite evident. Even during the industrial revolution, city authorities would often collaborate with industrialists for the

development of urban green spaces particularly for the large amount of workers that had moved to the city areas who needed a socially accepted way of spending leisure time. Though the perception of urban forest was limited to their aesthetic and utilitarian benefits, as stated before recent studies have enumerated the range of other benefits that urban tress provide particularly at the economic and environmental front. Furthermore the intense pressure that rapid urbanization has placed upon urban green areas has called for a comprehensive and integrated natural resource management strategy, which focuses greatly on the sustainability as well as nurturing of green spaces in the urban setups. All this can be achieved through a well thought out urban forestry plan. The formal concept of urban forestry emerged in North America, as a response to the rising pressures on urban green spaces and the term urban forestry was introduced in 1965 as part of a study that focused on the success and failure rates of municipal tree planting programs (Bosch and Randrup, 2004).

Picking up from then, countries around the world took the concept and have rigorously indulged and formulated effective urban forestry programs. Urban trees though associated with a range of benefits also have some potential costs involved making it a necessary that urban planners understand the numerous interactions that these forests would have with the ecosystem for optimization of benefits. Inadequate understanding of the management of urban forests may actually result in the reduction in the contribution of forests in improving the urban environment as well as the quality of life (Nowak and Dwyer, 2007). Particularly in the developing world where cities are usually in compact form, competition for space tends to be quite intense and often times poor development of urban green spaces or urban forests can actually deteriorate the quality of life in urban settings. Environmental planning can seriously be hampered as a result of rapid urbanization as well as intensification in developing cities. Urban forestry in general has to deal with a range of challenges, the predominant challenge is to protect or conserve the already existing urban green areas and trees from competition for space. Given the limited area in compact urban settings, ecosystems are the first to suffer as a result of degeneration in natural habitats as well an increase in many anthropogenic stressors, for example installation of traffic signals or other infrastructure. Furthermore many trees in the urban environment die within the first year since they are often faced by atmospheric pollution and harsh climatic conditions which are a result of the artificial environment that is created in the urban areas (Jim, 2004).

Given the wide range of benefits that urban forests provide, management of these forests and their subsequent sustainability require a top place in city management plans. It should be emphasized that management of urban forestry requires thorough ecological understanding and scientific tools, to be properly implemented. Generically speaking, the main elements of adequate urban forestry practices include, first assessing the potential costs and benefits of urban forests which requires comprehensive urban forest resource and function inventories as well as monitoring that would assist in the decision making process. Secondly adequate policymaking, planning and designing are crucial, thorough

knowledge of the development of trees is the basis for the design. Integration of urban forestry in urban and regional policies is highly important. Thirdly it must be emphasized that urban conditions vary greatly from rural or natural areas, the complex and harsh conditions that normally characterize an urban area requires that a careful selection of the right species be taken into consideration to ensure survival. There is a need to have an integrated focus on the identification as well as the selection of tree species for urban forestry as well as sound knowledge of site conditions and tree characteristics to safeguard the resilience of urban trees in the harsh urban environment (Bosch and Randrup, 2004). Furthermore a crucial aspect of urban forest management also entails understanding the urban forest structure and its resultant relationship with the forest functions. This would require that through sampling and inventories, structural information about urban forest be obtained and this information can greatly contribute to a comprehensive management plan that would recognize the linkages between the land uses and urban forests. Most importantly structural information about these forests tend to give valuable insight into the biological, social and economic functions of urban forest that could greatly assist future urban forest planning (Nowak, 1994).

On an international scale, several examples of urban forestry methods exist that have given positive results in terms of benefits and sustainability. The basic principle that underpins all these forestry techniques is sustainability by recognizing the fact that there is always a need to balance the social, economic and environmental outputs from forests. Given the multitude of challenges that urban forests face in the form of harsh urban conditions, impoverished soils as well as strategic challenges that include lack of relevant polices and budgetary constraints, several advancements in the dimension of urban forestry have taken place to curb these issues. Furthermore the array of benefits that ensue following a successful urban forest plantation has been motivation enough for many countries in pursuing rigorous management techniques to increase their forest covers. Currently public participation is becoming a mainstay in the urban forestry dimension and is important for ensuring social consensus, local empowerment as well as environmental justice (Steenberg et al, 2013). An example of this is formally known as the Community Based Forest Management, which refers to the system of managing forests by the participation of local communities for the mutual benefit of both forests and local people. The case of Nepal is exemplary when it comes to this type of urban forestry, where the country formally adopted this methodology and found positive results associated with it. What started as a simple plan, with limited local participation, has evolved into becoming the most prioritized forestry program. It has resulted in an increased handover of forestlands to the local communities. Operating under the *Panchayat Forest* (PF) and *Panchayat Protected Forest* (PPF), the local government units known as *panchayats* were assigned duties to manage the barren and degraded land for restoration activities (Gautam and Shivakoti, 2005).

