American Journal of
Biomedical Science & Research

www.biomedgrid.com
ISSN: 2642-1747

Review Article

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Awareness of Miyawaki Urban Forest Plantation Method in Pakistan

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To Cite This Article: *Muhammad Arshad Ullah*, Ali Hassan and Ameer Hamza. Awareness of Miyawaki Urban Forest Plantation Method in Pakistan. Am J Biomed Sci & Res. 2023 18(1) AJBSR.MS.ID.002446,* DOI: 10.34297/AJBSR.2023.18.002446

Received: February 04,2023; **Published:** March 09, 2023

Abstract

A Miyawaki forest; Potential Natural Vegetation, is an opportunity to take part in ecosystem restoration. Indeed, the method takes into account ecological successions, and allows to immediately plant an advanced forest through the choice of the most adapted plant communities. Cooperation between trees enhances quick development and great resilience. Natural restoration is an intentional activity that initiates or accelerates recovery of an ecosystem with respect to its health, integrity and sustainability. Currently ecological succession is the most forest reforestation programs adopt a scheme of planting one or more early successional species; after successful establishment, they are gradually replaced by intermediate species (either naturally or by planting), until late successional species arise. This pattern tries to simulate natural processes of ecological succession, from pioneer species to climax vegetation. However, it requires several silvicutural practices and normally takes a long time. It was said that it would take 150-200 years in Japan to reach the final indigenous natural forests by secondary progressive succession and 300-500 years in Southeast Asia. Dense, mixed planting of 30-50 species of potential natural vegetation is in accordance with the system of natural forests, and enables a multilayer forest to grow after 15-20 years by the peculiarity of planted species.

The Miyawaki method is an interesting tool to speed up forest restoration. Miyawaki's team does an attempt in Bintulu as early as 1990; Miyawaki gives details about the forest development. The Miyawaki method could offer a quicker and more effective reforestation approach in the Mediterranean environment, adopting naturalistic theoretical principles not previously tested in Mediterranean Europe, which has the additional challenge of a seasonal climate characterized by summer aridity compounded in several cases by winter cold, and also by thin soils. First, we used tillage to improve soil water storage over the winter and reduce water stress during the summer. Summer aridity implies the soil would be able to stock winter rainfalls in order to allow the plants avoiding water stress of the next season. Air quality in western (North American) cities has been assessed using models based on environmental databases and simulations: Despite the limitations, there are several advantages to the modeling estimates, which include the use of best available tree, weather, population and pollution data, modeling of tree effects on hourly pollution concentrations and modeling of pollution effects on human health.

Vegetation can also be used directly as a noise barrier, in the form of an urban forest. The study analyses the noise reduction resulting from urban forests along highways. It takes into account the porosity of the soil, the presence of plant cover, its density, its thickness, as well as the thickness of the trunks. One of the pillars of the Miyawaki forest technique is the identification of native vegetation species. For this purpose, a detailed field survey is needed to determine the type of vegetation. The field survey is coupled with the phytosociological survey and environmental description. It is important to investigate basic soil characteristics, light condition, effect of environmental factors on the survival of seedlings grown in three degraded vegetation. The vegetation units in the surrounding region is studied and classified as either native or substitute vegetation (PNV).

Introduction

Plant communities that have been destroyed are also generally quite difficult or sometimes impossible to restore [1]. Restoration of tropical rainforests is most effective for conservation of the global environment [2]. The fallen trees prevented the growth of Virola spp. and the other main component species of the potential natural vegetation in the forest. Unfortunately, biodiversity there cannot be said to be adequate [2]. A Miyawaki forest is an opportunity to take part in ecosystem restoration. Indeed, the method takes into account ecological successions, and allows to immediately planting an advanced forest through the choice of the most adapted plant communities.

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It is called the Potential Natural Vegetation. Cooperation between trees enhances quick development and great resilience. Natural restoration is an intentional activity that initiates or accelerates recovery of an ecosystem with respect to its health, integrity and sustainability [3]. Currently ecological succession is the most forest reforestation programs adopt a scheme of planting one or more early successional species; after successful establishment, they are gradually replaced by intermediate species (either naturally or by planting), until late successional species arise. This pattern tries to simulate natural processes of ecological succession, from pioneer species to climax vegetation. However, it requires several silvicutural practices and normally takes a long time [4]. It was said that it would take 150-200 years in Japan to reach the final indegenous natural forests by secondary progressive succession and 300-500 years in Southeast Asia. The ubiquity of positive interactions indicates that some plant communities may be real entities, albeit not necessarily with tidy, discrete boundaries." "Low plant density has been traditionally retained as appropriate in arid and semiarid environments in order to avoid competition for water resources between plants, but it is now evident that cooperative processes, e.g., mutual shading, prevail over competitive processes [4]. Dense, mixed planting of 30-50 species of potential natural vegetation is in accordance with the system of natural forests, and enables a multilayer forest to grow after 15-20 years by the peculiarity of planted species. At some planting sites, however, even after ecological dense, mixed planting, adequate natural selection is not seen until 10-15 years after planting and some tall trees have thin stems compared to their height. This problem will be solved in time [5].

In the Belem Forest fast-growing pioneer species developed shallow horizontal roots before soil conditions changed to those of mature sites. The stems of these species broke and fell in the somewhat strong winds. As a result, the broken pioneer stems killed many individuals of the PNV species, which waited in the lower layer. The fallen trees prevented the growth of Virola spp. and the other main component species of the potential natural vegetation in the forest. Unfortunately, biodiversity there cannot be said to be adequate [2]. Slash-and-burn farming over a large area has destroyed every tree within a forest and it takes quite a long time to see a forest naturally restored. Sometimes it is nearly impossible [5]. However, the Miyawaki method is an interesting tool to speed up forest restoration. Miyawaki's team does an attempt in Bintulu as early as 1990; Miyawaki gives details about the forest development [6]. The Miyawaki method could offer a quicker and more effective reforestation approach in the Mediterranean environment, adopting naturalistic theoretical principles not previously tested in Mediterranean Europe, which has the additional challenge of a seasonal climate characterized by summer aridity compounded in several cases by winter cold, and also by thin soils. First, we used tillage to improve soil water storage over the winter and reduce water stress during the summer.

