Facing Climate Change: Urban Gardening and Sustainable Agriculture

Eid M. Koriesh and Islam H. Abo-Soud

Abstract Measures to combat climate change encompass two primary titles: removal of the maximum greenhouse effective gases and decreasing causes of greenhouse gas emissions. The direct greenhouse gases are carbon dioxide, nitrous oxide, and methane. Nitrous oxide is approximately 300 and methane around 30 times than carbon dioxide at trapping heat in the atmosphere. Climate change affects and is affected by all communities, but its treatment must begin with the actions of individuals. Trees in the urban area strongly reduce pedestrian level heat stress by absorbing and reflecting solar irradiance. Vegetation in gardens is one of the most important components affecting climate change. Urban gardening, mainly consist of trees resource, is a valuable asset. Trees' benefits to the human being were most pronounced in their contribution to environmental benefits. Thus, plants in gardens were found to provide a particularly important function in mitigating climate change and maintaining environmental quality of communities. Gardeners can help lessen the global warming pollutants associated with waste disposal by turning leaves, grass, woody garden clippings, and dead garden waste into mulch or compost, then using it in the garden. Recycling these wastes will not only reduce *methane* emissions from landfills but also improve garden's soil and help it store carbon. One of the innovative methods that reduces greenhouse gases emissions is to make and use biochar. Because nitrous oxides is an important greenhouse gas, better management of nitrogen fertilizers can reduce its emissions. The four main management factors that help reduce nitrous oxide emissions from applied nitrogen fertilizer are commonly known as the 4R's: right application rate; right formulation (fertilizer type); right timing of application; right placement at the plant's root zone as possible. So, selecting right plants for urban gardens have a potential to influence Earth's climate by altering regional and global circulation patterns and changing the amount of CO_2 in the atmosphere. Also, it is important to deal with the soil to minimize the harmful impact it could cause to the environment. Planting appropriate tree species near industrial complexes is critical for aesthetic value and gases mitigation.

E. M. Koriesh (✉) · I. H. Abo-Soud
Department of Horticulture, Suez Canal University, Ismailia 41522, Egypt
e-mail: quriesheid@yahoo.com

I. H. Abo-Soud
e-mail: islamhassan@hotmail.com

E.-S. E. Omran and A. M. Negm (eds.), *Climate Change Impacts on Agriculture and Food Security in Egypt*, Springer Water, https://doi.org/10.1007/978-3-030-41629-4_16

Keywords Climate change · Gardening · Urban gardening · Trees · Shrubs · Biochar · Global warming

1 Introduction

Egypt is one of the potential susceptible countries to the effect of global warming [1] and regarded as the fifteenth most populated country in the world with affected human-induced of environment that would worsen the common problems [2]. This due to the large and tightly packed population, and if climate change makes Egypt's climate drier or warmer pressure on agriculture would aggravate. Also, competition among the limited water resources states for water could expand (even without climate change) in addition to increased warming, droughts and evaporation, reduced flow in the Nile would further aggravate. Egypt's problems and the country could face an unstable situation.

We can summarize the impact of climate change on the Egyptian Agriculture Challenges for Egypt in the 21st century as follows [3].

1. Sea level rise (as a result to temperature increasing)
2. Food Security (Land-, water-, and nutrients availability)
3. Poverty (income of farmers in rural areas)
4. Adverse impacts on human health
5. harm Egypt's tourism sector.

Sea level is additional influence of climate change. Nile Delta is at present dropping at a rate of 3–5 mm per year. A rise of 100 cm would flood one-fourth of the Nile Delta, forcing about 10.5% of Egypt's population from their family units (homes, farms, animals [1] Fig. 1). The effects would be more overwhelming if Egypt's population, as predictable, doubles to about 160 million by the middle of the century, with the current population density in Delta of around 4000 person per mile^2. As a consequence of sea level rise and flooding a great portion of Nile Delta (the most cultivated area of Egypt's land), food production and sources would not be

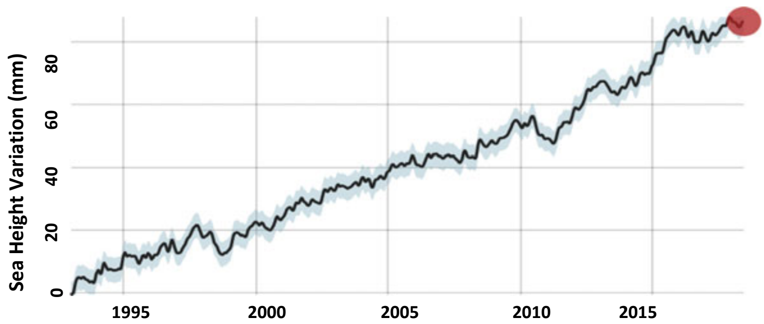

Fig. 1 Average global changes in sea level from 1995 to 2015 [4]

achieved Nearly half of Egypt crops, including wheat, rice, oranges and bananas, are cultivated in the Delta. Contrariwise the rest of Nile Delta areas (not under water) would also be affected, with salt water from the Mediterranean Sea which will pollute the fresh underground water used for irrigation. Also, agriculture activities and the self-sufficiency of food will expose to an additional effect as a result of temperature increase.

The decline in agriculture activities due to temperature increases is expected to range from 10 to 60% (production of main crops will be 18% for wheat, 11% for rice and 19% for maize). Such losses, if it is not planned and financed, will increase the risk of malnutrition and hunger among the population [5]. The increase in temperature will be associated with some changes in the ecological system and increase in air pollution as a result of emissions, soil erosion, and wind speed.

The new climate situation would increase the amount of Saharan dust carried across the country causing health troubles and economic problems. In all these dimensions' agriculture plays a crucial role.

Agriculture is threatened by climate change, responsible for food supply and employs about 30% of Egypt's labor force. Thus, a new criterion, "sustainable agriculture", is needed which addresses all these issues simultaneously! "Sustainable Agriculture" and climate change adaptation potential adaptation by adopting cropping patterns:

(a) Salt resistant crops (where sea level rise in agricultural areas)—jojoba, quinoa, sugar beets, row barley, safflower, sunflower, winter wheat, spring wheat, canola, and corn
(b) Less water-intensive crops. Farming practices such as using seed varieties that require less water and mature in less time should be widely promoted in water-deficient regions of India to help farmers reduce their vulnerability to climate change. vegetables such as cluster beans, watermelon, gourds and cucurbits
(c) Heat resistant crops (millet and sorghum, multipurpose grain legumes (cowpea, chickpea), barley, maize)
(d) Adaptation by adopting crop characteristics
(e) It is expected by 2050 that climate change will raise water demand by an average of 5% [6].
(f) Adapting soils, reducing the sources of greenhouse gases

Climate change is probable to have adverse effects on human wellbeing in Egypt, which is able be aggravated by high population densities. These may incorporate increments within the predominance and seriousness of asthma, and infectious diseases, vector-borne diseases, eye cataracts, heat strokes and skin cancer. Additional deaths from respiratory and cardiovascular diseases, dysenteric infection and diarrhea are expected. Children mortality frequency and malnutrition cases are expected to be further frequent. Climate change will harm Egypt's tourism sector through sea level rises. The Nile Delta is home of many of Egypt's tourism, and for cities like Alexandria and Matruh City, the threat of a rising sea level will reduce both their capability to sustain tourism as well as the desire of tourists to visit them. 49% of Alexandria's tourism industry would be underwater if sea level rose 0.5 m [7].

2 Gases that Contribute to the Greenhouse Effect

Most climate scientists agree that the main cause of the current global warming trend is the human expansion of the "greenhouse effect" warming that results when the atmosphere traps heat radiating from Earth toward space. Certain gases in the atmosphere block heat from escaping. Long-lived gases that remain semi-permanently in the atmosphere and do not respond physically or chemically to changes in temperature are described as "forcing" climate change. Gases that contribute to the greenhouse effect include [4, 8, 9]:

1. Carbon dioxide (CO_2)
2. Methane
3. Nitrous oxides
4. Sulfur oxides
5. Chlorofluorocarbons (CFCs)
6. Water vapor

Carbon dioxide (CO_2), a minor but very important component of the atmosphere, carbon dioxide is released through natural processes such as respiration and human activities such as deforestation, land use changes and burning fossil fuels. Humans have increased atmospheric CO_2 concentration by more than a third since the Industrial Revolution began. This is the most important long-lived "forcing" of climate change.

The gardener may cause extra carbon dioxide to be added to the atmosphere in several ways:

1. Using potting compost or peat;
2. Digging soil and leaving it bare so that the carbon in soil organic matter is oxidized;
3. Using power tools which working with burning fossil fuel;
4. Heating greenhouses and swimming pools; and
5. Burning garden pruning.

Climate change is an issue requiring urgent action by everyone who is a part of the global community. Reducing atmospheric carbon dioxide (CO_2) concentration through enhanced terrestrial carbon storage may help slow or reverse the rate of global climate change. Since desertification is projected to increase in the future, management strategies that increase carbon sequestration or decrease carbon loss are especially important [10].

2.1 Methane

A hydrocarbon gas produced both through natural sources and human activities, including the corruption of wastes in landfills, agriculture especially paddy cultivation, as well as ruminant digestion and manure administration associated with domestic livestock. On a molecule-for-molecule basis, methane is a more extra active greenhouse gas than CO_2, but also one which is much less abundant in the atmosphere.

Methane is one of a group of volatile organic compounds (VOCs) which include, also, chlorofluorocarbon (CFC), formaldehyde, benzene and others [11, 4]. It is produced both naturally and from man's activities. Although methane has adverse effects on global warming, there are little scientific studies concerning the importance of plant species that can absorb methane from the atmosphere. Studies have proposed aerobic methane (CH_4) emissions from plants, which increase the imbalance in the global CH_4 budget [9].

Plant management practices in forestry can alter soil conditions, affecting the consumption and manufacturing techniques that manage soil methane (CH_4) exchange. Forestry control practices encompass quick-term outcomes of thinning, clean-reducing and stump harvesting of coniferous forests usually consisting of pines, spruces, and larches [12]. Also, studies of Sundqvist et al. [13] showed a net uptake of (CH_4) by way of birch (*Betula pubescens*), spruce (*Picea abies*) and pine (*Pinus sylvestris*) which might be of significance for the methane resources.

There's an indirect study to reduce methane emissions related to decreasing the portions produced by way of cows, the biggest source of methane in the world. The reduction of methane produced or deamination within the rumen are facilitated with the aid of oregano oils [14]. Studies have observed that in a few instances, the complement of dairy cow diets with *Origanum vulgare* leaves resulted in better milk production, better feed performance and lowered the methane gas produced in the rumen [15, 14]. Again, there are a few studies related to different sorts of unstable organic compounds to which methane belongs and may absorb by ornamental plants. Gases studied were formaldehyde [16, 17] and benzene [18].

Agricultural practices inclusive of irrigation structures can affect methane creation through gardens. Drip irrigation combined with break up utility of fertilizer nitrogen injected inside the water (fertigation) is generally taken into consideration high-quality techniques for water and nutrient performance. As an outgrowth, its use is turning into common. A number of the primary factors (water-filled pore space, NH^{4+}, and NO^{3-} regulating the emissions of GHG (N_2O, CO_2 and CH_4) and no from agroecosystems can without difficulty be manipulated with the aid of drip fertigation without yield penalties. Fertigation with urea instead of nitrate of calcium accelerated N_2O and NO emissions through a component of 2.4 and 2.9, respectively. Day by day irrigation reduced No emissions via 42% however elevated CO_2 emissions with the aid of 21% in contrast with weekly irrigation. Generally, weekly fertigation with a NO_3 ion based fertilizer is the satisfactory option to integrate agronomic productiveness with environmental sustainability. No relation among irrigation frequency and N_2O emissions. Observe shows that suitable management of drip fertigation, at the same time as contributing to the realization of water and food security, might also offer the hope for climate change mitigation [19].

2.2 Nitrous Oxide (N_2O)

Nitrous oxide (N_2O) is an important GHG that contributes to climate change. It has a long atmospheric lifetime (100 years) and is about 300 times better at trapping heat than is CO_2, even small quantities of N_2O affect the climate. Nitrous oxide is produced by microbes in soils. N_2O is emitted mainly from fertilized soils and animal wastes. Of the three major GHG emitted naturally—CO_2, N_2O and CH_4; N_2O is the most important. Better management of N fertilizer can reduce N_2O emissions [20].

Gardeners can help lessen the global warming pollution associated with waste disposal by turning leaves, grass, woody garden clippings, dead garden plants, and kitchen waste into mulch or compost, then using it in the garden. "Recycling" these wastes will not only reduce *methane* emissions from landfills but also improve your garden's soil and help it store carbon [21]. Compost, which can be any mixture of decaying organic materials (for example, plant leaves, animal manure, food scraps), is created organisms that break down wastes into a nutrient-rich soil amendment. While composting does produce global warming gases, studies indicate that the best practices for creating and using compost have a smaller climate impact than landfills [22]. Climate-friendly gardeners may also choose to reduce their own personal greenhouse gas emissions by growing and using carminative plants such as fennel and garlic (can reduce intestinal gases such as *methane* [23]. Also, reduction in livestock product consumption on arable land use (which is a critical component of the link with deforestation) will depend on how consumers compensate for lower intakes of meat, eggs and dairy products. A switch from beef and milk to highly refined livestock product analogues such as tofu actually increase the quantity of arable land needed. A broad-based switch to plant-based products through simply increasing the intake of cereals and vegetables is more sustainable. We estimate that a 50% reduction in livestock production consumption would release about 1.6 Mha of arable land [24].