Assisted or Accelerated Natural Regeneration (ANR) is another methodology that is internationally poised to promote preservation of urban forests. The approach relies on human intervention to promote natural regeneration particularly in residual forests and is said to be a cheap method for reforestation. The interventions include a host of treatments that include tending, liberation and enrichment planting. Natural regeneration is deemed as a biological process that is implemented to achieve an increase in forest cover and for recovering native ecosystems. Other aims of this type of methodology are to improve the microclimate and eliminate factors that restrict the growth of residual forest. Here human intervention is required to promote the growth of the residual forests as well as to ensure the restoration of natural regeneration. This methodology has been widely used in Thailand where forest covers particularly improved due to the adoption of this method an example being the restoration of a forest at the Boong Pra Temple. The intervention of communities in this project greatly sped up the process all thanks to the communities increased awareness of the multitude of benefits that forests provided particularly in the context of the provision of safe drinking water and recharging of aquifers through rainwater infiltration (Thongvichit and Sommun, 2003).

Another form of methodology regarding urban forestry is through Public-Private Partnerships, though these are mostly restricted to green space planting and maintenance where normally private contracts carry out work for public authorities. However this type of urban forestry technique is widespread in the developed world where strategic partnerships were developed between public and private enterprises in co-managing urban parks examples of which are the Golden Gate and Central Park in New York. Public-Private partnerships have played quite a significant role in creating, managing as well as preserving New York's most famous and spectacular parks. It is the financial resources, flexibility as well as creativity that the private sector possesses that can greatly benefit public sectors in maintaining as well as preserving urban green spaces. The US Forest Service Public-Private Partnership Strategy is a prime example of how private enterprises can collaborate with the government to increase new social and capital investment in the ecosystem to diversify biodiversity as well as inculcate a broader appreciation of the public when it comes to ecosystem services.

Apart from these methodologies, in the last two decades, ecological scientists have begun to develop new insights in practical as well as theoretical methods for the reconstruction and restoration of the natural ecosystem. Rapid urbanization coupled with intense global climatic changes propelled by rapid industrialization has acted as the main anthropogenic factor in degrading the natural environment. Thus environmentalists worldwide have called for innovative and effective conservation strategies as well as recovery strategies as a means to conserve the genetic resources of target species that have been greatly disturbed by the anthropogenic activities.

Currently the greatest challenge in the dimension of environmental restoration is the conservation or restoration of existing resources leading towards the rehabilitation of degraded land with the preliminary objective of re-establishing the tree cover particularly for watershed protection and soil erosion. Literature has revealed that that degraded plant communities tend to be the hardest to restore, 200 years of restoration practices have confirmed that forest recovery is a slow process in general. In the past many reforestation projects have paid little heed to the source of planting material used as well as what the biological requirements which has resulted in their failure. For example, use of non-local seed sources of indigenous species has a tendency to result in the contamination of the gene pools of the nearby population. Furthermore it is crucial to restore natural vegetation using a combination of native species that not only restore the regional ecosystem but also conform to the natural trend of habitat of the region (Vesella et al, 2011). It is safe to conclude that urban forests impact the society in ways more than just conserving and contributing to the environment. Urban plantations can also back socioeconomic development and help yield pecuniary benefits to society.

Benefits of Urban Forestry

The most commonly perceived benefit of urban forests is identified as restoration and rehabilitation of environment. In particular, urban forests offer two types of services to cope with climate change namely adaptation and mitigation. The former refers to assisting cities adapt to social and environmental changes induced by climate change while the latter implies to the process of slowing down the climate change progression through absorption of atmospheric greenhouse gases. In terms of environmental value, urban forests act as a means of removing air pollution by sequestering carbon during photosynthesis, regulating hydrology as well as managing urban micro-climate. Over time, the trees help diminish the volume and rate of flow of rainwater, consequently controlling soil erosion. This happens primarily through water retention in tree canopies, interception by the roots and transpiration: thereby reducing the water runoff. In addition to protection of top soil, trees enhance the underground water quality by absorbing nutrient pollutants such as nitrogen and magnesium. Moreover, trees minimize the urban heat-island effect through provision of shade during summers. While in winters, tress act as a barrier against the wind and can reduce cold air infiltration into buildings (McPherson et al., 1997). Urban vegetation also provides various species with a habitat. Urban forests further assist reduce the reverberation amount in hard urban settings thus reducing nose pollution.

Urban trees tend to increase the value of residential property through enhancing the aesthetic quality of surroundings. Numerous studies have concluded urban trees to elevate the total appraised value of urban property (see for instance, Peters, 1971 and Payne, 1973). In addition, urban vegetation implicitly contributes to the community's economic development. This is evident from the fact that in many urban

areas, aesthetics, design and attractiveness have become important source of marketing and branding (Philo and Kearnes, 1993). Thus, these attractions act as a stimulus for economic growth.