Summer aridity implies the soil would be able to stock winter rainfalls in order to allow the plants avoiding water stress of the next season. This outcome has been achieved using tillage; such action is necessary and should be enough, even if it would be possible to get a better performance by adding compost or local soil. Mulching with green material does not seem effective [7], whereas mulching with dry material has been useful. Moreover, avoiding clearing all bushes is opportune for the Mediterranean environment, in contrast with some studies [4]. Urban forest benefits; Temperature reduction: -2°C minimum, locally, Air quality improvement, pollution clustering: absorption of 15% microparticules, leaves and bark intercept dust, Noise reduction: -10dB for a mature Miyawaki forest, Health and well-being: reduction of stress, anxiety, solitude, cardio-vascular et respiratory diseases, Biodiversity balance: biodiversity is on average 18 times higher, pest concentration can be lower, and the forest ensures transfers and biodiversity increase in urban context, Soils stability: the entanglement of roots forms a matrix-pillar system that retains soils CO2 sequestration : stock = 60kgCm-2 forest cover, flux= 0.5kgCm-2 forest cover year-1. 100m^2 of Miyawaki forest long-term compensates one year of a European person's carbon emissions and Real estate prices: properties with tree cover can see their price increase by a few thousands of Euros.

The study [8] focuses on the temperature difference between trees according to their location: isolated decorative trees (landscape), urban forests edge trees (edge) and trees within the urban forests (interior). As for whether urban forests create micro-climates, in other words, if nearby people can benefit from this additional freshness; the following study [9] shows that they do. Air quality in western (North American) cities has been assessed using models based on environmental databases and simulations: Despite the limitations, there are several advantages to the modeling estimates, which include the use of best available tree, weather, population and pollution data, modeling of tree effects on hourly pollution concentrations and modeling of pollution effects on human health [10]. The conclusions [11] are the total amount of pollution removal in the 86 cities in 2010 was 16,500t (range: 7500t to 21,100t), with a human health value of $227.2 million (range: $52.5 million to $402.6 million). Maximum annual air quality improvement among the cities averaged around 0.01 percent for CO, 2 percent for NO2, 3 percent for SO2, 4 percent for O3 and 15 percent for PM2.5. The greatest effect of urban trees on ozone, sulfur dioxide, and nitrogen dioxide is during the daytime of the in-leaf season when trees are transpiring water. Particulate matter removal occurs both day and night and throughout the year as particles are intercepted by leaf and bark surfaces. Carbon monoxide removal also occurs both day and night of the in-leaf season, but at much lower rates than for the other pollutants. Ozone studies that integrate temperature, deposition and emission effects of trees are revealing that urban trees can reduce ozone concentrations. Under stable atmospheric conditions (limited mixing), pollution removal by trees could lead to a greater reduction in pollution concentrations at the ground level. Large stands of trees can also reduce pollutant concentrations in the interior of the stand due to increased distance from emission sources and increased dry deposition (Cavanagh et al., 2009).

Trees reduce wind speeds, lowering mixing heights and can therefore increase pollution concentrations (Nowak, et al., 2006a). Trees also emit pollen, which affects allergies (e.g., Ogren, 2000), and volatile organic compounds (VOCs) that are precursor chemicals to O3 and PM2.5 formation (Hodan and Barnard, 2004).

At the local scale, pollution concentrations can be increased if trees: a) trap the pollutants beneath tree canopies near emission sources b) limit dispersion by reducing wind speeds, and/or c) lower mixing heights by reducing wind speeds (Nowak, et al., 2006a). Vegetation can also be used directly as a noise barrier, in the form of an urban forest. The study [9] analyses the noise reduction resulting from urban forests along highways. It considers the porosity of the soil, the presence of plant cover, its density, its thickness, as well as the thickness of the trunks.

The study [12] reports on the consequences of the loss of 100 million trees in the United States because of the emerald ash borer. Data collected between 1990 and 2007 lead to the following conclusions: "There has been an increase in mortality from cardiovascular and lower respiratory diseases in the counties infested with the emerald ash borer. (Ward Thompson, et al. 2012) conclude that salivary cortisol measurement offers considerable potential for exploring relationships between wellbeing and green spaces.

Results also indicate that these associations are partly mediated by air pollution and in a lesser extent noise, whereas physical activity and social support seem to play a minor role. Also, we did not find evidence that the observed benefits are particular for certain subgroups of society. (Gascon, et al., 2018). There are studies on the combined effects of sport and exposure to green areas. The study [9] documents the well-being of students who have been running or walking in 40% wooded areas (natural environment). Control experiments are carried out in a city environment (built environment). In terms of increased well-being, sport accounts for 9.2% of the variance and nature accounts for 17.9%. The combined effect of moderate physical activity and trees contributes for 58% of the total increase in well-being. There is therefore a synergy. Finally, urban forests also benefit people through the social events they generate, such as planting days. These events are environmental civism, defined as follows in the report [13]. Collective voluntary actions carried out to promote the sustainability of ecosystems.

A Miyawaki [14] expresses the completeness of an ecosystem and its ability to regenerate from fragments: A Miyawaki forest is an opportunity to take part in ecosystem restoration.

1) Indeed, the method considers ecological successions.

2) And allows to immediately plant an advanced forest through the choice of the most adapted plant communities.

3) It is called the Potential Natural Vegetation.