2.3 Nitrous Oxide (N_2O) and It's Importance

Nitrous oxide (N_2O) is an important greenhouse gas that contributes to climate change [25]. Because it has a long atmospheric lifetime (over 100 years) and is about 300 times better at trapping heat than carbon dioxide, even small emissions of N_2O affect the climate. Nitrous oxide is produced by microbes in almost all soils. In agriculture, N_2O is emitted mainly from fertilized soils and animal wastes—wherever nitrogen (N) is readily available. In the United States, agriculture accounts for approximately 8% of all greenhouse gas emissions but contributes about 75% of all N_2O emissions linked to human activity. Of the three major greenhouse gases emitted naturally—carbon dioxide, *methane*, and N_2O—N_2O is the most important. Better management of N fertilizer can reduce N_2O Emissions Natural part of the nitrogen cycle, but human activities add more [26].

Gardeners, also, may add nitrous oxide to the environment by applying nitrogenous fertilizers, especially if it is applied to young plants when plants cannot make use of the nitrogen, Burning garden waste [27]. So, Nitrogen dioxide is a major component of the complex of photochemical air pollutants in urban areas.

Plant leaves can absorb many kinds of gaseous air pollutants, including NO_2, through their stomata, and consequently, they have a capacity to remove this gas from the surrounding atmosphere [28]. NO_2 absorbed by the leaves can be converted into nitrate and nitrite, and then rapidly assimilated into organic nitrogenous compounds.

A powerful greenhouse gas produced by soil cultivation practices, especially the use of commercial and organic nitrogenous fertilizers, fossil and gas fuel combustion, nitric acid production, and biomass burning.

Soil Nitrous oxide emissions originate from three sources [29].

(a) Soil microorganism activity (55%);
(b) Organic manure applications (18%); and
(c) Nitrogen fertilizer applications (27%).

2.4 How Does Nitrogen Fertilizer Increase Nitrous Oxide Emissions?

Gardeners add new N to parks and all types of gardens as synthetic fertilizers such as urea or anhydrous ammonia, or rarely as organic fertilizers. When not taken up by plants, most fertilizer N is mobile, hard to contain in the field and susceptible for loss. Nitrogen from fertilizer can be lost as nitrate to groundwater or as the gases N_2O, dinitrogen (N_2) or ammonia. Nitrogen applied in excess is particularly susceptible for loss. Though the amounts of carbon and oxygen available in the soil also affect microbial N_2O production [30].

2.5 Management of Nitrogen Fertilizer to Decrease Nitrous Oxide Emissions

Numerous management strategies can keep soil N in check and minimize N_2O emissions. Many of these strategies also help to keep other forms of N from being lost, including nitrate and ammonia. In general, practices that reduce N_2O emissions increase N use efficiency (NUE), which keeps more of the added N in the crop. The four main management factors that help reduce N_2O emissions from applied N fertilizer are commonly known as the 4R's [31].

- Right N application rate;
- Right formulation (fertilizer type);
- Right timing of application; and,

- Right placement.

Nitrogen availability is the single best predictor of N_2O fluxes in ecosystems [32]. N_2O emissions are especially high when N fertilizer is applied at rates greater than plant need. The emission rate grows exponentially with increases in fertilizer rate, so at higher rates of fertilizer application N_2O emissions increase disproportionately. Fertilizer formulations also can alter N_2O emissions. The trend toward using more urea in may help reduce N_2O emissions. Fertilizer additives can also reduce N_2O emissions. Nitrification inhibitors such as nitrapyrin, which delay the microbial transformation of soil ammonium to nitrate, can delay the formation of nitrate until closer to the time that plants can use it [33].

Applying N fertilizer when it is most needed by plants can also help reduce N_2O emissions. Also, Placing N fertilizer close to plant roots can reduce N_2O emissions. For example, applying urea in narrow bands next to the trees and shrubs in hedges can reduce N_2O emissions [34]. An integrated approach is best suited to reduce N_2O emissions. The same principles of N fertilizer best management practices for increased nitrogen use efficiency (NUE) hold true for reducing emissions [35].

1. Apply fertilizer at the economically optimum rate;
2. Use an appropriate fertilizer formulation;
3. Apply as close to the time of plant need as possible; and,
4. Apply as close to the plant's root zone as possible.

2.5.1 Sulfur Oxides (SO_x)

Sulfur oxide (SO_2) is the component of greatest concern and is used as the indicator for the larger group of gaseous sulfur oxides (SO_x). Other gaseous SO_x (such as SO_3) are found in the atmosphere at concentrations much lower than SO_2. The sulfur oxide is the most voluminous chemically active gas emitted from some industrial processes such as chemical preparation, refining, pulp-making and solvent extraction and burning of fossil fuels such as coal, oil and natural gas. Coal-fired power stations, in particular, are major sources of sulfur dioxide, with coal burning accounts for 50% of annual emissions, as explained by the Tropospheric Emission Monitoring Internet Service (TEMIS). But trace amounts of SO_2 exert significant influence on climate. Large volumes of SO_2 erupted frequently appear to overdrive the oxidizing capacity of the atmosphere resulting in very rapid warming [36].

A study carried out by Zhang et al. [37] at China conditions (which is one of the highest countries in, SO_2 emitter in the world [38]) revealed that urban native street trees have a potential for purifying SO_2 [39]. SO_2 is a major air pollutant in developing countries. They added that many trees are seriously impaired by SO_2, while other species can mitigate air pollution by absorbing this gas. Planting appropriate tree species near industrial complexes is critical for aesthetic value and pollution mitigation. In their study, six landscape tree species were investigated for their tolerance of SO_2: *Cassia surattensis* Burm. f., *Ceiba insignis* (Kunth) P. E. Gibbs &

Semir, *Cinnamomum camphora* (L.) J. Presl., *Ilex rotunda* Thunb., *Lysidice rhodostegia* Hance and *Michelia chapensis* Dandy [37]. They measured net photosynthesis rate, leaf sulfur content and other physiological parameters under 1.31 mg m^{-3} SO_2 fumigation for eight days. Their results showed that the six landscape tree species differed in their responses under SO_2 stress. Based on these data, the most appropriate species for planting in SO_2 polluted areas (in China) was *Ilex rotunda*, since it grew normally under SO_2 stress and can able to absorb SO_2. This study confirms the importance of planting trees to absorb pollutants. Besides, the selection of trees to be cultivated in different locations according to their efficiency in the disposal of the most common polluter in this location. So, this makes us say that planting appropriate tree species nearby industrial complexes is critical for pollution mitigation besides aesthetic value.

El-sadek et al. [40] doing a test for some ornamental plants to absorb SO_2; NO_2 and other gases. Among the tested plants, *Chlorophytum comosum Variegatum* and *Spathiphyllum wallisii* displayed superior removal efficiency (Fig. 2).

Hence, SO_2 is playing a far more active role in starting and controlling global warming than known by the Intergovernmental Panel on Climate Change [41, 42]. Huge reduction of sulfur oxides should be a top priority for decreasing both global warming and acid rain. Nonetheless, man is also adding two to three orders of magnitude more CO_2 per year to the climate than one "large" volcanic explosion added in the past. Thus CO_2, a greenhouse gas, is contributing to global warming and should be reduced [43]. Urban Landscape Plants and Sulfur Dioxide (SO_2).

The total potential of purifying SO_2 by trees was studied in China. The integrated value of purifying SO2 including absorption by plant leaves in the Chinese area Shenyang. Studies indicated that the maximum daily potential of purifying SO_2

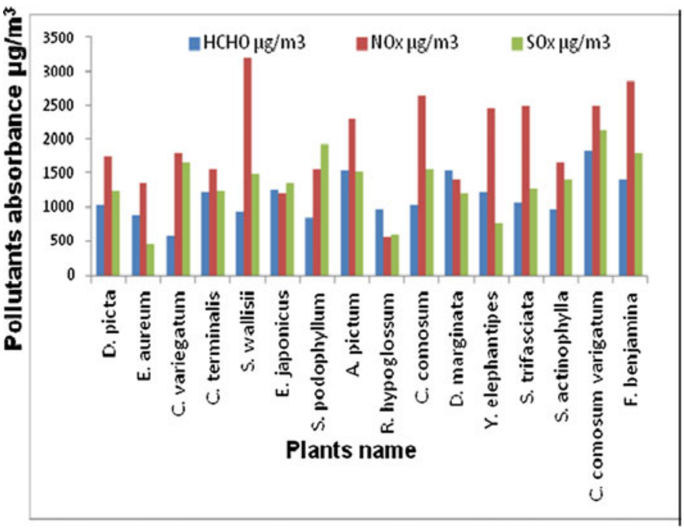

Fig. 2 Removal of formaldehyde, nitrogen and Sulphur oxides from the air inside sealed chamber

of trees might be 12.19 kg km^{-2}[39]. Supposed that the average annual absorption capacity for sulfur of trees in Shenyang area was 0.70 kg $tree^{-1}$ and the average annual absorption capacity for sulfur of broad-leaved trees was 1.35 kg $tree^{-1}$, 88.88 million broad-leaved trees would be required to purify the annual released SO_2 thoroughly. This number was equivalent to 12.9 times of existing trees. They added that on the conditions of strengthening environmental protection and decreasing 20% of annual released sulfur, if the broad-leaved trees were double of the present number, SO_2 content in the air might be below 0.06 mg m^{-3} and Shenyang would become a standardizing city with clear air. In another study, six landscape tree species belongs to subtropical area were investigated for their tolerance of SO_2. They were *Cinnamomum camphora* (L.) J. Presl., *Ilex rotunda* Thunb., *Lysidice rhodostegia* Hance, *Ceiba insignis* (Kunth) P. E. Gibbs & Semir, *Cassia surattensis* Burm. f., and *Michelia chapensis* Dandy. *They determined* net photosynthesis rate, stomatal conductance, relative water content, proline sulfur content and other parameters under 1.31 mg m^{-3} SO_2 fumigation for eight days. Their results revealed that the tree species under investigation differed in their biochemical appearances under SO_2 stress. Based on these data, the most appropriate species for planting in SO_2 polluted areas was *I. rotunda*, because it grew normally under SO_2 stress and could absorb SO_2 [37]. Trees are adapted to remove SO_2 from the atmosphere, thus donating to air quality and community health [44].

2.5.2 Chlorofluorocarbons (CFCs)

Chlorofluorocarbons (CFCs) are compounds doing as greenhouse gases. CFCs, as VOCs are unlikely to have any direct effect on the environment in the immediate vicinity of their release. They may be somewhat involved in reactions to outcome ground-level ozone, which consider cause injury to plants and other resources on a local scale. At a global level, releases of CFCs have severe environmental impacts. Their extended lifetimes in the atmosphere mean that roughly end up to the stratosphere where they can abolish the ozone layer, which protect the world from the sun's harmful UV rays. Although the amounts emitted are comparatively small, they propagate then have a high powerful warming effect (a very high "Global Warming Potential") [45].

3 Soil Management Help Mitigate Climate Change

Good soil management can help to regulate emissions of three key greenhouse gases (carbon dioxide, *methane* and nitrous oxide) from agriculture, which contribute to climate change.

Climate favorable landscaping is an innovative method of cultivation ornamental plants in urban gardens in ways which reduce emissions of different types of greenhouse gases and encourage the absorption of carbon dioxide and *methane* by plants in order to aid the reduction of global warming. To be a Climate favorable landscaper means considering both what happens in a garden and the materials brought into it and the impact they have on and climate. It can also include garden features or activities in the garden that help to reduce greenhouse gas emissions elsewhere.

The gardens of ancient Egypt included Palace gardens, Pleasure gardens, Temple gardens and Funeral gardens. These gardens also produced medicinal herbs and spices such as cumin, marjoram, anise, and coriander. These herbs can herb, indirectly, for reducing methane gas produced by cows. In this concern Nowers [14] in her thesis concluded that when oregano material was top-dressed and mixed with a portion of the total mixed ration. Also, Tekippe et al. [46] fed cattle with 500 g of common oregano (*Origanum vulgare*) leaves, for each cow per day for three weeks, and he found that the *methane* produced by the animal rumen was reduced by 40%.

The environment is the framework in which man's life. Human behavior, air quality and the emission of responsible gases affect the warming of the atmosphere and the consequent effects of changes in the global map. The rising temperature is a real and tangible phenomenon and future expectations are becoming clearly seen by residents of the northern cold areas in the melting of ice and seen by residents of the southern regions in the deadly hurricanes and the collapse of rocks. This is what the researchers found through their study of tree trunks and how to form the ring formations in tree trunks and study the evolution of the ice mountains, which confirms the continued warming of the atmosphere, which is known as global warming. Climate change can alter rainfall, influence crop yields, affect human health, cause changes to forests and other ecosystems, and even impact our energy supply. Climate-related impacts are occurring over many sectors of the economy [25]. Global warming is the result of human behavior, malpractice, industrial development and consumption of energy in all its forms, resulting in different pollutants. Also, cows, which human being man needs in his food chain, are known to let off a lot of gases including *methane*. Their belching and flatulence are estimated to contribute to almost 20% of global greenhouse gas emissions [47].

Tree foliage filter pollutants and particulates from the air, including dust, ozone, methane, carbon, sulfur, nitrous oxides and other air pollutants according to their morphological and physiological characters [48]. This mainly done through the process of photosynthesis. Trees remove CO_2 (a greenhouse gas, GHG) and release O_2 into our air (Fig. 3). Trees store the CO_2 (carbon sequestration), and according to the foliage size, leaves survival and area of the tree—can hold between 15 and 350 kg of CO_2 each year [25].