Another aspect of urban forestry is the advent of nature in a contemporary space. Forests prove to be habitats for various flora and fauna. Unique species inhabit these dense urban forests and provide sanctuary to wildlife particularly birds. Development of the tourism industry is an additional advantage of urban forests. Various tourism industries rely on natural environment's quality to lure visitors. Activities such as bird-watching, flower and fruit picking, camping, photography and hunting prove to be lucrative. These help attract not only foreign tourists, but locals looking for weekend recreation prefer places closer to home. Hence urban green spaces provide a source for tourism and recreational opportunities by enhancing the beauty of cities (Jim and Chen, 2006). Furthermore, tree-planting is relatively more cost-effective mode of conserving energy than other fuel-saving measures. Urban forestry also acts as a source of job provision for both unskilled and skilled workers.

In terms of social benefits, urban trees offer positive psychological effects, aesthetics and emotional as well as spiritual benefits (McPherson et al., 1999). More specifically, trees improve physical health by enhancing air quality and sheltering from urban phenomenon such as heat island effect. In addition to providing forest products to household for subsistence, forests provide water and air purification as well. For instance, they play a vital role in filtering the air, through carbon sequestration and thus reducing respiratory problems. Besides, physical activity also increases due to greater recreation opportunities which in turn enhances longevity (Takano et al., 2002). Green spaces contribute in establishing a sense of community and attachment to the neighborhoods, reduce social isolation and increase social contacts (Kuo et al., 1998). Furthermore, studies have confirmed a strong association between mental well-being and physical environment whereby green spaces act as a means of escaping from stress and help in reducing anxiety levels (see for instance, Guite et al., 2006). In addition, trees tend to minimize the exposure to ultraviolet light thereby reducing the risk of skin diseases such as cataracts and skin cancer (Tretheway and Manthe, 1999).

Costs of Urban Forestry

There are certain costs associated with urban forests with regards to environment, economy and society. Trees tend to affect the urban environment in various subtle ways. For instance, mitigation by urban trees can pose costs in the form of emitting pollutants like volatile organic compounds. They may also collect pollution deposits and affect atmosphere's chemical composition. In addition, they may alter the flow of air causing pollution to divert in the wrong direction. Furthermore, numerous diseases and insects can infest the urban trees thus killing them and minimizing the potential value, health benefits

and sustainability of the urban forests. Moreover, the water consumption also increases with plantation of more trees thus reducing the level of water table.

Certain direct and indirect economic costs are associated with urban forestry for instance, planting and maintenance of trees posit direct economic costs while indirect costs pertain to damages caused by tree roots to buildings and pavements, disruption to traffic during maintenance resulting in increased time cost. Moreover, blockage of drains by leaf litter may also incur repairing costs (Vogt et al., 2015). Specifically, maintenance cost includes the cost of planting, pruning, irrigation, tree removal, insect and disease control. In addition, program administration requires planning and trained workforce thus associated costs are involved. Further, infrastructure repair costs may also be incurred if the trees fall and damage the infrastructure.

In terms of social cost, trees can undermine air quality by producing pollens thus causing pollen allergy. This in turn may inflict health costs on the society. Moreover, litigation and liability costs may also be involved in the event trees damage the private property in which case, the owners may take legal action to claim compensation for property damages. Tree falls can also disrupt utilities causing power outages for the community. Furthermore, resources and money have to be diverted from other social programs for plantation and maintenance of urban trees (Dwyer et al., 1992). Precisely, households and communities need to invest in equipment, personnel and other necessities required for tree maintenance which may avert resources from other welfare expenditures.

In short, urban forestry entails costs and benefits and a careful assessment of these is necessary to aid private sector (households and industries/corporations) to better understand the importance of urban trees in enhancing community's welfare and managing and planning for urban forests. In general, net benefits can be maximized through proper planning and management. For instance, by planting right trees in right places, planting low maintenance trees, taking care of existing trees rather than planting new ones and seeking community's input regarding management of urban forests.

Miyawaki Method: Native Forests by Native Trees

A reliable forest reforestation method that has been gaining a worldwide reputation as being highly successful in reclaiming degraded land. The Miyawaki Method or the "Native Forests by Native Trees" based on the 'potential natural vegetation theory' that states that a piece of land that is free from any sort of human intervention, within a time frame of 600 to 1000 years, a forest will self-seed and take over the entire land. Professor Miyawaki successfully pioneered a method that amplified this growth process to establish a mature forest in just 10 to 15 years. This method has been successfully