4) Cooperation between trees.

5) Enhances quick development and great resilience.

As for whether urban forests create micro-climates, in other words, if nearby people can benefit from this additional freshness; the following study (Howe, et al., 2017) shows that they do. The study used a network of 10 identical weather stations and high-resolution land cover and land use data in Knoxville, Tennessee, to analyze the microclimates of a mid-sized city with a temperate climate.

The conclusions (Nowak, et al., 2018) are the following:

a) The total amount of pollution removal in the 86 cities in 2010 was 16,500 t (range: 7500 t to 21,100 t), with a human health value of $227.2 million (range: $52.5 million to $402.6 million).

b) Maximum annual air quality improvement among the cities averaged around 0.01 percent for CO, 2 percent for NO2, 3 percent for SO2, 4 percent for O3 and 15 percent for PM2.5.

c) The greatest effect of urban trees on ozone, sulfur dioxide, and nitrogen dioxide is during the daytime of the in-leaf season when trees are transpiring water. Particulate matter removal occurs both day and night and throughout the year as particles are intercepted by leaf and bark surfaces. Carbon monoxide removal also occurs both day and night of the in-leaf season, but at much lower rates than for the other pollutants.

d) Ozone studies that integrate temperature, deposition and emission effects of trees are revealing that urban trees can reduce ozone concentrations.

e) Under stable atmospheric conditions (limited mixing), pollution removal by trees could lead to a greater reduction in pollution concentrations at the ground level. Large stands of trees can also reduce pollutant concentrations in the interior of the stand due to increased distance from emission sources and increased dry deposition (Cavanagh, et al., 2009).

Trees reduce wind speeds, lowering mixing heights and can therefore increase pollution concentrations [15]. Trees also emit pollen, which affects allergies (e.g., Ogren, 2000), and volatile organic compounds (VOCs) that are precursor chemicals to O3 and PM2.5 formation (Hodan and Barnard, 2004). On the local scale, pollution concentrations can be increased if trees: a) trap the pollutants beneath tree canopies near emission sources b) limit dispersion by reducing wind speeds, and/or c) lower mixing heights by reducing wind speeds [15]. Traditional noise barriers allow a noise reduction of ten decibels A. This corresponds to the difference that human beings perceive between the noise of a highway (70dB) and a normal voice (60dB). Some studies focus on increasing the performance of noise barriers by adding vegetation. It appears that a noise barrier with approximately 30 cm of vegetation on each of its faces reduces the sound by an additional 3dBA. Vegetation can also be used directly as a noise barrier, in the form of an urban forest. The study [16] analyses the noise reduction resulting from urban forests along highways. It considers the porosity of the soil, the presence of plant cover, its density, its thickness, as well as the thickness of the trunks.

The study (Donovan, et al., 2013) reports on the consequences of the loss of 100 million trees in the United States because of the emerald ash borer. Data collected between 1990 and 2007 lead to the following conclusions: There has been an increase in mortality from cardiovascular and lower respiratory diseases in the counties infested with the emerald ash borer. The magnitude of this effect was greater as the infestation progressed and in counties with median household incomes above the average. In the 15 states in the study area, emerald cherry [loss] was associated with 6,113 additional deaths related to lower respiratory tract disease and 15,080 cardiovascular deaths. This finding is added to the growing evidence that the natural environment has major benefits for public health.

(Ward Thompson, et al. 2012) conclude that salivary cortisol measurement offers considerable potential for exploring relationships between wellbeing and green space.

i. A recent study concluded on the importance of green spaces for mental health: The present study suggests a potential protective role of green spaces on mental health (depression and anxiety) in adults. Results also indicate that these associations are partly mediated by air pollution and to a lesser extent noise, whereas physical activity and social support seem to play a minor role. Also, we did not find evidence that the observed benefits are particular for certain subgroups of society [11].

ii. There are studies on the combined effects of sport and exposure to green areas. The study [9] documents the well-being of students who have been running or walking in 40% wooded areas (natural environment). Control experiments are carried out in a city environment (built environment). In terms of increased well-being, sport accounts for 9.2% of the variance and nature accounts for 17.9%. The combined effect of moderate physical activity and trees contributes for 58% of the total increase in well-being. There is therefore synergy.

Finally, urban forests also benefit people through the social events they generate, such as planting days. These events are environmental civism, defined as follows in the report [13,14] expresses the completeness of an ecosystem and its ability to regenerate from fragments: the variety of species in a biological community is called biodiversity, a term that encompasses both the number of species (species richness) and some aspects of the relative abundance of the different species. A more comprehensive concept of biological diversity is that of biological complexity, which includes diversity not only in entities but also in the many functional relationships just suggested. No one creature monopolizes the available space and energy; rather, these resources are shared. Thus, within the biological community, the habitats of the member populations are segregated, horizontally and vertically, according to each group's mode of life. For example, a forest consists of an over storey tree layer, a ground layer of herbaceous plants, possibly a layer of mosses or lichens directly on the ground, and certainly an underground system of roots. All these components, above and below ground, divide the living space three coexist while competing with one another. To a certain extent, a biological community can restore a destroyed portion of itself by re-forming its living environment a new or by relocating itself.

The study [17] reports on this phenomenon by which the urban forest gains in biodiversity and subsequently serves as a reservoir and relay of biodiversity: Site colonization by native species was particularly high at sites ≤100m from existing native vegetation, suggesting that even small patches of native vegetation in urban landscapes will be valuable as seed sources for accelerating native plant establishment at nearby receptive sites. In his study [5]; Miyawaki observes native trees after the 2011 tsunami. He concluded on the protective role of native trees. The well-rooted trees served as protection, and their roots retained part of the soil (b) This is not the case for non-native conifers originally planned for protection (c), their weak rooting failed to resist, and the trunks swept away by the tsunami created even more damage.