4 The Balance Between the Carbon and Nitrogen Cycles in Urban Forestation

Increasing Nitrogen deposition to urban forests can impact the balance between the carbon and Nitrogen cycles. This Nitrogen source, if taken up and used by trees can increase growth and carbon storage. Foliar uptake and utilization of inorganic

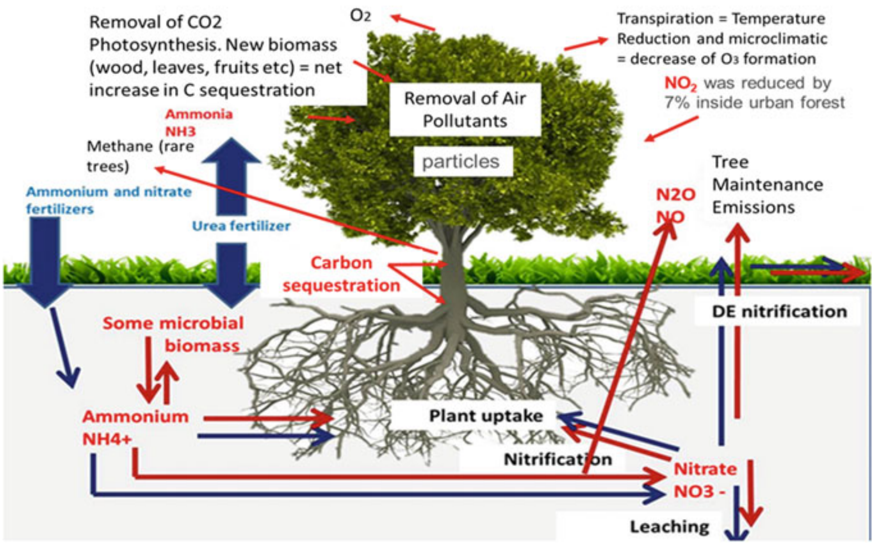

Fig. 3 Relationship between trees (vegetation) and climate change

Nitrogen, such as NO_2 and NH_3, has been shown to occur, but utilization of organic Nitrogen has not been demonstrated directly [49].

Slow-release formulations such as polymer coatings can have the same effect.

To improve the effectiveness of plant growth, more fertilizers are required, which may become an environmental hazard, unless adequate technical and socioeconomic impacts are addressed. Multifunctional slow-release nitrogen fertilizer has been developed to improve fertilizer use efficiency and reduce environmental pollution [37]. Same conclusion recorded by Ball et al. [50]. They found that NPK slow-release fertilizer also maintained grass yields and was the most effective substitute for the conventional NPK fertilizer for mitigation of N_2O fluxes.

5 Impact of Soils and Plant Nutrients on Climate Change

Soils are highly variable due to differences in local geology, topography, climate, vegetation, and management over thousands of years. Good soil management will provide a range of wider environmental benefits.

The soil has the potential to be an effective regulator of climate change by storing carbon and therefore reducing losses of carbon to the atmosphere [51].

Means to enhance storage of carbon in soil or avoid its loss from soil are, technologies that have until now received little attention. The main means by which soil carbon might be increased are first listed, these are [52]:

– Increasing the rate of input of organic matter;

– Decreasing the rate of its decomposition by biological or chemical means;
– Increasing the rate of its stabilization by physio-chemical protection within aggregates and organo-mineral complexes; and
– Increasing the depth or more correctly the total soil volume sequestering carbon at the maximum rate.

Urban forest or trees canopy can take up and use organic Nitrogen is really important. Increasing Nitrogen deposition to forests can impact the balance between the carbon and Nitrogen cycles. This Nitrogen source, if taken up and used by forests, can increase growth and carbon storage [53].

Drip irrigation combined with the fragmented application of fertilizer nitrogen (N) dissolved in the irrigation water (fertigation) is commonly considered best management practice for water and nutrient efficiency in gardens (lawns, trees, shrubs and shrubbery, grasses climbers and creepers, topiary hedges etc., some of the foremost factors (water-filled hole space, $NH^{4+,}$ and NO_3^- managed the emissions of GHG (i.e. N_2O, CO_2 and CH_4 and NO) from agroecosystems can simply be operated by fertigation without yield disadvantages. Fertigation with urea (UR) instead of calcium nitrate increased NO and N_2O emissions by a factor of 2.9 and 2.4, respectively. Generally daily irrigation reduced NO emissions by 42% but increased CO_2 emissions by 21% compared with weekly irrigation [19]. Dobbie and Smith [54] added that the variances between N fertilizers are not stable during the year. They found that at the end of spring and early summer applications, variations from ammonium nitrate (AN) were larger than variations from UR applications (5.2 ± 1.1 kg N_2O–N ha^{-1} from the AN application, compared to 1.4 ± 1.0 kg N_2O–N ha^{-1} from the UR applications). Nevertheless, through the late summer application, there was no changes between AN and UR (3.3 ± 0.7 kg N_2O–N ha^{-1} from AN and 2.9 ± 1.1 kg N_2O–N ha^{-1} from UR).

5.1 Mineral Nutrition of Garden Plants and Climate Change

Efficient use of nutrient inputs on gardens is important for the climate, plant growth as well as plant efficiency in absorbing CO_2. By improving nitrogen efficiency, less nitrous oxide will be released, reducing agriculture's contribution to climate change. Planning is necessary to balance nutrient supply to the demands of a plant type. A planning approach essentially involves [55]:

– Testing, to establish what nutrients are lacking for every plant type (evergreen or deciduous; woody or herbaceous; tree or vine; lawn or groundcover etc.)
– An assessment of the nutrient resources (not recommended to use manures after garden establishment).
– A good plan must include all nutrient-based activities: safe and secure nutrient storage, management and timely use according to recognized recommendations.

It is important to estimate, as accurately as possible, the amount of nitrogen required by the plant and to apply it in response to periods of plant demand. The amount of fertilizer required will be influenced by growth potential, but also by soil type, previous fertilizer and winter rainfall which will affect soil nutrient supply.

5.2 Opportunities from Powerful Plant Nutrient Making Plans

1. Ability reducing within the lawn's direct and indirect greenhouse fuel emissions of nitrous oxide and in ranges of diffuse pollution.
2. Fertilizers should be accurately incorporated to meet each plant kind needs.
3. Greater green use of manufactured fertilizer can result in monetary financial savings.

5.3 Risks of Not Carrying Out Plant Nutrient Planning

1. Using excess nutrients is uneconomic and might cause multiplied emissions of nitrous oxide.
2. the usage of too little nutrient risks mineral deficiency and a tailing-off of plant efficiency in decreasing pollutants [56].
3. Neglecting to measure soil nutrient substances via assessment or soil analysis can result in incorrect choices on the amount of nutrient carried out, risking additional greenhouse gas emissions and water and air pollutants.
4. If soil pH, phosphate, potash or Sulphur supplies are restricting then the nitrogen carried out cannot be utilized successfully by garden plants.
5. Uneven spreading of implemented nutrients because of inconsistent substances, or the insufficient preservation, placing and calibration of spreading device can lead to excess nitrogen in a few components of the sphere and/or nutrient deficiencies in different elements of the sphere, also main to poor nitrogen utilization.

6 Innovative Methods that Reduce GHG Emissions

6.1 Biochar

Is charcoal used as a soil amendment. Biochar is a stable solid, rich in carbon, and can endure in soil for thousands of years. "Biochar is under investigation as an approach to carbon sequestration" [57]. Biochar thus has the potential to help mitigate climate change via carbon sequestration [58]. The efficacy of applying plant residues to agricultural soils as a carbon (C) source for microorganisms and C sequestration is dependent on soil physiochemical properties, which can be improved by aggregation using soil conditioners. Biochar and BP accelerated the decomposition of plant residues as indicated by $14CO_2$ efflux, and resulted in reduced stabilization of residues in both soils relative to that observed in the control and polyacrylamide treatments [57].

"Biochar" is thought to be a useful soil amendment to reduce greenhouse gas (GHG) emissions [59]. Biochar also improves the physical and biological properties of soil, thereby allowing it to retain nutrients and enhance plant growth [60] and large applications enhance C stock in soil [61].

6.2 Irrigation Methods and Fertilization

A field study was conducted to compare the emissions of N_2O and methane (CH_4) as GHG under interaction between some irrigation methods (drip irrigation and furrow irrigation) and fertilization regimes. The emissions of N_2O and methane were significantly lower by fertilization through irrigation (fertigation). The key factor affecting GHG production in agricultural soil is soil moisture. Optimum irrigation can decrease GHG emissions by regulating the N and carbon turnover process in soil through manipulating soil water content [62].

Drip irrigation is one of the water saving irrigation methods generally extended in semiarid or arid regions, ever since it can reduce surface evaporation, surface runoff, and deep percolation [63].

Water and mineral N fertilizer are directly supplied to the crop root zone through a drip irrigation method to adjust to the plant requirements. Therefore, improving the water and nitrogen use efficiency (NUE). Therefore, drip irrigation may have a large influence on the nitrogen and carbon income in soil and decrease the N fertilizer induced N_2O or carbon-related greenhouse gas (e.g., CH_4) creation, in relation to ordinary furrow irrigation method [59].

7 Gardens and National Parks Soil Management Assist Mitigate Climate Change [64]

Exact soil management can assist to regulate emissions of three key greenhouse gases (carbon dioxide, methane and nitrous oxide) from agriculture, which make contributions to climate change.

- Including the addition of nitrate to soils, whether or not in fertilizer or mineralized natural be counted, will increase the chance of nitrous oxide emissions. The risks of nitrous oxide release are finest in wet, warm and clay or compacted soils, and where levels of decomposable natural organic matter are excessive.

- Decreasing compaction will improve nutrient uptake in the soil and assist lessen the discharge of nitrous oxide.
- Green nitrogen control can reduce nitrous oxide emissions, by minimizing residual nitrogen.
- Use an identified nutrient control plan and observe fertilizer recommendations.
- Reducing the intensity and frequency of disturbance will assist guard soil carbon sinks.

7.1 Role of Urban Landscaping to Reduce Greenhouse Gas Emissions and Absorb Carbon Dioxide

7.1.1 The Relationship Between Gardens and Climate

Scientists agree that global warming is properly underneath manner, the result of a buildup within the ecosystem of carbon dioxide (CO_2) and different heat-trapping gases generated using human activities consisting of the burning of fossil fuels. When an excessive amount of worldwide warming pollution is released into the air, it acts like a blanket, trapping warmness in our atmosphere and changing climate patterns around the world. This climate disruption is in all likelihood to have huge-ranging consequences no longer most effective for our health and nicely-being, but that of other living things as well.

Woody plants can uptake atmospheric organic nitrates [53], so increasing nitrogen deposition to city trees can impact the balance of the carbon and nitrogen cycles. This nitrogen source, if taken up and used by urban trees, can increase growth and carbon storage. Foliar uptake and usage of inorganic nitrogen, such as NO_2 and NH_3, has been proven to occur. However utilization of natural nitrogen has not been proven without delay. Woodland canopies can suck up organic nitrogen compounds made from pollution and turn them into beneficial amino acids.

Vegetation is already known to use their leaves to absorb inorganic airborne nitrogen molecules, which includes ammonia or nitrogen dioxide, and turn them into amino acids, and a distinctly reactive compound referred to as peroxyacetyl nitrate may be absorbed through leaves.

Many trees emit reactive volatile organic compounds (VOCs), the most commonplace of which is known as isoprene. These VOCs are so reactive that they speedy get consumed up in the atmosphere, and some react with nitrogen oxides (NO_x), emitted from combustion in engines, to form longer-lived organic nitrate compounds, extra stable than peroxyacetyl nitrate. Studies about how seedlings of the trembling aspen, a significant North American local and an isoprene emitter, reacted to an analogue of those compounds referred to as 1-nitroxy-three-methyl butane [53]. The researchers tracked two amino acids: glutamate, the primary amino acid the tree makes from absorbed nitrogen compounds, and aspartate, that is shaped further downstream in the biochemical method.

Many homeowners already see proof of global warming in their backyards. Summers are getting hotter, and generally milder winters. These adjustments could make re-planning your garden, which flowers to select, how soon to put new seedlings within the ground, and while to harvest veggies, greater of a challenge. At the same time as a longer developing season will gain a few gardeners, weather disruption is likewise projected to boom the frequency and severity of extreme climate [65]. Gardeners and landscapers can do extra than merely adapt to worldwide warming, but, wherein they could make alternatives in their gardens that don't add more problem to mankind. That is due to the fact every patch of soil (and the plant life that develop in it) takes in and gives off numerous sorts and quantities of warmth-trapping gases, depending on how it is far managed.

7.1.2 Urban Gardens Include

1. National parks (recreation areas)
2. Street gardens
3. Parks and playgrounds
4. Community gardens
5. Private or home gardens
6. Others (sanatorium gardens, college and universities gardens, governmental gardens, and so on.)

Careful interest in the world's garden soils is one piece of solving the change problem. Agriculture and forestry, which dominate managed soils worldwide, virtually have the most important roles to play. But, as cities enlarge, there is a growing possibility for urban and suburban areas to play a part. Recent researches advise that city urban green areas (lawns, gardens, parks, golf course, and trees planted alongside streets) have the capability to capture CO_2, and store that carbon through time years [66]. Practices that maximize carbon storage without producing too much global warming pollution in the process (cover crops, crop rotation, woody planting, and "low-input" lawn and garden renovation) can help sluggish the tempo of climate change. If you are a gardener or landscaper or garden designer, you should take into account the application of these results in your garden and in the gardens responsible for you.