implemented around the globe and has shown positive results in not only rejuvenating degraded lands but that too in a smaller time period. When first applied in Japan, Miyawaki discovered that restoring native green environments as well as multilayered forests with well-developed ecosystems could quickly be established with the simultaneous use of intermediate as well as late successional species in plantation. In the 1980s, Professor Miyawaki pioneered the now successful approach to reforestation in Japan to restore the indigenous ecosystem as well as maintain the global environment through disaster reduction and CO_2 mitigation. In Japan this type of forestry was normally done around newly built power stations as well as newly built ironworks. The most striking aspect of the Miyawaki method was the use of indigenous plant species, which was based on the ancient Japanese practice of growing forests indigenous to the area, particularly around shrines. It was the Great Hanshin Earthquake that occurred in 1995, which established that forest around infrastructure played a huge role of reducing the amount of destruction causes to them in a grave event such as an earthquake. Miyawaki noted that during earthquakes, infrastructures that had no trees around them had a tendency to burst into flames but infrastructures that did have trees around them with broad leaves did not seem to catch fire thus establishing the fact that trees provided the role of disaster reduction as well. It was also found that trees that surrounded houses actually hindered the falling roofs and pillars that normally trapped people during an earthquake (Miyawaki, 1999).

The Miyawaki Method relies on a range of principles for a faster growth of forests, which are explained as follows,

- The method first requires a thorough surveying of the proposed area of at least 100 square meters for rehabilitation, to determine the species that are native to the area. It should be highly stressed that tree species chosen must be indigenous to the land for optimal results. For the correct selection of the tree species, it is imperative that experts conduct a thorough analysis that involves studying the topography, soil profiling as well as land utilization.
- The second principle of the method is land preparation, for healthy growth of trees the right nourishment for them is essential. To do so the topsoil of the land, with the depth of 20 to 30 cm, must be removed followed by mixing compost from organic material as well as rice husk with the soil in equal proportions to reduce the time required for the natural process of soil evolution. Here the compost performs the function of providing the necessary nutrients to the plants and the rice husk allows for water to pass to the soil and thus hinder any chances of soil dryness even if there is no rain for a period of time.
- After the selection of main native tree species and companion specie, the third principle is to take the seeds of these and allow them to grow in pots until the root system is developed. Once the root system is developed the seedlings are mixed and then densely planted together (3 to 9 seedlings in each square meter), mixing the species tend to reinforce species diversity as well as resistance, which leads to coexistence of trees. A time frame of 2 to 3 years is required for

sustaining the forest with the help of human intervention. The biggest upside to the Miyawaki Method is the ability of the forest to sustain itself on its own after the initial period of plantation.

It should be mentioned that though in the earlier phases of the plantation the costs incurred may be more than traditional methods in the form of a requirement for specialists for the ecological and botanical investigation, higher manpower required for planting coupled with the higher cost of plant material due to the high level of plant density involved. The method also requires that the plants we intensely watered in the initial phases. However the analysis of the method has revealed the self-sustaining nature of the Miyawaki forest; after a period of one to two years, no human care is required and the forest stands on its own in a short period of time. What makes this forest self-sufficient is the fact that due its dense plantation, every drop of rainwater is conserved and every leaf that falls is converted into humus, which acts as a nutrient for the forest. As the forest grows it keeps self-generating nutrients and the density also implies that the trees would compete for sunlight thus they grow faster (Miyawaki, 2004) (Vesella et al, 2011).

The Miyawaki Method has been deemed successful due its ability in generating a forest that has had a 10 times faster development due to the emulation created between the plants, has a density 30 times higher and thus allowing for a greater CO_2 sequestration and most importantly these forests have a biodiversity that is a 100 times higher as a result of a thicker plant density[8]. The method has been successful worldwide, in Japan where it all started, the results of the ecological planting were quite impressive where seedlings that were only 30 to 50 cm long high grew up to 7 meters in under 10 years and more than 10 meters in under 15 years. It should be mentioned that usually a forest planted by humans in a traditional manner, when left to nature's own devices usually takes around 100 years to mature.

The dense plantation of a mix of 30 to 50 species of potential as well natural vegetation was crucial in developing a multilayered forest in a time frame of 15 years. The method also reached South-East Asia where it was used in the tropical rainforest zones of Malaysia, Indonesia and Thailand where slash and burn farming as well as felling of natural trees was common and had greatly damaged the forest areas. When areas are damaged by slash and burn farming then restoration of such areas is either impossible or takes a very long time however through the Miyawaki method the restoration did happen and that too in a small time frame. In order to begin the restoration, Professor Miyawaki collected seeds of 92 tree species that were native to the area and cultivated them while following the principles of his method. After 12 years of the first planting, the seedlings grew into a splendid quasi-natural forest. As

[8] A. (2018, April 25). A wild urban forest thanks to the Miyawaki Method. Retrieved from https://www.reforestaction.com/en/blog/wild-urban-forest-thanks-miyawaki-method

per Khopai et al (2003), when the technique was specifically used in Bintulu, Malaysia where soil erosion had completely degraded the land it was found that the Miyawaki method allowed for the percentage survival of seedlings on the degraded area to amount up to approximately 71 percent. The percentage of survival increased to 89.2 percent when half a meter wide strips of vegetation were retained to provide shade to the planted seedlings. Furthermore the planted seedlings grew very well with the mulching technique that Miyawaki had proposed, the native seedlings of 50 cm height grew up to 150 to 270 cm in just 6 months.