According to [18] fine roots are proportionally more resistant to tensile forces due to their elasticity. Large diameter roots can withstand higher absolute forces but are more rigid and brittle. Diversified vegetation forms a complementary matrix-pillar system, by entangling the horizontal and pivot root systems. The study concludes on the interest of taking vegetation into account in the study of soil stability: Combined with the knowledge on vegetation dynamics, ecological site properties and species resistance to erosion, these results can help in evaluating land vulnerability to erosion and the efficiency of restoration actions in eroded marly lands [18].

Forests are the second largest carbon stock on Earth after the oceans. For a given area in France, forests absorb each year 15times more carbon than meadows [19]. It can be noted that these average values bring together those of different types of forest ecosystems: Thus, in the continental biogeographically region, carbon stocks in deciduous closed forest are among the highest, of the order of 730 tCO2eqha-1 whereas those in the Mediterranean biogeographically region, notably made up of low-productivity holm oak coppices, have much lower carbon stocks, of the order of 500 tCO2eqha-1 [19]. The study from [15,10] is also very popular but does not incorporate the storage of forest soils either. Annual sequestration is estimated from the total carbon accumulated during tree growth, subtracted from the estimated amount of carbon lost during decomposition of dead trees. The average annual value of total carbon accumulated as a stock by urban forests in the United States is 7.69kgCm-2of forest cover (standard error (SE) =1.36kgCm-2). Estimates of annual sequestration (flow) vary according to the length of the growing seasons, the average value is 0.226kgCm-2 year-1 (SE=0.045kgCm-2 year-1). Values range from 0.430kgCm-2 year-1 (Hawaii) to 0.135kgCm-2 year-1 (Wyoming).

A study [20] conducted in Florida screens the impact of different vegetation types on real estate prices : "Results, on average, indicate trade-offs in that more trees with greater Leaf Area Indices (LAIs) [Individual LAI is the amount of one-sided leaf

surface area (m2) over ground unit area (m2) and is often used as a proxy for the amount of tree crown density and overall tree health] add to property value, while biomass and tree-shrub cover have a neutral effect, and replacing tree with grass cover has lower value. On average, property value increased by $1586 per tree and $9348 per one-unit [400m2] increase in LAI, while increasing maintained grass from 25% to 75% decreased home value by $271 [20]. Trees can also transfer water to each other, through their roots or connecting fungi networks: We found up to 21.6% of the water in a seedling could be supplied by HR from a source tree. The average value was substantially lower, only 1.8% after two weeks and 4.9% after three weeks. This is an approximate estimate, but it does highlight the potential importance of HR for seedlings surrounding residual trees [21]. It can be estimated that hydraulic redistribution is usually low, but it can reach up to 20% when stress occurs.

Also, there are some carbon (C) transfers. Carbon is an essential element for green plant storage and energy: we showed that mycorrhizal networks exist in tundra and facilitate belowground transfer of C among Betula nana individuals, but not between or within the other tundra species examined. Total C transfer among conspecific B. nana pairs was 10.7±2.4% of photosynthesis, with the majority of C transferred through rhizomes or root grafts (5.2±5.3%) and mycorrhizal network pathways (4.1±3.3%) and very little through soil pathways (1.4±0.35%). I ''Below-ground C transfer was of sufficient magnitude to potentially alter plant interactions in Arctic tundra, increasing the competitive ability and monodominance of B. nana. C transfer was significantly positively related to ambient temperatures, suggesting that it may act as positive feedback to ecosystem change as climate warms [22]. The study [23] is interested in the complexity of these networks, illustrating the concept of central tree by surveying the DBH (diameter) of trees correlated to their age, and their degree of connection (node degree). Within the same species, the more mature the tree, the higher its degree of connection to others. The variety of species in a biological community is called biodiversity, a term that encompasses both the number of species (species richness) and some aspects of the relative abundance of the different species. A more comprehensive concept of biological diversity is that of biological complexity, which includes diversity not only in entities but also in the many functional relationships just suggested. No one creature monopolizes the available space and energy; rather, these resources are shared.

Thus, within the biological community, the habitats of the member populations are segregated, horizontally and vertically, according to each group's mode of life. For example, a forest consists of an over storey tree layer, a ground layer of herbaceous plants, possibly a layer of mosses or lichens directly on the ground, and certainly an underground system of roots. All these components, above and below ground, divide the living space three coexist while competing with one another. To a certain extent, a biological community can restore a destroyed portion of itself by re-forming its living environment a new or by relocating itself. The study [17] reports on this phenomenon by which the urban forest gains in biodiversity and subsequently serves as a reservoir and relay of biodiversity: ''Site colonization by native species was particularly high at sites ≤100m from existing native vegetation, suggesting that even small patches of native vegetation in urban landscapes will be valuable as seed sources for accelerating native plant establishment at nearby receptive sites.

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In the last two decades, scientists have developed new insights both in theoretical and in practical actions for restoration and reconstruction of natural ecosystems [27-30]. Natural restoration is strictly related to increased sustainability and includes rehabilitation of ecosystem functions, enlargement of specific ecosystems, and enhancement of biodiversity restoration [31]. At the ecological level, restoration is also defined as ''an intentional activity that initiates or accelerates recovery of an ecosystem with respect to its health, integrity and sustainability'' [3]. Degraded plant communities are generally quite difficult or sometimes impossible to restore [32]. One reliable forest restoration method is the ''native forests by native trees,'' based on the vegetation-ecological theories [33] proposed by Prof. Akira Miyawaki and applied first in Japan. After these field surveys, all intermediate and late successional species are mixed and densely planted, with as many companion species as possible [34], and soil between them is mulched. Mulching is needed to prevent soil dryness, erosion on steep slopes even with heavy rainfall, weed growth, protect seedlings against cold, and as manure as materials decompose [5]. In fact, biocoenotic relationships involve auto regulations between species, favoring a dynamic equilibrium and avoiding any further silvicutural practice and need no insecticides or herbicides (with some exceptions). Indeed, in the Miyawaki method, the principles of self-organized criticality and cooperation theories have been essentially applied [33,35,36].