Planting forests to soak up carbon dioxide from the atmosphere can have a range of side effects, including drying up water flow and making soil pungent. The discovery highlights the accommodation involved in tree-planting projects [67]. There are many ways in which climate-friendly gardeners may reduce their contribution to climate change and help their gardens absorb carbon dioxide from the atmosphere.

7.2 Protective and Enhancing Carbon Stores

Climate-friendly gardening includes actions which protect carbon stores beyond gardens. The largest carbon stores are:

- Soil
- woods and
- wetlands;

Construction of Woods in woody plants (trees, shrubs and some climbers) absorb more carbon dioxide per area per year than most other habitats. Climate-friendly gardeners, therefore, purpose to make certain that nothing they do will damage these habitats.

A climate-friendly gardener, therefore, does not contain large irrigated lawns, but instead includes water-butts to collect rainwater; water-thrifty plants which survive on rainwater and do not need watering after they are established; trees, shrubs and hedges to shelter gardens from the drying effects of sun and wind; and ground-cover plants and organic mulch to protect the soil and keep it moist. There are numerous methods wherein climate-friendly gardeners can also lessen their contribution to climate change and assist their gardens to soak up carbon dioxide from the environment.

7.2.1 Climate-Friendly Plants

All vegetation that soaks up carbon dioxide. However, a few plant life are more weather-pleasant than others, and it's what we do with them that counts. If we make an orchard garden with many layers, then we can boom the ground covers or lawn's productiveness and absorb greater carbon dioxide. Trees, bushes, hedges, and shrubs are lovely, supply our gardens structure, provide meals and safe haven for wild animals, and shelter our gardens from the drying consequences of wind and sun, and so assist to hold soil moist and wealthy in carbon. If we grow ordinarily perennial vegetation rather than annuals, and if we grow ground-cover vegetation, then we'll protect the carbon inside the soil and forestall it being oxidized by using cultivation. Almost any water in a lawn makes it feel extra peaceful. We want to consist of oxygenating plants inside the water to keep it oxidized and reduce the threat of methane being produced from anaerobic sediments. Climbers, like trees, shrubs, and hedges, can insulate our buildings and decrease the fossil-gasoline impact of heating or air conditioning [68].

7.2.2 Climate-Friendly Gardens

Climate friendly gardens consists of [69, 70, 25]:

1. Trees
2. Shrubs and hedges

3. Herbaceous perennials
4. Some annuals and biennials
5. Ground-cover plant life
6. Garden and meadow vegetation in small areas
7. Pond, wetland flowers
8. Climbers
9. Portable gardens

Portable gardens (Fig. 4) can help reducing suddenly polluted area with carbon dioxide Master gardener must always remember other things that make any of those plant life extra climate-pleasant:

1. Soil protection;
2. Feeding soil with carbon and nitrogen, consisting of nitrogen-fixing flowers, deep-rooted flora, and vegetation with proper root structures;
3. Long existence, which means more carbon dioxide absorbed and extra soil carbon created;
4. Resilience in extraordinary situations, especially water-thriftiness;
5. Usefulness—food plant life, craft plant life, medicinal plants;
6. Vigorous growth.

Also, he must bear in his mind other criteria which observe in all gardens:

1. Right plant in the right place; choosing plants which fit the garden's conditions.
2. Beauty, whatever form it takes in our viewer's eyes;
3. Plants as flora wildlife and for flora or fauna wildlife;
4. Multipurpose plants which benefit from pollutants and kitchen.

The master gardener or administrator must know that there is not one or more plants that can achieve all the required in place. Simply ensure it is balanced by using

Fig. 4 Portable gardens

plenty of weather-pleasant vegetation. But we want to keep away from plants with a few characteristics which would be bad for the climate so try to:

1. Avoid fire-inclined vegetation (lichen, grass leaves, deciduous leaves, conifer needles, western larch, aspen, western hemlock, western white pine, grand fir, douglas fir, Eucalyptus, Engelmann spruce);
2. Avoid thirsty flowers which cannot continue to exist without introduced tap-water;
3. Avoid vegetation which inhibits different flora.
4. Use fire-retardant plants (Yucca, Lemonade Berry, Oak, Woolly blue curl, Catalina cherry).

7.2.3 The Priorities for Climate-Friendly Gardeners Are in Ways to Reduce Emissions of GHG from Different Types of Gardens, and to

- Keep the soil's current carbon stores;
- Rise the soil's carbon stores.

To protection the soil, climate-friendly gardens:

(a) Based on plants rather than buildings and paving [71];
(b) Have soil that is kept at a fairly stable temperature by hedges from trees, shrubs and some times climbers [72];

Have soil that is constantly kept covered and therefore moist and at a moderately constant temperature by lawns and groundcover plants, fast-growing legume and herbs grown as green manures (which can be used as an intercrop in kitchen gardens of annual vegetables) and/or organic mulches [72]. Climate-friendly gardeners avoid things which may harm the soil. They do not step on the soil when it is damp, because it is then greatest weak to compressed. They dig as little is possible, and firstly when the soil is saturated rather than damp because increases the oxidation of soil organic matter and produces CO_2 [73]. To rise soil carbon sink, climate-friendly gardeners confirm that their gardens generate optimum conditions for strong, healthy growth of plants and other garden plants either above or underground, and diminish the impact of any preventive factors. In general, the extra biomass that the plants can form each year, the more carbon will be added to the soil [74].

7.2.4 Climate-Friendly Gardens Therefore Include

The changing climate will have a vast impact on the method we garden. Plants are considered the main material of gardens, by contrast with the attention of structures in cities. Climate-friendly gardens will contain group of plants that prepared for design purposes in numerous ways [75, 51, 76, 77, 78]:

1. *Annuals and Perennials*: Perennials' longer have roots allow them to clamp onto moisture and carbon, making soil better-off, even throughout droughts and floods, that many scientists have connected to climate change.
2. *Shrubs, Hedges and* Borders for living quarters: Climate change produces more shrub vegetation that can reduce CO_2.
3. *Trees*: Trees are growing further quickly due to climate change. When a tree receipts in carbon from the atmosphere, used it through its lifetime through carbon sequestration. Planting trees in areas anywhere they have not historically grown, help mitigate climate change.
4. *Ornamental Grasses:* Ornamental Grasses can Take the Heat, so reduce climate change effects.
5. *Groundcovers*: shrubs, creeping plants or lawns as groundcovers retain soil moist and at relatively constant temperatures. Generally, lawns, like other grasslands, can accumulate good levels of soil carbon, and in accordance, they will grow more strongly and store extra carbon.
6. Nitrogen-fixing plants, for example cover crops and legume plants may show an important role in mitigating the effects of climate change on agriculture.

8 Radionuclide's and Gardens

The Arctic is the fastest and severe climate change on the earth. over the following a hundred years, weather change is predicted to accelerate, contributing to important physical, ecological, social and monetary adjustments, lots of which have already begun. No matter that the contaminants of radioactive substances aren't commonplace in Egypt, however, scientific studies indicate that the global warming of the world is showing a robust impact now inside the Arctic. Scientific research had proven that some pollutants which have a tremendous impact on global warming had been located in the arctic are [79]:

1. Persistent organic pollutants (POPs),
2. Heavy metals and
3. Radionuclides.

So, it can say that gardeners must installation a design that makes use of greater absorbent plants from the ornamentals for radioactive materials. The occurrence of incidents causing the leakage of radioactive material is not the content of non-availability. Also, some radioactive materials may also move from other distant geographical areas that ultimately affect the place. Here, a brief notes about some plants that may have an ability to get rid of radioactive materials. We hope to plant them in Egyptian gardens.

8.1 Uptake of Radionuclides by Plants

Measurements of some plants showed that radioactivity in plants depended on the area of surface exposed, the developmental seasons, and on the external morphology of their above and underground parts.

Auto-radiographs on several plants showed the presence of radioactivity in certain spots (hot spots) which were distributed randomly on the surface of the plants and differed in size and activity [80]. Studies of Itoh et al. [81] showed that radioactive particles attached to outdoor plant leaves persisted for nearly 1 year.

8.2 Accumulation of Radionuclides by Plants as a Monitor System

The accumulation of radionuclides by plants acting as a monitoring system in the environment may occur by two modes; foliar absorption by the leaves and shoot of the plant, or by root uptake from the soil [82, 83]. The epidermal features of plant foliage may exert an effect upon particle retention by leaves, and subsequent uptake of radionuclides from the surface. The role of plants as monitors of radionuclides is threefold:

- as monitors of recent atmospheric releases of radionuclides; and
- as indicators of the long-term behavior of aged deposits of radionuclides in the soil [82].
- different plant species had different uptake activities for the elements [84].

Pulhani et al. [85] found that fertilizer application and soil nutrient content can affect the absorption of radionuclides by plants.

Phytoremediation of radioactive waste is a process that uses plants to remove, transfer, or immobilize radionuclides from the contaminated soil, sediment, sludge, or water, and it is a useful method for treating large-scale low-level radionuclide contamination.

There have not been established criteria which can be utilized to screen out suitable plant species that are capable of remediating the radioactivity. Important factors influencing the selection of a natural plant to remediate radioactivity, including the vegetation plant species and vegetation community composition and the criteria based on the phytoremediation factor (PF) for the selection of a natural plant to remediate radioactive waste. The vegetation plant species and vegetation community composition are important for selecting the natural plant Species [84]. An equation for Phytoremediation Factor (PF) was defined using three parameters including the target radionuclide concentration in the plant, the plant biomass, and the target radionuclide concentration in the tailings [86].

$$\mathrm{PF} = \frac{\text{Target radionuclide concentration in the plant shoot } \times \text{ biomass of the plant shoot}}{\text{Target radionuclide concentration in the tailings}}$$

Using the PF as the criteria, *Phragmites australis* (grown wild in Egypt). Through applying numerical classification for the plants recorded by Hu et al. [84] using the accumulation levels in different areas (from 1 to 9) as variables, we can arrange the most plants which can grow in Egypt for reducing nucleotides as follow:

Pteris nervosa	28
Pteris multifida	26
Phragmites australis	23
Oxalis corymbosa	21
Broussonetia papyrifera	20
Cyperus rotundus	19
Rubus hanceanus	19
Solanum nigrum	18
Artemisia capillaris	18
Clerodendrum cyrtophyllum	18
Phytolacca acinosa	16
Kyllinga brevifolia	16
Ixeris chinensis	15
Paspalum scrobiculatum	15
Cyperus iria	15
Herba gnaphaii	13
Ricinus communis	13
Vitex negundo	11
Paspalum distichum	11
Senecio scandens	10
Artemisia lavandulaefolia	10
Hibiscus syriacus	9
Melia azedarach	9
Xanthium sibiricum	9
Polygonum posumbu	8
Portulaca oleracea	8
Potamogeton pectinatus	8
Moraceae Morus alba	7
Youngia japonica	6
Solanum lyratum	6
Oxalis violacea	6
Rubus corchorifolius	6
Rosa laevigata	5
Alpinia japonica	5
Gynura crepidioides	5
Ligustrum quihoui	4
Amaranthus spinosus	4
Cyperus difformis	4
Paulownia fortunei	4
Cinnamomum camphora	4
Rubus alceaefolius	3
Herba taraxaci	3
Plantago asiatica	3
Plantago major	3
Medicago sativa	3
Salix matsudana	2

The best plants are the ones with the highest numbers

8.3 Shortwave and Longwave Radiation

Profound changes in vegetation composition in the Arctic tundra have been observed and are predicted in a warmer future climate. Shrub expansion may positively feedback to climate warming by decreasing the shortwave albedo. In Canadian studies [87], they measured an average transmission of 36% of the incoming shortwave radiation below dwarf shrub (*Betula nana*), the transmission of wet sedge (*Eriophorum angustifolium*) was 28%.

Global warming can be affected by shortwave and longwave radiation. Results of Donohoea et al. [88] suggest that, although greenhouse gas forcing predominantly acts to reduce outgoing longwave radiation, the resulting global warming is likely caused by enhanced absorbed solar radiation. They added that global conservation of energy is a powerful constraint for understanding Earth's climate and its changes. Variations in atmospheric composition that result in a net positive energy imbalance at the top of atmosphere drive global warming, with the world ocean as the primary reservoir for energy accumulation. In turn, increasing global surface temperature enhances emission of longwave (LW) radiation to space. Anthropogenic radiative forcing is dominated by LW active constituents, such as CO_2 and *methane*, and shortwave (SW) forcing agents, such as sulfate aerosols (used for a suspension of fine solid particles of a sulfate or tiny droplets of a solution of a sulfate [89]), are thought to be acting to reduce absorbed solar radiation compared with their preindustrial levels. Reduced outgoing longwave radiation, thus, seems the likely cause of the observed global energy accumulation, although the limited length of satellite TOA radiation measurements precludes determination of the relative contributions of ASR and OLR by direct observation [90].

Trees in the urban area strongly reduce pedestrian level heat stress by absorbing and reflecting solar irradiance although air temperature reduction effect is weak. Modeled results are verified by measuring shortwave radiation under trees and roof of the adjacent building [91].

Absorption profiles of incoming solar radiation determine incoming fluxes between vegetation-covered ground and the atmosphere. Model calculations demonstrate significant deviations of absorption profiles from an exponential distribution in the near-IR spectral region and high dependence of profiles on foliage orientation and the solar zenith angle. The set of input parameters of the model coincides with that of the Nilson-Kuusk canopy reflectance model. These parameters can be estimated from remote measurements [92].