The method was also used in China, where devastation of forest areas was quite severe around the Great Wall; several projects were carried out to restore the land to its former state but to no avail. Following the Miyawaki Method, a field survey was conducted in the area to determine the tree species required, around 80,000 to 100,000 acorns of the indigenous trees were germinated in pots and in 1988 in the first planting festival held in China, where the seedlings were planted with the help of 1200 volunteers from China and 1400 volunteers from Japan. The method successfully restored much of the degraded land around the Great Wall (Miyawaki, 2004). Schirone et al (2011) in their bid to study the effectiveness of the Miyawaki method in the Mediterranean region focused on two land plots in Sardinia, which were completely damaged as a result of human exploitation. The idea was two compare two reforestation methods and see their effectiveness, one of the methods being the Miyawaki Method. The results revealed that the Miyawaki Method was a more effective and quicker approach to reforestation in Sardinia. The interesting aspect here is that the Sardinian weather is characterized as having summer aridity as well as harsh winters for which the method was easily tweaked to accommodate the harsh weather. Adhering to the basic principles of the Miyawaki method and altering the tillage technique, the soil water storage capacity greatly improved in the winters and water stress was reduced during the summers. After 12 years a well-developed forest was found in the plot where the Miyawaki Method was used thus confirming that the Miyawaki Method could also be altered to suit the climatic environment of different regions.

The method has also been successful in India, where rapid amounts of unplanned development have wreaked havoc on the natural vegetation of the country. The most notable case is the plantation done by Shubhendu Sharma, who using the Miyawaki method was successful in planting 33 forests across India. Sharma began by taking on the endeavor of growing a forest in his very own backyard, a 93 square meter plot, using the techniques proposed by Professor Miyawaki. His project was a success and Sharma found himself with a forest with 300 trees, which comprised of 42 plant species. His success led him to start his very own for-profit company known as Afforest, which was devoted to growing native forests. Explaining the specifics of the forest, Sharma states that the minimum area required to plant the forest is 100 square meters and the base cost can be as little as RS 60,000 to 70,000 thus making this forest model a low cost one. What is interesting about his company is that they design and grow forests

according to the needs of a particular setting, for example to grow a forest for public parks his company would grow species that would grow small fruits to attract birds to appeal to the general public. He further explained that the tangible benefits of the forest he grew in his backyard included an increase from 7 bird species to 17 and furthermore he found that the trees also helped in recharging the aquifers thus sustaining the groundwater. Sharma believes that native forests are exceedingly beneficial not only because of the range of environmental benefits associated with them but also due to their low maintenance (Eng, 2015).

Inspired by Shubhendu Sharma, Shaille Mehta of Acacia Eco collaborated with a university professor and successfully created a mini-forest of 14000 trees within the premises of a local school. Various other Indian companies have emulated the Miyawaki method and have successfully transformed barren lands into thriving forests, for example an Indian non-profit company Say Trees converted a barren land near the railway in Bengaluru into a verdant forest in just 5 years, and their aim is to create forests that develop faster than development itself[9]. These cases very well indicate the fact that the Miyawaki Method may easily be implemented, and that too by common folk. All that is required is willpower and the right ecological expertise. Furthermore with the rapid loss of green spaces in urban landscapes, the Miyawaki Method can surely offer respite. The time for spreading awareness of the harms of deforestation is now no longer enough and as per Sharma the 'narrative must move forward from awareness to action'[10].

The Case of Pakistan

Pakistan much like its developing counterparts is facing a rise in urbanization and the environmental issues attached with it. The urbanization rate of the country is 3 percent, which is the highest on the South Asian region. The main reason behind this intense growth is the high population pressures that the country faces. With 209 million citizens, Pakistan stands as the sixth most populous country in the world and thus prompting a major rural to urban migration within the country. Within the timeframe of 1998 to 2014, the urban population in Pakistan increased from 43 million to 72.5 million and at present 47 million people are concentrated in 9 major cities and the country will predominantly be urbanized by 2025 i.e. 50 percent population will reside in urban settings (Ministry of Climate Change, 2015). An

[9] Joshi, S. (2018, January 20). Now, even city folk can grow their own jungle - Times of India. Retrieved from https://timesofindia.indiatimes.com/home/sunday-times/now-even-city-folk-can-grow-their-own-jungle/articleshow/62584056.cms

[10] Mantri, G. (2017, May 25). Tired of living in a concrete jungle? Here's how you can grow your own forest. Retrieved from https://www.thenewsminute.com/article/tired-living-concrete-jungle-heres-how-you-can-grow-your-own-forest-62596

obvious consequence of this rapid urbanization has been a sharp spike in the deforestation rate of the country.