A and site B, selected according to the natural phytocoenoses. After planting, mulching with straw, green material [7] as Trifolium subterraneum L. and sawdust were applied. added; some autochthonous early-successional species [37,38] were planted together with late-successional ones to improve plant community resilience [37-39] mulching was provided using different types of material, as mentioned above, instead of using only straw. Further comparisons regard the role played by each species in the plant community as a result of interspecifc competition and natural evolution of vegetation [33]. High plant density also reduces the impact of acorn predators, thus encouraging oak regeneration, i.e., the main late-successional forest species in Mediterranean environments [40]. In addition, excellent plant stock remains fundamental for planting success in harsh environments [41].

If this new approach turns out to be more expensive, then it will be important to take measures to make it economically advantageous. In any case, if the high costs of the Miyawaki method were still not competitive with the traditional techniques on a large scale, the forest quality achieved would make it a noteworthy tool for protected areas and natural parks [42], where traditional plantings are not easily accepted because of their aesthetic and ecological impacts.

The greatest challenge today is to manage the environment in a sustainable way whilst offering pleasant surroundings for the urban dweller, and at the same time maintaining some natural areas. Nairobi, for example, has been ranked among the top ten cities in the world that have the biggest declines in live ability over 5 years with a score of -2.9% according to the latest Global Live ability Survey of 140 cities world-wide [43]. The unit measured cost of living, health care, pollution, education, infrastructure, and green spaces to obtain the scores. In general, green environments, and specifically trees, offer an array of benefits that can be categorized broadly into ecological benefits, architectural functions, climate moderation, and monetary benefits, as well as recreational and social values [44]. Trees are the most memorable aspect of a roadside planting design. They have an appropriate scale for a road corridor, are clearly noticed when travelling and are the best means for ameliorating the hard built elements of the road corridor. Subject to their safe use, they should be the primary element of a

landscape design. Trees should, however, be used selectively in a corridor. For example, they should not obscure expansive views and they should be located carefully and deliberately, outside clear zones and away from utilities [45].

Urban environments are major sources of carbon dioxide (CO2) and other green house gases (methane, nitrous oxide, and fluorinated gases) that contribute to global warming, a major contributor to climate change today. CO2 is the primary green-house gas emitted through human activities. The majority of GHGs emanate from burning fossil fuels, mainly from motor vehicles and industry [46]. These emissions have risen steeply over the last century with some cities now being covered in smog that not only reduces visibility, but also reduces air quality, generating air pollution which in turn can cause major respiratory issues and associated health complications. Smog generally can affect plant development and human health, as well as cause damage to materials such as rubber, textiles, and paint [47]. Three major outdoor air pollution problems are industrial smog from burning coal, photochemical smog from motor vehicle and industrial emissions, and acid deposition from coal burning and motor vehicle exhaust [47]. A wide range of experts have advocated decreasing individual carbon footprints and investing billions to reduce the risks of a major change in the earth's environment [48].

The restoration of degraded lands is an urgent necessity in urban settings. An innovative and (relatively) rapid method of land restoration is Miyawaki forests, named after Dr. Akira, Miyawaki (a Japanese botanist). This method has been used to restore forests and green cover at hundreds of locations throughout Japan. In addition, it has shown promising results in other parts of Asia, including Thailand, Malaysia, and India. This approach is based on identifying and growing native species in each region. Non-native plant species, generally introduced for providing green cover and other purposes, have more stringent nutrient and environmental requirements. And, hence such species require more care, resources, and have a slower growth rate. Native species are already accustomed to the local soil and environmental conditions and hence stand a better chance of growth and that took a rapid one. The Miyawaki method makes use of this key advantage of native vegetation. It is important to provide conservation planner for the conservation of biology [49].

The technique supports the growth of a dense, mixed, native forest and results in a native forest ecosystem, complete with small animals, rodents, birds, etc. The natural selection, resulting from the competition between different types of native species, creates a diversified natural forest. The method supports the growth of primarily canopy trees. To match a natural forest system, random plantation of different types of native seedlings (with extensive root system) is randomly planted. Growth rates of a meter per year or higher are generally observed, ultimately resulting in a complete, mixed, native forest ecosystem in a span of few years, instead of decades (to centuries) needed by other systems of planting. There is another study also which is based on the relationship of the major forest types to the forests of the adjacent Korean Peninsula, Northern China, and Russia Far East. The ability of plants to consume carbon dioxide and produce oxygen, during the process of photosynthesis, is generally considered the best deterrent to global warming. Miyawaki forests have the potential to act as carbon -sinks in our cities and minimize the global warming [50].

According to the study of World Health Organization, the World is becoming hotter, as it gets more crowded. Engines continue to pump out dirty emissions and half of the World has no access to clean fuels or technologies. Air is growing dangerously polluted that we breathe in. Out of ten, nine people now breathe polluted air. Air pollution has several different emissions sources, but the major contributors are motor vehicles and industrial processes [51]. Ambient air pollution can have adverse effects on the health of exposed population [52]. Exposures to pollutants such as airborne participate matter and ozone has been associated with increases in hospitals admission also. Effects are found in short -term studies [53]. It is estimated that particles pollutants cause more than 500,000 deaths annually [54]. Mortality and morbidity were estimated the impact of outdoor and traffic- related air pollution on public health in Austria, France, and Switzerland [55]. Combustion of fossil fuels is responsible for the progressive change in the atmospheric composition [56]. Many health effects also arise from air pollution like death from stroke, lung cancer and heart diseases. It is difficult to escape air pollution from the environment, no matter if you are living in the posh area. According to the study, it has been shown that exposure to the natural environment has an independent effect on health and healthy related behaviour [57]. Microscopic pollutants can penetrate deep into our respiratory and circulatory system. It damages our lungs, heart, and brain. In atmospheric science, the new focus is on the impact of global air pollution on climate and the environment [58]. Few countries have some of the highest particulate matter level in the world. China is one of them. Objective of the study was to examine the association of particulate matter with an aerodynamics diameter of less than 10μm (PM10) [59].