9 Particulate Matter

9.1 What Is the Influence of Particulate Matter on the Climate?

Generally, it can be said there is a coherence between climate change and air quality. Some studies state elementary or carbon particulates would be the second or third most important pollutant in terms of global warming. Elementary carbon is a fraction of particulate matter and originates mainly from incomplete burning processes [93]. When it comes to predicting climate change, researchers need to take into account the effects of particles in the air. The ways in which atmospheric particles, such as mineral dust, affect climate are important.

The particle number and size fractions were compared between 14 plant species [94]. $PM_{2.5}$ particles dominated the particle distribution for all studied species. *Salix matsudana*, *Euonymus japonicus*, *Magnolia denudate*, *Salix japonica*, *Fraxinus chinensis* and *Ginkgo biloba* were efficient species in accumulating $PM_{2.5}$. PM capturing ability of shrubs and leaf undersides of plant species should be paid more attention.

Particulate matter that accumulated on leaves were comprised mainly of C, O, Si, Ca, Fe, and Pb. The densities and size fractions of the particles deposited on the adaxial and abaxial sides of leaves were significantly different, and 24% of the particles were deposited on the abaxial side of leaves. The densities of the particles in four size fractions differed significantly among the species at the two sampling sites. *Salix matsudana*, *Euonymus japonicus*, *Magnolia denudate*, *Sophora japonica*, *Amygdalus persica*, and *Salix babylonica* efficiently captured all particle sizes on their leaf surfaces. *S. matsudana*, *E. japonicus*, *M. denudate*, *S. japonica*, *Fraxinus chinensis,* and *Ginkgo biloba* efficiently captured submicron and fine particles, which can have serious effects on human health. These differences among species provide more insight into the sink capacity of green tree species, and the efficiencies of plant species for trapping particulates can be used to guide urban tree planning and decrease air pollution.

Plants not only improve air quality by adsorbing particulate matter (PM) on leaf surfaces but can also be affected by their accumulation. In a study [95, 96] about the relationship between seven leaf traits and the accumulation of three different sizes of PM (PM_{11}, $PM_{2.5}$ and $PM_{0.2}$) on leaves. The retention abilities of plant leave with respect to the three sizes of PM differed significantly at different sites and species. The average PM retention capabilities of plant leaves and specific leaf area (SLA) were significantly greater in a seriously polluted area. The findings from their study provide useful information regarding the selection of plants to reduce atmospheric pollution.

9.2 Removal of Particulate Pollutants

Suspended particles in the atmosphere are deposited on plant surfaces by three processes:

1. sedimentation under the influence of gravity,
2. impaction under the influence of eddy currents, and
3. deposition under the influence of precipitation.

Sedimentation regularly results in the deposition of particles on the different aboveground plant parts and increases onupper surface of leaves and is most important with large particles. Sedimentation velocity varies with particle mass, size [97], particle density, nutrient and organic matter content [98], shape, and trace elements [99] and other factors. Impaction happen when air flows fast on the obstacle, and the air stream divides, but particles in the air be likely to continue in a straight track due to their momentum and strike the obstacle.

The efficiency of the collection via impaction is the principal means of deposition if:

(a) particle size is of the order of tens of micrometers or greater,
(b) obstacle size is of the order of centimeters,
(c) approach velocity is of the order of meters per second or more, and
(d) the collecting surface is wet, sticky, hairy or otherwise retentive.

Ingold [100] presented data indicating that leaf petioles are considerably more efficient particulate impactors than either twigs (stems) or leaf lamina. For particles of dimension 1–5 μm, impaction is not efficient, and interception by fine hairs on vegetation is possibly the most efficient retentive mechanism [101].

The transfer of particles from the atmosphere to natural surfaces is commonly expressed via deposition velocity. For small particles, for example, condensation aerosols less than 1 μm, deposition velocities are much less than for large particles:

For example, spores and pollen 20–40 μm in diameter.

Trace metals, especially heavy metals, are most commonly associated with fine particles in contaminated atmospheres.

Trace element investigations conducted in roadside, industrial, and urban environments have dramatically demonstrated the impressive burdens of particulate heavy metals that can accumulate on vegetative surfaces.

Based on a literature survey, particulate removal efficiencies for trees have been estimated (Table 2). It is based on the following assumptions:

Particulate average deposition velocity of 1 cm s^{-1} for trees and 0.8 cm s^{-1} for grass and weeds, leaf area index of 5.1 for deciduous trees and 2.3 for conifers, and approximately 2 ha of deciduous tree surface and 1 ha of coniferous tree surface ha^{-1} of land area.

Black carbon and particulate matter are not a gas, but it acts as a greenhouse gas. It can be hanging in the air and absorb heat [102]. Gardeners may cause more carbon particulates in the atmosphere by burning garden wastes.

Particulate matter $PM_{2.5}$ alone is responsible for over 2 million deaths a year around the world [103]. PM also causes damage to the circulatory and respiratory systems and are also the second largest cause of lung cancer [104] and autism [105]. The literature on particulate matter uptake from the air by outdoor-growing plants is very extensive, most probably because of this pollutant's increasing negative impact worldwide on human health and the environment. The results of Gawrońska and Bakera [106] demonstrated that the amount of PM accumulated on aluminum plates was always significantly lower than that accumulated on the plants' leaves, showing that more than simply gravity forces are involved in PM accumulation on leaf blades.

Broad-leaved taxa with a rough surface (*Ulmus* sp.) efficiently capture airborne particulate matters [107]. The importance of plant functional traits differs by site and plant characteristics.

The literature on the atmospheric particulate matter (PM), and atmospheric aerosol, has augmented extremely over the last two decades. Fuzzi et al. [108] concluded that increasing scientific awareness in atmospheric PM or aerosol is owed to their great significance for environmental policy. Particles hanging in air interrelate with shortwave radiation from the sun and longwave radiation from the Earth, these relations greatly affect the energy budget and climate of the planet [109]. Actually, PM starts one of the most interesting problems for air quality and climate change policies. Atmospheric aerosol particles play an important role in radiation budget of the Earth's as they scatter and absorb both shortwave solar radiation and longwave terrestrial radiation [110]. Particulate matter can directly relate with cloud formation developments and may control both the amount and location of rainfall [111]. Similarly, the degree of the global effects of PM on climate remains extremely undefined. In spite of the uncertainty, there are numerous things that could be done to alleviate local and global harms of atmospheric PM.

Studies have shown that dropping black carbon (BC), one of the further main PM emissions, using known control measures, would reduce global warming and delay the period when anthropogenic effects on global temperature would exceed 2 °C. Therefore, there is ample that could be done to lessen the effects of atmospheric PM on the climate and the health of the environment and the human population.

9.3 Landscape Plants and Particulates

With the rapid progress of urbanization and industrialization, urban environmental pollution has become a public concern. This has directed to a huge studies on the urban environmental pollution issue [112]. Urban air pollution is an ambiguous type of environmental pollution. Among the pollution types, particulate pollution, notably PM_{10} and $PM_{2.5}$ directly or indirectly affect human health.

The sources of urban particulate matters are various, and the most significant ones come from the emissions of road traffic, fossil fuel combustion and construction dust [113]. Controlling and reducing urban particulate pollution has become a pressing problem. Using plants to absorb atmospheric particle matter has been confirmed as an effective method [114]. A plants' ability to remove atmospheric particulates mainly relies on its leaf function, and leaf structure, such as leaf surface texture, hair, grease, and moisture, along with other beneficial features for atmospheric particles absorption, and a huge leaf area supported by a complex stem structure can fix a lot of atmospheric particles.

Unfortunately, the atmospheric particles can crimp stomas and reduce the chlorophyll content of leaves so that gas exchange action is blocked and photosynthesis is decreased [115]. Therefore, analyzing plant stagnation differences with respect to atmospheric particulates in different contaminated areas by the use of plant leaves it is a good method.

The adsorption capacities for airborne particulates of different tree species display differences because the different tree species have different crown profiles, branches and leaves ratios and leaf surface characteristics (including waxiness, epidermis, stomata's and pubescence length, etc.).

In England, Freer-Smith et al. [116] studied the adsorption capacities for particulates of five coniferous and broadleaved species in England, and the results showed that the adsorption capacity for particulates of *Pinus tabuliformis* is the highest, that of *Sorbus aria* is the second highest and that of *Populus deltoides* is the lowest.

Urban landscape plants are an important component of the urban ecosystem, playing a significant role in the adsorption of airborne particulates and air purification. In a study carried at China Zhang et al. [117] on six common landscape plants in Beijing as research subjects, and the adsorption capacities for each different plant leaf and the effects of the leaf structures for the adsorption capacities for particulates. Preliminary results show that needle-leaved tree species adsorbed more airborne particulates than broad-leaved tree species for the same leaf area. *Pinus tabuliformis* exhibits the highest adsorption capacity, at $3.89 \pm 0.026\ \mu g\ cm^{-2}$ of PM_{10}, almost two times as much as that of *Populus tomentosa* ($2.00 \pm 0.118\ \mu g\ cm^{-2}$) as compared with same tree species leaves in the Botanical Garden. They added that there are significant adaptive changes to the leaf structures, and when compared with the slightly polluted region. In the seriously polluted region the epidermis cells of the plant leave shrinked, the surface textures of the leaves became rougher, and the stomas' frequency and the pubescence length increased.

10 Importance of Urban Landscape Plants Especially Trees for Climate Change

10.1 How Do Trees and Forests Relate to Climate Change?

Deforestation, particularly the damage of rainforests, is a vastly significant contributor to climate change. Scientists estimate that forest injury and other changes to the use of the land account for around 23% of current man-made CO_2 emissions—which compares to 17% of the 100-year warming impact of all current greenhouse-gas emissions.

As children are qualified at school, all plants absorb CO_2 from the air as they grow. Using solar energy, they use the carbon captured from the CO_2 molecules to built carbohydrates building blocks for their roots, main trunks and branches, foliage, flowers and seeds.

A mature (long lived) forest doesn't certainly absorb much more CO_2 that it releases, but when every tree dies and either rots down or is burned, for human activities, much of its stored carbon is released once again. Briefly, in the background of climate change, the most important thing that mature forests is not that they reduce the amount of CO_2 in the air but that they are big reservoirs of stored carbon. If such a forest is burned or cleared, then much of its carbon is released back into the atmosphere, totaling to atmospheric CO_2.

Obviously, the similar process also works in contrary. If new trees are planted where previously there weren't any, they will on soak up CO_2 according to the stages of growth reducing the amount of GHG in the atmosphere. Generally, it is thought that plants as "carbon sinks" currently soak up about 25% of all the CO_2 that humans add to the air each year. This figure could change as the planet warms.

Obviously, the relationship between trees and local and global temperature is very complex than the simple question of the GHGs they absorb and emit. Afforestation have a major impact on local weather structures and can affect the amount of sunlight trapped by the planet [118].

10.2 How Do Timber and Forests Relate to Climate Change?

Deforestation, and particularly the destruction of rainforests, is an enormous contributor to climate exchange. Scientists estimate that wooded area loss and other changes to using the land account for round 23% of the present-day guy-made CO_2 emissions—which equates to 17% of the warming effect of all current greenhouse-gasoline emissions.

As kids are taught at faculty, timber and different flowers absorb CO_2 from the air as they grow. The usage of electricity from the solar, they flip the carbon captured from the CO_2 molecules into building blocks for his or her trunks, branches and foliage. This is all part of the carbon cycle.

A mature forest doesn't always soak up a good deal more CO_2 that it releases, however, because while each tree dies and either rots down or is burned, tons of its stored carbon is released once more. in other phrases, in the context of weather trade, the most critical element approximately mature forests is not that they reduce the quantity of CO_2 inside the air however that they may be huge reservoirs of saved carbon. If such a wooded area is burned or cleared then a lot of that carbon is launched again into the environment, including to atmospheric CO_2 ranges.

Unsurprisingly, the connection among trees and nearby and worldwide temperature is greater complicated than the simple query of the greenhouse gases they soak up and emit. Forests have a prime impact on local weather structures and can also have an effect on the amount of daylight absorbed by means of the planet: a new vicinity of bushes in a snowy area may additionally create extra warming than cooling general via darkening the land surface and lowering the quantity of daylight reflected again to the area.

Types of Urban gardens that affect global climate change

- Street gardens
- Parks and playgrounds
- Community gardens
- Home or private gardens
- *Greenbelt*s
- Special gardens (hospital gardens, school and universities gardens, governmental gardens, etc.).

Careful attention to the world's garden soils is one piece of solving the climate problem. Agriculture and forestry, which dominate managed soils world-wide, clearly have the largest roles to play. However, as cities expand in the United States, there is a growing opportunity for urban and suburban areas to play a part.

Recent studies suggest that urban green spaces (lawns, gardens, parks, golf courses, and trees planted along streets) have the potential to capture CO_2 and "store" that carbon over time [66].

Practices that maximize carbon storage without producing moreover global warming pollution in the procedure cover crops, crop rotation, tree and shrubs planting, and groundcovers and garden maintenance) can help unhurried the jump of climate change. Garden managers and owners can lead the way in their gardens and yard.

10.3 Impression to a Climate Friendly Garden

A garden can be thought of as climate-friendly if it stores (or prevents the release of) more heat-trapping gases and generate oxygen. Researchers in landscape architecture, horticulture, climate, forestry, and urban ecology have determined some practices can change garden in facing climate change, these include:

Minimize Carbon-Emitting Inputs through [119].

- Select kinds of tools and chemicals, "inputs" which can affect the amount of heat-trapping gases your garden absorbs.
- Gasoline-powered tools are sources of CO_2.
- Synthetic nitrogen fertilizers, require a lot of energy to manufacture, which generates a significant amount of CO_2.
- Use liquid organic fertilizer after sterilization. Not recommend using non-sterilized organic nitrogen-based fertilizers (compost, animal manure), especially if the timing and amount of fertilizer are not precise.
- Understanding the Types of Lawn Fertilizer.