As per the FAO, Pakistan currently has the highest rate of deforestation that has been estimated to be 0.2 percent to 0.5 percent per annum. The major contributing factor that has led to these grave statistics is none other than the rapid urbanization that is taking place in Pakistan, which prompts excessive land clearing for urban development as well as the dependence of local populations on forests for livelihood. This is especially alarming since the forest area of the country only accounts for 5.2 percent of the land area of Pakistan, the optimal forest cover of any country should account for at least 20 to 30 percent. Given the diverse landscape and ecological zones in the country, Pakistan is home to a rich and unique biodiversity. However with the increase in deforestation that has led to major habitat loss, there has been a noticeable decline in the population of many species. According to the IUCN Red List, 6 mammal species have faced extinction as a result of intense deforestation in Pakistan (Ministry of Climate Change, 2015).

The intense loss in forests area has brought along with itself a host of other predicaments other than loss in biodiversity. Another most prominent consequence of intense deforestation has manifested itself in the form of climate change. Pakistan has witnessed an average annual temperature increase of 0.6 degrees in the last century owing to the diminishing green areas of the country[11]; to date Pakistan has lost 7.3 million hectares of forests. This has brought with itself a string of grave problems, which include water scarcity, loss in food security, and increase in natural disasters to name a few. What is most ironic is the fact that though Pakistan has the lowest greenhouse gas emissions (ranked 135th in the world in terms of emissions per capita) yet is one of the 10 most vulnerable countries to climate change. The gravity of the situation can also be highlighted by the 2015 heat wave that killed 1271 people in Karachi. It should be mentioned here that the rate of urbanization has been the strongest in Karachi where urban area density increased from 233 per km square to 3566 per km square from 1947 to 2004 owing to a significant increase in the population of the city. The rapid urbanization coupled with rising global warming led to one of the prime reasons cited for this heat wave as being the Urban Heat Island (UHI) effect. The poor coping strategies of the city are what led to UHI killing many in the 2015 heat wave (Chaudhry et al, 2015).

These very reasons have led the Parliamentary Secretary of Climate Change Romina Khursheed to term urban forestry as the 'need of the hour'.[12] The efforts made at the federal and provincial level have

[11] The Environment and Climate Change Outlook of Pakistan, United Nations Environment Programme, March 2013; https://www.uncclearn.org/sites/default/files/inventory/unep25082015.pdf

[12] Green cover: Urban Forestry termed need of the hour. (March 22, 2018). *The Express Tribune.* Retrieved from https://tribune.com.pk/story/1666200/1-green-cover-urban-forestry-termed-need-hour/

proved to be unsatisfactory in bringing Pakistan's forest levels at the par with the international standards. Green cover of the major cities of Pakistan has witnessed a noticeable decline in green covers, greatly deteriorating the air quality as well as greatly hampering the sustainability of the cities. As per the World Economic Forum, Karachi, Peshawar and Rawalpindi have been deemed as among the top most polluted cities on the planet, having the worst air quality in the country. Highlighting the significance of trees in improving air quality in urban settings, IUCN forest expert Syed Ghulam Qadir stated that an increase in urban forests might actually offer a huge respite in the ongoing air pollution predicament in the major cities of Pakistan. He lamented that in Karachi only a single tree species known as Conocarpus, has been copiously planted and that too of the wrong kind which has consequently become a health concern due to its high pollen count which causes asthma. He stressed that planting a variety of tree species indigenous to the area was imperative in controlling much of the environmental concerns of Karachi, he further stated that growing native trees tend to be of low cost and low maintenance.[13] Thus the need for proper implementation of urban forest management is pressing given the poor state of affairs in the context of the environment.

The Pakistani government's efforts when it comes to general forest management have been quire unsatisfactory at both provincial as well as federal level. A range of forest related legislations have been passed at the provincial as well as federal level, the results however do not indicate any level of improvement in the green spaces of the country. The National Forest Policy of Pakistan though gives a range of comprehensive objectives and recommendation to provide viable solutions to the dwindling forest predicament of Pakistan and promotion of environmental sustainability. However the effective implementation of these is yet to be seen. Promotion of urban forestry is part of the policy yet implementation is again missing thus reducing effective urban forestry management to a mere pipe dream. Inherent structural weakness and a lack of resources at the governmental level have played a huge part in the lack of implementation of an effective forest management plan and emphasis on urban forestry is largely missing. Furthermore a lack of proper and scientific methods and plans for adequa.te forestry management are largely missing (Aftab and Hickey, 2010). Furthermore the government's failure in establishing a suitable private property regime hindered the prospects of optimal forest exploitation due to the discordant structure of property rights that greatly fuel rapid deforestation. Moreover despite the implementation of quantity restriction on the wood removal by the community, the state itself indulged in excessive timber harvesting to further its developmental plans, through the system of contracts collusions among foresters, contractors as well as the local influential propelled the business of the 'timber mafia' (Hasan, 2007). These failures had a huge price attached to them in terms