Dr. McDonald Kinver, observed, there is no other replacement of trees, only trees can help in order to clean the air [60]. One of the pillars of the Miyawaki forest technique is the identification of native vegetation species. For this purpose, a detailed field survey is needed to determine the type of vegetation. The field survey is coupled with the phytosociological survey and environmental description. It is important to investigate basic soil characteristics, light condition, effect of environmental factors on the survival of seedlings grown in three degraded vegetation. The vegetation units in the surrounding region is studied and classified as either native or substitute vegetation (PNV). This data is then compared with the actual vegetation at the site of interest and potential natural vegetation is identified for restoration purposes. The potential natural vegetation consists of each unit of species combinations. Such detailed studies provide the knowledge of potential major tree species of the native plant communities of that region. Once the potential natural vegetation is identified, their seeds are collected and germinated. These are allowed to grow in pots till their root systems are fully developed. This overcomes the

difficulties associated with transplantation of bare seedlings of natural vegetation. The potted seedlings are then mixed with similar seedlings of other natural vegetation species and these are planted in a dense, yet random manner. This is done to ensure true natural vegetation. The degraded land may have to be prepared by mulching with rice straw and similar organic materials (of agricultural origins) to minimize the soil dryness. The other advantages include prevention of soil erosion (especially on steep slopes and under extreme precipitation events), protection against cold and fertilization potential of the organic materials used. In the initial growth phase, weeding may be needed once or twice in first couple of years. The weeded grass is an additional source of mulch. Over time, natural selection takes over and a dense, mixed, native forest is resulted.

Since then over 1300 sites in Japan have benefitted from this approach. Apart from the Asian countries (including, Malaysia and Thailand), Italy and Chile have also had success with this method. The outcomes include dense native forests, complete with native fauna including, birds, insects, squirrels, etc. Growth rates of about one meter per year have been reported on several sites. In India, the technique has been used at few sites and is gaining popularity. Several startups are working to promote this method and make it affordable to interested individuals and/or organizations. These include, Digital Green, Waste Ventures, Banyan Nation, Saytrees, etc. [12]. Another way of doing plantation is vertical gardening. Greater Chennai Corporation is planning to set up a vertical garden on flyovers, skyways, causeways, and bridges. Generally, those species are mostly found in vertical gardening which can absorb heat and dust. Treated water from sewage treatment plant will use to maintain these gardens [61]. Inspiration is being drawn from China and Italy's vertical forests. Noida also has started setting up vertical gardens to raise the aesthetics of the city and to reduce the pollution [62]. These will help in neutralizing the pollution which is caused by dust and vehicular emissions [63]. A competing technique, vertical gardens, has gained a lot of attention in Delhi. This is a relatively flexible and highly productive system. In this system, gardening is done on a vertical surface than on a horizontal surface [64]. It has various advantages like it takes less space, is easier to harvest and maintain. In this method, the plants are easier to reach for fertilizing, watering, and harvesting in convenient manner. It provides improved air circulation by putting plants in a vertical configuration. It saves plants from damage due to pets or wild animals by keeping them out of their reach. Such gardens can be easily developed in congested areas and traffic intersections. Additional advantages of vertical gardens include temperature regulation, shade, and improvement in air quality by absorption of pollutants (including volatile organic compounds, etc.) [65].

Chiarucci, et al., [66] is concerned with the recent debate about the validity and usefulness of the potential natural vegetation (PNV) concept, which, after starting as a street brawl, has evolved to a true scientific level. The opinions and ideas put forward here will not repeat those presented by [25,67,68] rather we will attempt to complement these publications and will address the main questions raised in the critique of the validity and usefulness of PNV. The debate about the validity of European phytosociology is very old and we have no intention of entering it here, its current status being established by the papers published in volume 42 and some others [69,70]. Despite the methodological constraints, extant remnants are the reference because they must provide the sources of propagules for the dominant and engineer species of the PNV unit, as well as for the other species associated with them. A parallel, loosely defined concept is that of the 'reference' or 'target' ecosystem used in restoration ecology [3,71-76].

Acknowledgements

None.

Conflict of Interest

None.