– Using a fertilizer for ground covers is an effective way to prevent disease and pest damage and minimize maintenance.
– Use time-release fertilizers which are beneficial at feeding the lawn over many months.
– Use humic acids
– Liquid or water-soluble fertilizers are spread using a hose and provide a quick, effective way to introduce nutrients rapidly to grassroots.
– Studies have suggested that fertilizer over-use can be a source of nitrous oxide [27].

10.3.1 Don't Leave Garden Soil Naked

Whether you grow summer vegetables, annual flowers, or perennial borders, there are periods of time perhaps as much as half the year, depending on your local climate—when plants are not actively growing. During these times, bare soil is vulnerable not only to erosion and weeds but carbon loss as well.

The use of cover crops grasses, cereal grains, or legumes that can be grown when other plants cannot is a mainstay of organic farming systems because it helps develop healthy and productive soil, reduce the need for energy-intensive chemical fertilizers and pesticides, and store large amounts of carbon. Cover crops are not meant to be harvested but to stabilize, build, and add nutrients to the soil that would otherwise remain bare.

Non-legume covers crops such as rye and winter wheat are also useful. When planted at the correct time, they can capture excess nitrogen from fertilizers or decaying plant matter; several studies showed these cover crops reduced nitrogen losses into groundwater by about 70%. By holding nitrogen in their tissues, they also prevent soil microbes from converting it into heat-trapping nitrous oxide. And non-legume cover crops typically grow larger and faster compared with legumes, absorbing more CO_2 from the atmosphere and returning more organic matter to the soil.

10.3.2 Plant Trees and Shrubs

Governments ask people, please if you have space in your home garden, plant—and keep one or more trees or large shrubs because it is an excellent way to remove more heat-trapping CO_2 from the atmosphere over a long period of time. Entirely terrestrial plants captivate CO_2 through their green organs, storing the carbon in their tissues. Trees and shrubs, because they are large and woody, and long-lived, can store larger quantities of carbon than other plants, for longer periods of time [120].

The geometric experiments [121] show that through a hypothetical scenario of worldwide sustainable forestry, the world's forests (mainly trees) could offer a large carbon sink, about one gigatonne (GT) year^{-1}, due to improvement of carbon stock in woody plants biomass. In addition, a total amount of wood, 11.5 GT of carbon year^{-1}, could be removed for reducing CO_2 emissions by replacement of wood for fossil fuels. A recent multi-city study estimated that, as a whole, the urban trees of the contiguous United States accumulate nearly 23 million tons of carbon in their tissues per year. While all trees store carbon, urban and suburban trees can also prevent CO_2 emissions because they help reduce energy use in nearby homes and buildings. Well-placed trees can shade buildings from the summer sun or buffer them from cold winter winds, reducing heating. Through evapotranspiration, urban and suburban trees can lower temperature during the summer. Thus, one study found that in addition to storing between 4 and 10 kg of carbon annually, a single shade tree in Los Angeles helps residents and businesses save enough energy to avoid the release of nearly 18 kg of carbon from power plants each year [122].

10.3.3 Expand Recycling to the Garden

According to the USEPA [123], yard trimmings and food wastes make up about one-quarter of the country's municipal solid waste (EPA [124]. When these organic wastes are disposed of in landfills, ample of the carbon is deposited underground, but the waste that breaks down releases methane gas—a heat-trapping gas 23 times strong than CO_2 [125].

Horticulturists can help decreasing the global warming pollution linked with waste disposal by turning leaves, grass, woody garden clippings, dead garden plant parts, besides kitchen waste into biochar, mulch or compost, then using it in the garden or reclamation of sandy soils. "Recycling" these wastes will not only reduce methane emissions but also improve garden's soil and help it store carbon [126, 127].

Compost, which can be any mixture of decaying organic materials (for example, plant leaves, animal manure, food scraps), is created by a and other organisms break down wastes into a nutrient-rich soil amendment. While composting does produce global warming gases, studies indicate that the best practices for creating and using compost have a smaller climate impact than landfills [128, 22].

That's because efficient composting takes place aerobically (that is, in the presence of oxygen), which minimizes the formation of *methane*. By contrast, landfills lack oxygen circulation, so organic materials are broken down primarily by bacteria that thrive in the absence of oxygen and produce *methane*. One study suggests composting is also better than incinerators for reducing heat-trapping emissions from organic waste disposal [129].

d. Think a lot about private and public Lawns

lawns can be make climate-friendly

A growing frame of research indicates that soils covered in lawn grasses can capture and store noteworthy amounts of carbon.

It appears that practices designed to maximize lawn growth and health with minimal inputs of fertilizer and water may achieve the best balance of carbon storage and nitrous oxide emissions.

Every plant from grasses absorbs CO_2 from the air. Grass have a seasonal cycle of fast growth periods beside flowering. But when grasses frequently mowed no flowering can achieved. Throughout this cycle, lawn grasses continuously cover root system and depositing carbon in the soil. After mowing grass, clippings left on the lawn to decompose, these clippings are extra source of carbon that can be kept in the soil below. Contrasting to gardens, which are often ploughed and ploughed, lawns are naturally left undisturbed, allowing the soil to store carbon for long periods of time [130]. Rates of carbon storage vary depending on the climate, soil type, and how the grasses are managed [131].

Zirkle et al. [132, 133] calculated efficiency of lawns relating to Soil organic carbon (SOC) sequestration for U.S. lawns. SOC was 46.0 to 1216.1 g C/m^2/year. They added that additional C sequestration can result from biomass gains attributable to fertilizer and irrigation management. However, nitrous oxide emissions from lawns have been related to the addition of nitrogen fertilizer and large watering [27].

10.4 The Role of Plants, Especially Trees, Solve Climate Change Problems

Climate favorable landscaping is an innovative method of cultivation ornamental plants in urban gardens in ways which reduce emissions of different types of greenhouse gases and encourage the absorption of carbon dioxide and *methane* by plants in order to aid the reduction of global warming. To be a Climate favorable landscaper means considering both what happens in a garden and the materials brought into it and the impact they have on and climate. It can also include garden features or activities in the garden that help to reduce greenhouse gas emissions elsewhere.

Plants in forests play an important role in *climate change*. Afforestation or planning a forest garden can help mitigate against *climate change* by removing CO_2 from the atmosphere. It is stored in this "biomass" until being returned back into the atmosphere, whether through natural processes or human interference [134].

Permaculture is most frequently applied in gardening. Urban gardening provides habitat for wildlife, carbon sequestering, biodiversity and others. Simple urban gardening must be contained (containing or contained) three layers: trees, shrubs, and ground plants. But for those who like to take advantage of every planting opportunity, a deluxe urban garden can contain at least six tiers of vegetation.

As the illustration below shows, a seven-layered urban garden contains (Fig. 5):

1. Big or tall trees
2. Small or low trees
3. Hedges and shrubs
4. Bedding plants, perennial or herbs
5. Lawns or ground covers or annuals

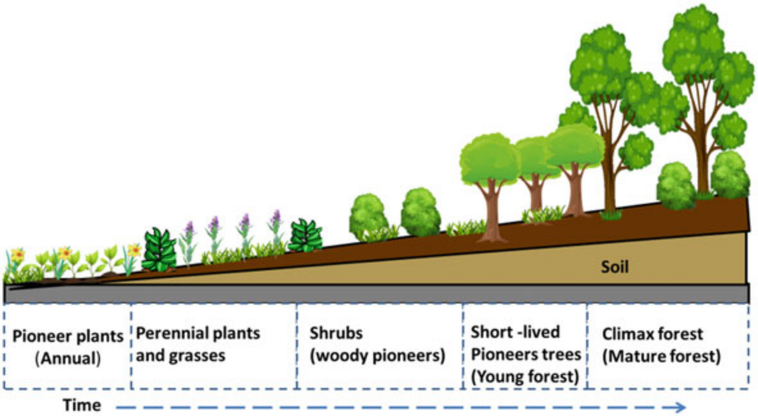

Fig. 5 Ideal layers of urban garden

11 Street Trees: Species Selection Criteria [135, 61, 56, 136]

Street trees are one of the greatest important gears of urban landscaping and they play a vital role in town pollution and climate change besides street aesthetics. When choosing trees, consider the following:

1. *Absorb pollutants*: Has a great ability to absorb specific pollutants dominant in the area.
2. *Suited to climate and soil characters*: only species which will tolerate and succeed in the specific setting are recommended.
3. *Reliable form*: A higher and taller canopy on a single trunk keeps paths clear for pedestrians and similarly keeps sightlines open for traffic safety and personal security.
4. *Scale elements*: Trees of a size which will provide a substantial degree of comport when mature are preferred. In this setting, the occurrence of overhead power lines will require the selection of trees with a tall narrow canopy, or a decision not to plant beneath wires. Longevity: Some fast-growing plants are short-lived. A long life—several decades—is required to defend the cost of establishment, and maintenance, and to supply an appropriate level of comfort.
5. *Extend or support a worthy existing theme*: native or exotic will depend on the situation. Selection should be governed by site valuation Not a weed and unlikely to become a weed. Species which yield large amounts of either fleshy fruits or light windblown seeds are discouraged. Some domestic plants are weeds, and the possible for hybridization between introduced “exotic” natives and local gene pools is regarded as a risk.
6. *Resistance to local diseases and insects*: Trees are not carriers or hosts of pests that infect plants in the area.

7. *Quality of wood*: Once the trees reach the age known to them, the municipality may resort to re-culture, and in rare cases may require digging out trees. In these cases, wood quality is required.
8. *No Street Tree is Perfect*: There is no such thing as the street tree that will fulfil perfectly all aspects of our selection criteria.
9. *Root system characteristics*: Trees species which do not have a history of problematic root behaviour are preferred.
10. *Branch drop and windthrow:* Choose trees which are not known for unexpected branch drop, or likely to blow over in strong winds.
11. *Deciduous versus evergreen*: The requirement for summer shade and winter sun should be factored into the selection process.
12. *Non-grafted cultivars*: carefully consider if a grafted species has been short-listed. When suffering hardship, grafted specimens can shoot from the under-stock, creating a maintenance burden.
13. *Fruit production*: Apart from potential weed production from fruit, fleshy or woody fruit can create a hazard when they fall on pavements.
14. *Habitat linking*: strategic location of particular indigenous tree species to link fragmented habitat or continue a wildlife corridor, can be important to some classes and populations of animals. This must be considered on a site-by-site basis.

11.1 Big or Tall Trees

Tree planting and plantation urban forestry are well established both in the private and public sectors. The data released by the UN's Food and Agriculture Organisation suggest that plantation forests comprised an estimated 7% of global forest area in 2010 [137]. Trees are also planted as part of efforts to restore natural forests as well as in agroforestry, which involves increasing tree cover on urban and agricultural lands.

- Under certain conditions plantations can grow relatively fast, thus absorbing CO_2 at higher rates. In the absence of major disturbances, newly planted or regenerating forests can continue to absorb carbon for 20–50 years or more. Tree planting could sequester (remove from the atmosphere) around 1.1–1.6 GT of CO_2 per year (that compares to total global greenhouse gas emissions equivalent to 50 GT of CO_2.
- Tree planting and afforestation were included as activities eligible for finance under the Kyoto protocol. Kyoto's rules and procedures, however, restricted the scale and scope of these activities. As a result, projects have struggled to get off the ground and the carbon sequestered has been almost negligible.
- Dense, spreading species—the classic shade trees such as *Ficus retusa*, *F. benghalensis*, *Delonix regia*, and *Cassia nodosa* don't work well in the forest garden because they cast deep shadows over a large area. Better choices are *F. religiosa*, *Khaya senegalensis*, and *Bauhinia variegatum*.

Nitrogen-fixing trees will help build soil and most bear blossoms that attract insects. In Egypt, these include *Erythrina indica, Cassia nodosa, Delonex regia, Jacaranda ovalifola* and *Albizia lebbeck*. The canopy trees will describe the chief patterns of the forest garden, thus they necessity be chosen wisely. Plant them with careful in respect to their expected final size so enough light will fall among all above-ground tree parts [138]. Most Important Street Trees According to Their Efficiency for Reducing Carbon Dioxide from Atmosphere.