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[13] Ilyas, F. (2016, March 21). Greener city: Urban forestry to counter air pollution in Karachi. *The Express Tribune*. Retrieved from https://tribune.com.pk/story/1069565/greener-city-urban-forestry-to-counter-air-pollution-in-karachi/

of a spike in the dwindling green spaces of the economy, which led to a host of environmental predicaments to ensue in the country.

Islamabad, which was considered the greenest city of the country, has been facing an immense strain on its urban vegetation because of the escalation in the deforestation rate. Its lush trees that covered even its urban areas was what made it stand out in all the other urban centers of the country. According to a study done by Hammad Gillani, a post-doctorate research from the University of Illinoi, revealed that the rapid conversion of green areas into concrete for the purposes of residential and commercial use has greatly exposed the soil, making Islamabad extremely vulnerable to any natural disaster. Furthermore the rapid deforestation has led to a significant decline in the indigenous as well as exotic plants of Islamabad taking a huge toll on the environment as well as the ecosystem of the region. If the rate at which the deforestation is occurring continues, Islamabad will soon witness a collapse in its urban ecosystem. The rapid loss in the urban forests of the city have contributed to the rising temperatures the city has recently been facing, putting Islamabad on the road towards experiencing a heat wave much like Karachi did in 2015. Reduced rainfalls coupled with declining water aquifers are another consequence that Islamabad has faced amidst the rapid deterioration of the urban green spaces of the city. The Capital Development Authority (CDA) has had a huge role to play in this, where in the name of development several green areas of Islamabad have been damaged particularly for road expansions thus wreaking havoc on the ecosystem of the city. In their defense CDA has initiated projects such as *Ghar Ghar Aik Shajar* where 30,000 plant saplings would be distributed amongst residents to inculcate a sense of social responsibility in them. Furthermore the CDA has also initiated a range of tree plantation drives on which there has been criticism that the government has a habit of planting exotic species that tend to do more harm than good in terms of extra consumption of groundwater and increased health issues.[14] Furthermore Dr. Zafar Iqbal Shams, a Pakistani environmentalist has too lamented on the lack of expertise that government has when it came to horticulture, he stated that the government had a persistent habit of planting shrub like Conocarpus plants or grass that provide no assistance in carbon sequestration and yet require hard work and a lot of funds. He stressed on the dire need of increasing efforts towards planting native trees to mitigate the effects of climate change as well as environmental degradation.[15]

Given the government's inherent weaknesses in effectively tackling the dwindling rate of forest (both urban and natural) and the subsequent tribulations attached to it, it is time that the corporate sector of

[14] Abubakar, S. M. (2018, April 4). Is Islamabad on its way to becoming the next Mohenjo-Daro? *The Express Tribune*. Retrieved from https://tribune.com.pk/story/1672201/10-islamabad-way-become-next-mohenjo-daro/

[15] Ali, S. (2017, August 7). Pakistan's first urban forest reaches greater heights. *The Express Tribune*. Retrieved from https://tribune.com.pk/story/1475405/pakistans-first-urban-forest-reaches-greater-heights/

Pakistan increase their efforts in making the country more environmentally sustainable particularly by taking part in urban forestry projects given. The motivation of the corporate world though maybe profit driven however their choices tend to have an impact on the citizens at large thus making it imperative that they invest in initiatives that would then lead to the well-being of the citizens. About 93 percent of Pakistan's corporate entities are indulged in some sort of charity but recently the trend seems to have shifted towards Corporate Social Responsibility (CSR) plans and projects, with MNCs having the highest share in these projects (Ahmed and Ahmad, 2011). Recently the Securities and Exchange Commissions of Pakistan (SECP) that regulates the corporate sector and the capital markets has approved a set of general Corporate Social Responsibility (CSR) guidelines, under the guise of *Corporate Social Responsibility Voluntary Guidelines* 2012, for public companies to follow where environmental protection is also present as a guideline. CSR obligations may very well compel companies to indulge or invest in urban forestry programs in their bid to improve the environment.