References

1. Miyawaki A (2001) A vegetation-ecological study on regeneration and restoration of vegetation. Vegetation Science News 6: 55-62.
2. Miyawaki A, Abe S (2002) A reforestation project of low land forest in Brazilian Amazon-Growth behavior in ten years. Abstracts of 45th Symposium of IAVS. Porto Alegre, Brazil: 114.
3. Aronson J, Clewell A, Covington W, Harris J, Higgs E, et al. (2002) Society for Ecological Restoration International Science & Policy Working Group. The SER International Primer on Ecological Restoration.
4. Schirone B, Borelli S, Isopi R (2004) A review of European Union funded research into the prevention and mitigation of Mediterranean desertification processes. Adv Environ Monit Mod 1(4): 1-50.
5. Miyawaki A (2004) Restoration of living environment based on vegetation ecology: Theory and practice: Restoration of living environment. Ecol Res: 19: 83-90.
6. Miyawaki A (2011) Rehabilitation of Tropical Rainforest Ecosystems 6.
7. Navarro Cerrillo RM, Ariza D, Gonzalez L, Del Campo A, Arjona M, et al. (2009) Legume living mulch for afforestation in agricultural land in Southern Spain. Soil Till Res 102: 38-44.
8. Long LC, D Amico V, Frank SD (2019) Urban forest fragments buffer trees from warming and pests. Sci Total Environ 658: 1523-1530.
9. Han KT (2017) The effect of nature and physical activity on emotions and attention while engaging in green exercise. Urban For. Urban Green 24: 5-13.
10. Nowak DJ, Greenfield EJ, Hoehn RE, Lapoint E (2013) Carbon storage and sequestration by trees in urban and community areas of the United States. Environ Pollut 178: 229-236.
11. Nowak DJ, Hirabayashi S, Doyle M, McGovern M, Pasher J, et al. (2018) Air pollution removal by urban forests in Canada and its effect on air quality and human health. Urban For Urban Green 29: 0-48.
12. Daisuke H, Tanaka K (2013) Rehabilitation of Degraded Tropical Rainforest using Dipterocrap Trees in Sarawak, Malayasia. International Journal of Forestry Research: 11.
13. Townsend M (2006) Feel blue? Touch green! Participation in forest/woodland management as a treatment for depression. Urban For. Urban Green 5: 111-120.
14. Miyawaki A, Box EO, (2006) The healing power of forests. The philosoohy behind restoring Earth's balance with native trees. Kosei Publishing Co Tokyo ed.
15. Nowak DJ, Greenfield EJ (2010) Evaluating the National Land Cover Database Tree Canopy and Impervious Cover Estimates Across the

Conterminous United States: A Comparison with Photo-Interpreted Estimates. Environ Manage 46: 378-390.

16. Ow LF, Ghosh S (2017) Urban cities and road traffic noise: Reduction through vegetation. Appl Acoust 120: 15-20.

17. Sullivan JJ, Meurk C, Whaley KJ, Simcock R (2009) Restoring native ecosystems in urban Auckland: urban soils, isolation, and weeds as impediments to forest establishment. NZJ Ecol 33: 12.

18. Burylo M, Hudek C, Rey F (2011) Soil reinforcement by the roots of six dominant species on eroded mountainous marly slopes (Southern Alps, France). CATENA 84: 70-78.

19. (2019) La sequestration de carbone par les écosystèmes en France. 102.

20. Escobedo FJ, Adams DC, Timilsina N (2015) Urban forest structure effects on property value. Ecosyst Serv 12: 209-217.

21. Schoonmaker AL, Teste FP, Simard SW, Guy RD (2007) Tree proximity, soil pathways and common mycorrhizal networks: their influence on the utilization of redistributed water by understory seedlings. Oecologia 154(3): 455-466.

22. Deslippe JR, Simard SW (2011) Below-ground carbon transfer among Betula nana may increase with warming in Arctic tundra. New Phytol 192(3): 689-698.

23. Beiler KJ, Simard SW, Durall DM (2015) Topology of tree-mycorrhizal fungus interaction networks in xeric and mesic Douglas-fir forests. J Ecol 103: 616-628.

24. Miyawaki A (2011) Utilize debris from the disaster areas and build high coastal levees with native forests. Urgent proposal for planting trees for recovery from the ruin and for disaster mitigation. Gakken Publishing Tokyo (in Japanese): pp. 259.

25. Mucina L (2010) Floristic-phytosociological approach, potential natural vegetation, and survival of prejudice. Lazaroa 31: 173-182.

26. Miyawaki A (2012) The Great Wall of Forests" Saves Japan! Build native forests along the coastline of Japan. Kawade Shobo Shinsha Publishers (in Japanese) Tokyo: pp. 200.

27. Clewell AF, Aronson J (2007) Ecological restoration: principles, values, and structure of an emerging profession. Island Press: Washington US.

28. Falk DA, Palmer MA, Zedier IB (2006) Foundations of restoration ecology. Island Press: Washington DC.

29. Perrow MR, Davy AJ (2002a) Handbook of ecological restoration. 1: Principles of restoration. Cambridge University Press: Cambridge.

30. Perrow MR, Davy AJ (2002b). Handbook of ecological restoration. 2: Restoration in practice. Cambridge University Press: Cambridge.

31. Stanturf John A, Madsen P (2004) Restoration of boreal and temperate forests (integrative studies in water management and land development), 1st Edn. CRC Press: Boca Raton.

32. Van Diggelen R, Marrs RH (2003) Restoring plant communities: introduction. Appl Veg Sci 6(2): 106-110.

33. Padilla FM, Pugnaire FI (2006) The role of nurse plants in the restoration of degraded environments. Front Ecol Environ 4(4): 196-202.

34. Kelty MJ (2006) The role of species mixtures in plantation forestry. For Ecol Manag 233: 195-204.

35. Camazine S, Deneubourg JL, Franks NR, Sneyd J, Theraulaz G, et al. (2003) Self-organization in biological systems. Princeton University Press: Princeton.

36. Sachs JL, Mueller UG, Wilcox TP, Bull JJ (2004) The evolution of cooperation. Q Rev Biol 79: 135-160.

37. Castro J, Zamora R, Hodar JA, Gomez JA (2002) Use of shrubs as nurse plants: a new technique for reforestation in Mediterranean Mountains. Restor Ecol 10: 297-305.

38. Castro J, Zamora R, Hodar JA, Gomez JM, Gomez Aparicio L, et al. (2004) Benefits of using shrubs as nurse plants for reforestation in Mediterranean Mountains: a 4-year study. Restor Ecol 12(3): 352-358.

39. Lortie CJ, Brooker RW, Choler P (2004) Rethinking plant community theory. Oikos 107: 433-438.

40. Gomez JM, Garcıa D, Zamora R (2003) Impact of vertebrate acorn-and seedling-predators on a Mediterranean Quercus pyrenaica forest. For Ecol Manag 180: 125-134.