1. *Albizzia lebbeck*
2. *Bauhinia variegate*
3. *Bombax malabaricum*
4. *Cassia fistula*
5. *Cassia nodosa*
6. *Chorisia speciosa*
7. *Erythrina variegate*
8. *Eucalyptus camaldulensis*
9. *Ficus retusa*
10. *Ficus* benghalensis
11. *Ficus religiosa*
12. *Ficus sycamores*
13. *Khaya senegalensis*
14. *Tipuana speciose*

Table 2 shows the role of Egyptian street trees in reducing carbon emissions or absorbing carbon dioxide from the surrounding air. The results deal with specific leaf area, i.e. calculated for every 1000 cm^3 of one leaf surface only. It is better to calculate the total leaf area of the entire tree. Because it is difficult to find different trees in the same age at the same environmental conditions. Data in Table 1 and Fig. 6 show that *Ficus religiosa* trees are best in CO_2 uptake through the first 5 min after

Table 1 Efficiency of some ornamental trees grown in Egypt for reducing CO_2/1000 cm^2 leaves area and transpiration rate, arranged ascendingly [139]

CO_2	mmol H2O m−2 min−1
1. *Ficus religiosa*	1. *Cassia fistula*
2. *Bauhinia variegate*	2. *Ficus religiosa*
3. *Cassia nodosa*	3. *Ficus benghalensis*
4. *Eucalyptus camaldulensis*	4. *Eucalyptus camaldulensis*
5. *Ficus sycamores*	5. *Ficus sycamores*
6. *Khaya senegalensis*	6. *Chorisia speciosa*
7. *Albizzia lebbeck*	7. *Albizzia lebbeck*
8. *Chorisia speciosa*	8. *Khaya senegalensis*
9. *Cassia fistula*	9. *Bauhinia variegata*
10. *Bombax malabaricum*	10. *Ficus retusa*
11. *Erythrina variegate*	11. *Tipuana speciose*
12. *Ficus retusa*	
13. *Ficus benghalensis*	
14. *Tipuana speciose*	

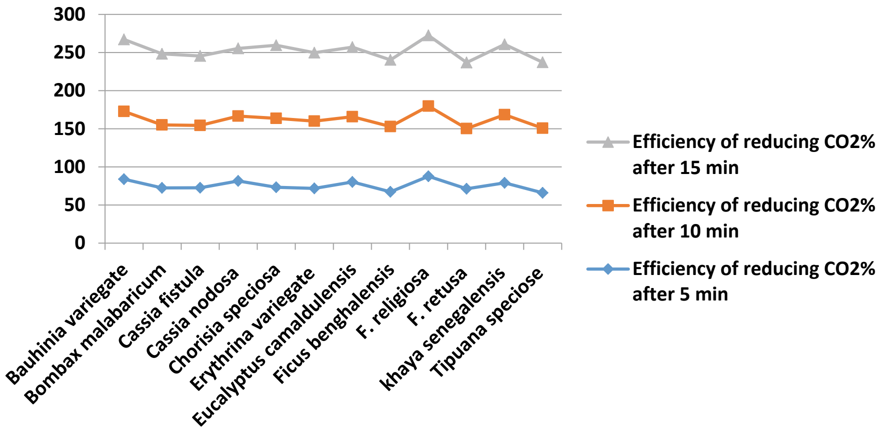

Fig. 6 Efficiency of some ornamental trees grown in Egypt for reducing CO_2/1000 cm^2 leaves area [139]

the start of the carbon dioxide pollution, as well as after 10 min and after 15 min. This is followed by *Bauhinia variegate* trees as in the following table.

On the other hand, studies were conducted on the most common trees and shrubs cultivated in Egypt, from these studies on the transpiration of plants from their leaves in the plant and this property depends on various factors:

(a) Plant type, including the anatomical structure of the leaves
(b) Climatic conditions prevailing in the region such as temperature and humidity
(c) Different soil conditions.

Scientific studies show that for transpiration of 1 g of water, plant require 633 Cal, this amount of energy is withdrawn by the plant from the surrounding environment. This energy is believed to affect heat reduction in the atmosphere. However, the arrangement of the trees studied was not the same with the arrangement of trees in the disposal of carbon dioxide.

The following is an explanation of some of the common species cultivated in Egypt and have a role in the disposal of carbon dioxide that causes climate change which is also important in tempering the atmosphere, which also affects climate change (Table 3; Fig. 7).

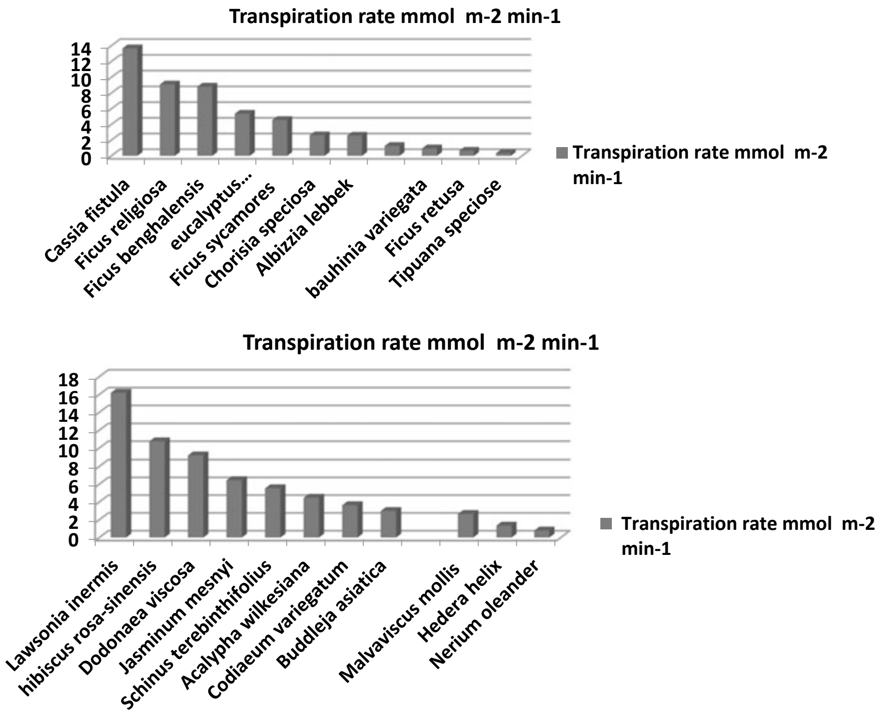

Fig. 7 Efficiency of some ornamental trees (**a**) and shrubs (**b**) grown in Egypt for transpiration rate/1000 cm^2 leaves area [17]

11.2 The Relationship Between Some Landscape Plants and Climate Change (Tables 2 and 3; Figs. 7 and 8)

11.2.1 *Ficus religiosa*

It is a large tree for dry season, semi-deciduous in Egypt, up to 30 m tall. Because the leaves have a tall petiole, it move continuously even when the air around is immobile, and no perceptible wind is blowing. This motion can be explained due to the long leaf petiole and the broad leaf blade. This movement may be the reason why this tree is one of the highest trees in the disposal of carbon dioxide in our studies [17, 139], resulting in more movement contributing to the entry of larger quantities of air gases. *Ficus religiosa* is grown as an ornamental tree, in public gardens, community and universities gardens, large private gardens and parks. They prefer full sunlight and can grow in most soil types. While it is possible for the plant to grow indoors in a pot (as a bonsai plant), it grows best outside [140]. Some scientific studies [141] have shown that the genus of *Ficus* in general, including *F. religiosa* produces moderate amounts of volatile organic compounds (VOCs) in the atmosphere, it is a pollutant.

Table 2 The efficiency of some ornamental trees and shrubs grown in Egypt for reducing percentages of carbon dioxide

	CO_2 reduction percentages after 5 min	CO_2 reduction percentages after 10 min	CO_2 reduction percentages after 15 min
Trees			
Ficus religiosa	87.65	92.11	92.64
Bauhinia variegate	83.76	89.04	94.33
Cassia nodosa	81.53	85.15	88.78
Eucalyptus camaldulensis	80.15	85.66	91.18
Ficus sycamores	79.61	90.92	92.11
Khaya senegalensis	79.04	89.35	92.27
Albizzia lebbeck	75.84	87.21	89.02
Chorisia speciose	73.29	90.36	95.92
Cassia fistula	72.54	81.82	91.10
Bombax malabaricum	72.34	82.76	93.19
Erythrina variegate	71.81	88.14	89.80
Ficus retusa	71.33	78.93	86.53
Ficus benghalensis	67.20	85.72	87.45
Tipuana speciose	65.99	84.77	86.35
Shrubs			
Bougainvillea glabra	58.68	62.28	62.47
Dodonaea viscosa	43.28	47.38	48.25
Hedera helix	25.12	25.57	25.61
Lantana camara	20.92	22.21	22.32
Schinus terebinthifolius	19.11	20.57	20.81
Malvaviscus mollis	14.88	16.62	16.83
Nerium oleander	6.32	6.96	7.04
Acalypha wilkesiana	1.73	2.06	2.11

11.2.2 *Erythrina indica*

– Has large natural distribution in the tropics
– For cultivation in gardens
– Deciduous tree
– Growing up to 27 m
– Cultivated as an ornamental tree.

Table 3 Transpiration rate of some ornamental trees and shrubs grown in Egypt as an indirect method for prediction the efficiency plants for reducing air temperature (every 1 g needs about 600 calories for evaporating from plants)

Plant	Transpiration rate as mmol m^{-2} min^{-1}
Trees	
Cassia fistula	13.68
Ficus religiosa	9.10
Ficus benghalensis	8.82
Eucalyptus camaldulensis	5.38
Ficus sycamores	4.59
Chorisia speciosa	2.63
Albizzia lebbek	2.58
Khaya senegalensis	1.27
bauhinia variegata	0.96
Ficus retusa	0.66
Tipuana speciose	0.35
Shrubs	
Lawsonia inermis	16.19
Hibiscus rosa-sinensis	10.76
Dodonaea viscosa	9.17
Jasminum mesnyi	6.45
Schinus terebinthifolius	5.54
Acalypha wilkesiana	4.47
Codiaeum variegatum	3.64
Buddleja asiatica	3.00
Malvaviscus mollis	2.65
Hedera helix	1.34
Nerium oleander	0.79

11.2.3 *Ficus benghalensis*

– The Genus are among the largest trees Egypt
– The species are among the largest trees in the world by canopy coverage
– Due to the large size of the tree's canopy, it provides useful shade in hot climates.

11.2.4 *Eucalyptus camaldulensis*

– One of around 800 species within the genus
– It is a plantation species in many parts of the world
– Can grow to 45 m tall

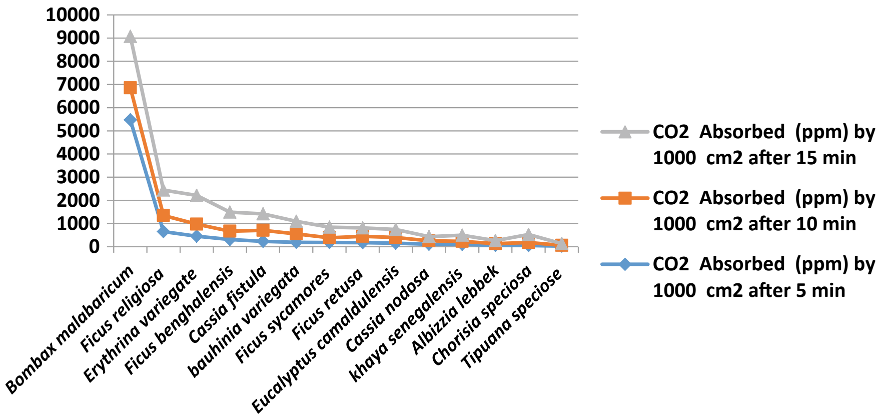

Fig. 8 Efficiency of some ornamental shrubs grown in Egypt for reducing CO_2/1000 cm^2 leaves area Koriesh [139]

- The tree has a large, dense crown of leaves
- It may contain a specific phytoncides
- Self-pruning. Saving water
- The speed of growth of the tree makes it a useful plantation.

11.2.5 *Bombax ceiba,* L.

- Has a straight, tall trunk
- Deciduous in winter
- Red flowers appear in the spring before the new foliage
- Produces a capsule which, when ripe, contains white fibers like cotton
- Grows to an average of 20–60 m
- Widely planted in parks and on roadsides there because of its beautiful red flowers which bloom in March/April.

11.2.6 *Chorisia speciosa*

- Deciduous trees
- In younger trees, the trunk is green due to its high chlorophyll content, which makes it capable of performing photosynthesis when leaves are absent; with age, it turns to grey
- The leaves are composed of five to seven long leaflets.

11.2.7 *Khaya senegalensis*

Khaya senegalensis is a species of tree native to Africa.

- The medium-sized tree which can grow up to 15–30 m
- The bark is dark grey to grey-brown
- Used for its timber
- It is now used more locally and is planted ornamentally as a roadside tree.

11.2.8 *Ficus retusa*

- Rapidly growing tree, rounded, broad-headed, evergreen
- Can reach 15 m
- Massively spreading canopy
- The tree has small, dark green leaves.

11.2.9 *Tipuana tipu*

- Semi-deciduous tree
- Height up to 10–35 m
- The flowers are abundant in number from the end of spring until the beginning of the summer
- Cultivated parks and large recreation areas
- Leaves fall briefly at the end of winter and grow again after a few weeks.

11.3 Small or Low Trees

The Low-Tree Layer

Here are many of the dwarf and semi dwarf plants. Plus, we can plant naturally small trees such as *Bauhinia variegata*, *Cassia fistula,* and *Cassia nodosa*. In a smaller forest garden, these small trees may serve as the canopy.

Both large and small nitrogen-fixing trees as *Erythrina variegata, Bauhinia variegata, Cassia fistula, Cassia nodosa and Tipuana speciose* grow quickly and can be pruned heavily to generate plenty of effective leaves.

11.3.1 *Bauhinia variegata*

- Reach a height of 6–12 m and their branches spread 3–6 m
- Flowers are 7.5–12.5 cm diameter, in shades of red, pink, purple, orange, or yellow
- Flowers are often fragrant
- Flowering in late winter and often continues to flower into early summer
- Prefer acidic soils and do not tolerate salty conditions
- Full sun exposure is preferred, but they can be grown under the partial sun.

11.3.2 *Cassia fistula*

- Popular ornamental plant and used in herbal medicine
- Medium-sized, up to 10–20 m with fast growth
- Flowers are produced in pendulous racemes with yellow petals
- Flowers with a pungent odor
- Strong and very durable wood
- Widely grown as an ornamental plant
- Trees were covered with yellow flowers, many times with almost no leaf being seen
- Grow well in dry climates
- Relatively drought-tolerant and slightly salt-tolerant.