An analysis of the CSR initiatives of various companies reveals a motivation to improve the environment as well investing in environmental related projects as a recurring theme. The Pakistan Tobacco Company (PTC) has engaged in several afforestation programs and has successfully planted 75 million trees since 1981. Recently they have collaborated with the Ministry of Climate Change and have begun rigorous afforestation efforts in Barakahu.[16] Shell Pakistan, the leading Petroleum and Oil Company recognizes the pressing need of adopting a low carbon model in mitigating the effects of climate change as well as improving air quality. Openly admitting to the fact that their projects do have an effect on the local biodiversity, Shell Pakistan has committed to engage in methods to help reduce the impact.[17] Its most prominent project regarding conservation of the environment was the fuel substitution/conservation project, which entailed encouraging LPG usage over fuel wood to save the forest resources of Ayub National Park. The idea was to support the local communities in improving their household fuel wood saving to discourage incessant woodcutting in the area to improve environmental sustainability. Thus Shell Pakistan was successful in striking a balance between profit motives and its conservation mandate as prescribes by its CSR obligations (Khan et al, 2007). Attock Refinery Limited (ARL) cited itself as an environmental friendly company, which takes investment in environment as its core social responsibility. As per their Sustainability Report (2017)[18] their environmental strategy is focused on the minimization as well as the prevention of the negative impacts of the environment through effective procedures, measures and technologies. A successful environmental initiative that company undertook was the establishing a biodiversity park known as the Morgah Biodiversity Park near Rawalpindi, where 268 plant

[16] Corporate Social Responsibility - Giving back to the community. *Pakistan Tobacco Company.* Retrieved from http://www.ptc.com.pk/group/sites/PAK_AMPC26.nsf/vwPagesWebLive/DO9T5K52

[17] Environment. *Shell Pakistan*.
Retrieved from https://www.shell.com.pk/sustainability/environment.html

[18] Sustainability Report 2017, *Attock Refinery Limited*.
Retrieved from http://www.arl.com.pk/sustainability_report_2017.php

species have been grown, all indigenous to the region. As per their report the motivation behind this initiative was to create awareness regarding the importance of biodiversity and its contribution to human welfare. ARL has also recognized the importance of adequate air quality and a reduction in carbon emissions as paramount in reducing environmental impacts associated with the company's ongoing activities. The Dawood Hercules Chemicals Limited in its bid to promote public awareness about the degrading natural habitat launched a series of documentaries known as the 'TDF Nature Series' which was launched in over 130 cities to inculcate a better understanding of the urgent need to sustain the environment.[19] Even the banking sector of Pakistan in its CSR initiatives has made environment a priority; HSBC for example has collaborated with the World Wide Fund (WWF) in a Mangrove Watch and Saplings Plantation project in Karachi to show its commitment to environment conservation.

The above analysis points at the ability and willingness of the corporate sector in effectively implementing environmental strategies that though may seem minute in scale have had significant benefits for the environment. However initiatives regarding urban forestry are largely missing owing to the lack of understanding of its associated benefits. Thus educating the corporate sector regarding the benefits of urban forestry particularly for a climate vulnerable country like Pakistan and subsequently engaging them in urban forestry initiatives is now highly imperative. The government's failures in managing its forest sector have exacerbated the environmental predicaments of Pakistan to a great extent. Thus the corporate sector with its resources and the adequate managerial skill can assist Pakistan greatly in reversing the damage done to its green spaces and subsequently mitigating the effects of climate change and ensuring environmental sustainability.

Despite the lack of initiative regarding urban forests at the public and corporate sector, urban forestry has been picked up in Pakistan as well by a young entrepreneur by the name of Shahzad Qureshi. Inspired by Shubhendu Sharma's urban forestry initiative in India, Qureshi took it upon himself to implement Sharma's methodology that was derived from the Miyawaki Method and plant a forest. Qureshi implemented the method immediately in a park near Karachi where he planted a total of 1280 saplings and after a period of two years, 95 percent of the saplings he planted grew into healthy trees. The forest has grown into a thickly dense green space covering an area of 400 square meters and is home to 45 species of trees. The forest has even managed to attract a host of species thus increasing the biodiversity as well. After his successful project, Qureshi much like Sharma started his own company called Urban Forest to continue his efforts in making a positive impact on the environment. Qureshi even collaborated with Shubhendu Sharma to work on a collaborative urban forest pilot project in Karachi. Commenting on the features of urban forests he stated that the way the soil is prepared is

[19] Corporate Social Responsibility- The Dawood Foundation. [Retrieved: December 05, 2018] from https://www.dawoodhercules.com/csr_dawood-fdn.php

highly important and it is the organic trash mixed with the soil that allows for the vegetation to prosper. He further stated that the plants grown in this type of forestry could very well use the sewerage water that normally drains into the sea.[20]

Qureshi's company has initiated several urban forest projects in Karachi as well as Lahore and has collaborated with companies to finance these projects. For example the Dream Gardens, Lahore project has allowed for the creation of an urban park at Dreams Garden Phase II Housing Scheme, which covers an area of 1800 square meters and is home to 30 native plant species. The project is a part of collaboration between Urban Forest and Izhar Monnoo Developers, a leading real estate company in Pakistan. This is an adequate example of how the private sector of Pakistan can indulge in urban forestry programs.

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