41. Palacios G, Navarro Cerrillo RM, Del Campo A, Toral M (2009) Site preparation, stock quality and planting date effect on early establishment of Holm oak (Quercus ilex L.) seedlings. Ecol Eng 35(1): 38-46.

42. Reque JA (2008) Selvicultura en espacios naturales protegidos. In: Serrada R, Montero G, Reque JA (eds) Compendio de Selvicul-tura Aplicada en Espana. Ministerio de Educacion y Ciencia-INIA/Fundacion Conde del Valle Salazar: pp. 1005-1035.

43. (2013) The Economist Intelligence Unit. A summary of the live ability ranking and overview. The Economist Group, London, UK.

44. (2011) The Economics of Ecosystems and Biodiversity (TEEB), TEEB manual for cities: Ecosystem services in urban management.

45. Chang J, Collins G (2008) Landscape guideline. Landscape design and maintenance guidelines to improve the quality, safety and cost effectiveness of road corridor planting and seeding. RTA, Sydney.

46. (2012) International Energy Agency, CO_2 Emissions from fuel combustion highlights. IEA Publications, Paris.

47. Rani B, Singh U, Chuhan AK, Sharma D, Maheshwari R, et al. (2011) Photochemical smog pollution and its mitigation measures. J Adv Sci Res 2: 28-33.

48. Stern N (2008) The economics of climate change. Am Econ Rev 98(2): 1-37.

49. Grenyer R, Rouget M, Davies J (2007) Preserving the evolutionary potentials of floras in biodiversity hotspot. Nature 445: 757.

50. Okitsu S (2017) Forest Vegetation of Northern Japan and Southern Kurils. Forest Vegetation of Northern Asia 28: 231-261.

51. Mackness MI, Mackness B (2016) Effects of air pollution on human health and practical measures for prevention in Iran. J Res Med Sci 21: 65.

52. Makri A (2008) Vulnerability of air pollution health effects. Int J Hyg Environ Health 211: 326-336.

53. Brunekreef B, Stephen T (2002) Air pollution and health. The Lancet 360: 1233-1242.

54. Nel A (2005) Air pollution- Related Illness: Effects of Particles. Science 308: 804-806.

55. Kunzli N, Kaiser R, Studnicka M (2000) Public health impact of outdoor and traffic related air pollution: a European assessment. The Lancet 356: 795-801.

56. Kampa M, Castana E (2008) Human Health effects of air pollution. Environmental Pollution 151: 362-367.

57. Mitchell R, Popham F (2008) Effect of exposure to Natural Environment on Heal the Inequalities: an observational population study. The Lancet 372: 1655-1660.

58. Akimoto H (2003) Global Air Quality and Pollution. Science 302: 1716-1719.

59. Chen R, Kan H (2012) Association of Particulate Air Pollution with Daily Mortality: The Chin a Air Pollution and Health Effects study. Am J Epidemiol 175: 1173-1181.

60. Kinver M (2016) Science and Environment. *https://www.bbc.com/news/science-environment-37813709.*

61. (2019) The Times of India. Vertical Garden. *https://timesofindia.indiatimes.com/topic/VERTICAL-GARDEN/news*

62. (2018) India's Today, Noida to go green with vertical garden. *https://www.indiatoday.in/education-today/gk-current-affairs/story/noida-to-go-green-with-vertical-garden-1313278-2018-08-13*

63. Sharma V (2018) Vertical gardens planned at Delhi's schools, markets and historical structures. *https://www.hindustantimes.com/delhi-news/vertical-gardens-planned-at-delhi-s-schools-markets-and-historical-structures/story-FY82lBnPsNnKSAkR23NXpL.html.*

64. Binabid J (2010) Vertical Garden: The Study of Vertical Gardens and Their Benefits for Low- Rise Buildings in Moderate and Hot Climate. University of Southern California 11(7): 1-5.

65. Gulcinay B, Arzu C (2016) Ecological-Social-Economical Impacts of Vertical Gardens in the Sustainable City Model. Yyu J Agr Sci 26(3): 430-438.

66. Chiarucci A, Arau jo MB, Decocq G, Beierkuhnlein C, Fernandez Palacios JM, et al. (2010) The concept of potential natural vegetation: an epitaph? J Vegetation Sci 21: 1172-1178.

67. Loidi J, Del Arco M, Perez De Paz PL, Asensi A, Dıez Garretas B, et al. (2010) Understanding properly the potential natural vegetation concept. Journal of Biogeography 37: 2209-2211.

68. Farris E, Filibeck G, Marignani M, Rosati L, (2010) The power of potential natural vegetation (and of spatial-temporal scale): a response to Carrio n & Fernandez (2009). Journal of Biogeography 37: 2211-2213.

69. Ewald J (2003) A critique for phytosociology. J Vegetation Sci 14: 291-296.

70. Willner W (2006) The association concept revisited. Phytocoenologia 36: 67-76.

71. (2004) SER (Society for Ecological Restoration International Science &Policy Working Group). The SER international primer on ecological restoration. Society for Ecological Restoration International: Tucson, AZ, US.

72. Gomez Aparicio L, Zamora R, Gomez JM (2004). Applying plant facilitation to forest restoration: a meta-analysis of the use of shrubs as nurse plants. Ecol Appl 14: 1128-1138.

73. Marie O (2010) Les successions écologiques.

74. Miyawaki A, Abe S (2004) Public awareness generation for the reforestation in Amazon tropical lowland region. Tropical Ecology 45: 59-65.

75. Schirone B, Salis A, Vessella F (2011) Effectiveness of the Miyawaki method in Mediterranean forest restoration programs. Landsc Ecol Eng 7: 81-92.

76. (2013) WSDOT Design Manual. Roadside safety.