11.3.3 *Cassia javanica* (*C. nodosa*)

- Worldwide as a garden tree owing to its beautiful crimson and pink flower bunches
- Fast growing, semi-deciduous tree which flowers in spring
- The trunk that reaches heights of 25–40 m
- Planted as a shade and ornamental tree on streets and in parks
- Used medicinally.

11.4 Hedges and Shrubs

1. *The Shrub Layer*. This tier includes flowering, fruiting, wildlife-attracting, and other useful shrubs. A small sampling: *Lawsonia inermis, hibiscus rosa-sinensis, Dodonaea viscosa, Jasminum mesnyi, Schinus terebinthifolius, Acalypha wilkesiana, Codiaeum variegatum, Buddleja asiatica, Malvaviscus mollis, Hedera helix, Nerium oleander*, and dozens of others

2. The broad palette of available shrubs allows the gardener's inclinations to surface, as shrubs can be chosen to emphasize food, crafts, ornamentals, birds, insects, native plants, exotics, or just raw biodiversity
3. Shrubs come in all sizes, from dwarf to nearly tree-sized
4. Shade-tolerant varieties can lurk beneath the trees, sun-loving types in the sunny spaces between.

11.5 Bedding Plants or Herbs

– The Herb Layer is used in the broad botanical sense to mean nonwoody vegetation: flowers, culinary herbs, and cover crops, as well as mulch producers and other soil-building plants.
– Emphasis is on perennials and annuals.
– Shade-lovers can peek out from beneath taller plants, while sun-worshiping species need the open spaces.
– It is better to use more efficient shrubs in reducing $CO_{2.}$

11.6 Lawns or Ground Covers

– It is best to use high-efficiency shrubs that absorb more carbon dioxide as *Bougainvillea glabra, Dodonaea viscosa, Hedera helix, Lantana camara, Schinus terebinthifolius* and *Malvaviscus mollis*

– They play a critical role in weed prevention, occupying ground that would otherwise succumb to invaders.

11.7 Climbers and Vines

– This layer is for climbing plants that will twine up trunks and branches, filling the unused regions (https://www.motherearthnews.com/organic-gardening/garden-planning/backyard-fores).
– It is best to use high-efficiency shrubs that absorb more carbon dioxide as *Bougainvillea glabra* and *Hedera helix.*
– Some of the perennial vines can be invasive or strangling; hence, they should be used sparingly and cautiously.

11.8 Efficiency of Trees for Reducing CO_2/1000 cm^2

The following is an explanation of some of the common species cultivated in Egypt [142, 143] and has a role in the disposal of carbon dioxide that causes climate change which are also important in tempering the atmosphere, which also affects climate change.

12 Vertical Gardens to Reduce *Climate Change*

12.1 Benefits of Using the Vertical Garden System

1. The benefits of the use of the walls vary according to several criteria. Perhaps the most important of which is the location of the origin and the method and manner of cultivation of the outer envelope and the nature of the surrounding environment. In addition to the aesthetic character and the establishment of a distinct environment and an enjoyable environment of existing architecture, these benefits can be arranged under three main titles [144]. On the environment scale
2. On the scale of the building
3. Scope of users

On the environmental scope, Results of Safikhani et al. [145] showed that the living wall and green facade reduced indoor temperature up to 4.0 and 3.0 °C, respectively. The living wall and green facade also reduced cavity temperatures by 8.0 °C and 6.5 °C, respectively.

> The beauty of this system is that more than 90% of the water goes directly to the plant and the absorption rate is lower as compared to normal absorption of water by the plants (http://www.talkafrica.co.ke/vertical-gardens-technology-to-reduce-climate-change).

Vertical gardens, especially, which use solar energy have come as a savior to those living in high polluted areas, water stressed and less space environments. The beauty of this arrangement is that more than 90% of the water drives directly to the plant and the absorption amount is lesser as compared to regular absorption of water by the plants [146].

One of the major problems in landscape design in crowded cities, like Cairo, Giza, Tanta, Assiut etc. in Egypt, is looking to find free areas to establish new gardens, also old methods of street trees maintenance still used. We recommend following the new systems of external surfaces cultivated at least for the governmental buildings, using different plant species with higher efficiency in absorbing carbon dioxide (and other common pollutants in every city). Research of Koriesh [17, 139] indicated that the use of *Sciendapsis aureus, Dracaena with narrow leaves (D. marginata), Chlorophytum comosum* and *Aspidistra elatior* plants for cultivating façades and Vertical gardens showed the highest efficiency in the elimination of carbon dioxide.

Also planting *Ficus religiosa, Bauhinia variegate, Cassia nodosa, Eucalyptus camaldulensis and Khaya senegalensis* trees is better in new gardens or replacing old ones when implementing targeted maintenance programs [17, 139].

12.2 Green Walls [147, 144]

The concept of green walls is representative of the green roofs vertical or near the vertical position and is based on the elements of construction vary according to the type of the wall itself and is covered by the structures of plants. This concept is historically the presence of climbing plants next to existing architecture and then used in the coordination and beautification of sites. It is also considered the attention and spread of that system recently because it provides a quick and effective environmental solution to the scarcity of green areas and the impossibility of the development of green areas within the existing building.

Green walls are Vertical gardens on the surfaces where plants are attached to the surface. It is classified as 'green facades' or 'living wall'. On the right hand, green facades are created by directly attaching hanging pots or shrubs to the wall, or attached the plants to the wall using any supporting methods as wires, ropes and meshes either in the form of double skinned green facades or indirect green facades. On the left hand, living walls are created by attaching growing media to the vertical wall, and this relatively new technique is classified as 'continuous living walls' or 'modular living walls' [148, 149]. Green walls can improve air quality. Dunnett and Kingsbury [144] recommended green walls as one of the planting concepts to reduce particulates through deposition. Pollutant reduction along with a footpath in open areas [150]. This system is defined as a wall consisting of a set of plants supported by vertical anchors either on the inner or outer wall and sometimes stand alone. It also includes plants, irrigation and drainage system all within one system.

12.3 Greening with Self Climbing Plants

Often at walls 'self-climbers' are set like *Jasminum grandiflorum Lonicera japonica* and English Ivy, with which climbing assistance is unnecessary. The wall crest must deflect all precipitation, so that no water from above can penetrate. All joints should be closed, so that the impulses of the plants mentioned cannot penetrate there. *Climbing hydrangea*, C*lerodendrum inerme* climbing roses are also suitable [151, 152]

Common climbing plants such as ivy was found suitable for the green wall. The removal potential of pollutants using a green wall was shown to be influenced by plant species, methods of climbing wind, humidity and leaf area index (LAI). We suggest that air pollution tolerance index (APTI) and anticipated performance index (API) should be measured prior to selecting species for the urban gardens.

These considerations were made based on limited defined research, and further investigations research are required to produce guidance for determining the role of green walls on climate change.

12.4 Living Walls

This term refers to innovative technological methods based on prefabricated media, homogeneous soil, or a water system on a vertical surface. This concept can also be referred to as Vertical garden. The need for continuous maintenance and the need for irrigation and drainage systems and the need for fertilizers to be distributed, the cost of installation of living walls is three to five times higher than the cost of installation for the Green Facade system and the cost of replacement of unsuitable plants [153].

It is known that these walls, which occupy some forms of agriculture, are also composed of climbing plants, as *Euonymus fortune, Hedera algeriensis, Hedera colchica, Hedera helix, Hydrangea seemannii*, *Clematis*, *Lonicera henryi*, *Lonicera japonica, Jasminum humile* (yellow jasmine), *Jasminum grandiflorum* and *Jasminum mesnyi* whether of one type or more.

Recently, additional structural elements were used to support the development and growth of plants. These walls are characterized by their environmental benefits of biodiversity, thermal insulation, noise reduction and reducing carbon dioxide and increasing oxygen [154].

12.5 Green Façade

Are the façades that rely on climbing plants that are cultivated in the soil surrounding the building directly or are grown in containers. These plants need structural elements that are supported, cared for and monitored continuously throughout the growth periods. This system is scalable and depends on a wide range of plant species that can be used. These plants (as *Cissus antarctica, Clematis aristata*, *Ficus pumila, Vitis vinifera* and *Wisteria sinensis*) can adapt to the risks and seasonal changes (Considerations for Advanced Green Facade Design).

12.6 Brief History (Green Screen) [153]

In 1920, the use of cabling and cable systems began as a supporting system for climbing plants, allowing them to grow and spread and were used in gardens and houses.

A. In 1988, the use of stainless steel wire systems for the facades and the walls of the plant was started
B. In the early 1990s, the United States of America began to enter the market of green walls and cultivated walls for wider use through systematic innovation
C. In the mid-1990s Patrick Blanc, who was the founder and pioneer of Vertical gardens in the modern era, began to pay attention to this trend due to its great environmental importance.
D. After 1994, the use of green walls in the spaces was started, supported by Bio-Filtration System in Toronto, Canada.

Plants for living wall

(A) Plants for sun	(B) Plants for shade	(C) Edible plants
(i) Bacopa (ii) Campanula (iii) Fuchsia (iv) Impatiens (v) Lobelia (vi) Nasturtiums (vii) Petunia (viii) Pelargonium (ix) Salvia (x) Scabious	(i) Ajuga (ii) Campanula (iii) Heuchera (iv) *Vinca* (v) Viola (vi) Tiarella (vii) Pansies (viii) Wallflowers	i. Lettuce ii. Salad leaves iii. Herbs iv. Tomatoes v. Strawberries vi. *Anethum graveolens* = Dill vii. *Coriandrum Sativum* = Coriander viii. *Petroselinum crispum* = Parsley

12.7 Bio-filtration System

Biofilters represents a new technology that holds great promises for GHG reduction and air pollution control [155]. This system is known as the process of drawing air through organic matter (such as algae, soil, plants, etc.) leading to the removal of carbon oxudes, sulfur oxides, nitrogen oxides, organic gases, volatile organic compounds and contaminants [11].

12.8 Reduced Urban Heat Island (UHI) Effect

Climate change and the heat island effect interact in different ways.

1. First, our warming climate will increase already higher temperatures in heat island areas.
2. Second, cooling strategies to reduce heat islands can help communities adapt to the impacts of climate change.

3. Third, lower the greenhouse gas emissions that cause climate change [25].

The average temperature of the built-up areas is higher than the surrounding rural areas and may be more than 5 °C. This is known as the Urban Heat Island (UHI) phenomenon, which causes a loss of thermal comfort for users and a significant loss of energy used for air conditioning. The use of façade and roofing works to reduce the temperature caused by solar brightness and thermal reflections, thus reducing the phenomenon of thermal islands within the existing building, leading to better temperatures within the architectural spaces [156].

12.9 Purify Air and Reduce Dust

Plants may play a major role in eliminating carbon dioxide (CO_2), where we can eliminate more than half the concentration of carbon compounds by using some plant species [139, 150]:

Acalypha wilkesiana	*Ficus religiosa*
Bauhinia variegata	*Ficus retusa*
Cassia fistula	*Hedera helix*
Chorisia speciosa	*Khaya senegalensis*
Dodonaea viscosa	*Malvaviscus mollis*
Eucalyptus camaldulensis	*Nerium oleander*
Ficus benghalensis	*Schinus terebinthifolius*
	Tipuana speciose

Green walls also can dispose of more than 200 volatile organic compounds (VOC) compounds at their intermediate concentrations and can eliminate other harmful gases such as NO_x, SO_x, formaldehyde, etc. In addition to the ability of plants to dispose of particulate matter and dust, which have many negative effects on the respiratory system and the general health of users. Different types of Vertical gardens that affect climate change through decreasing ambient temperature and carbon dioxide:

Although the walls are cultivated as a principle and method of environmental treatment and aesthetic of the facades, but have three classifications through which we can review all types of Vertical gardens and the three categories differ between them through principle and methods of installation and methods of handling and the quality of plants used and those classifications are:

1. Green Facades
2. Wall Vegetation
3. Living Walls

There is no doubt that the green area is an important element to restore balance in the environment which is in flagrant violation of its natural resources due to the wave of urbanization sweeping many countries and the negative effects. It has on living organisms and on human beings in particular.

Some modern countries have realized the dangers of vegetation cover in disrupting the balance of nature and the environment. This led them to go to the cultivation of land through the revival of the soil again. The vast and extended areas of trees and shrubs in a beautiful aesthetic harmony, as the streets roam Residential neighborhoods until you find yourself in a singing garden, stretching along the opposite street to the houses. Facades are lined with tree-lined trees, shaded with flowers, which usually begin to reveal their splendor in the spring. This green chain of plants has contributed to the city's remarkable urban landscape. Modern cities have become more oriented towards increasing the area of parks and public gardens through the cultivation and beautification of the main streets and sub-streets as well as the streets of residential neighborhoods. The main target is to break the stalemate of buildings and concrete blocks, and make this area shows some of the living aesthetic components that affect the surrounding environment. The comfort that is quickly realized in the hearts of passers-by comes from the visual enjoyment in coordination with aesthetic arrangement. This is shown by cultivation groups of trees and shrubs along the length of the streets and on both sides.

13 Cultivation of Shrubs in Cities to Combat Climate Change

Shrubs are the second largest group of plants cultivated in cities. Because they are always dense vegetative and the number of leaves on them have an important role in reducing the heat of the surrounding environment and absorbing large amounts of CO_2 and losing water by evaporation. It is known that one gram of water requires 633 cal for evaporation. So increasing evaporation water contributes to the reduction of surrounded air then atmospheric temperature. High humidity also contributes to reducing the impact of atmospheric temperature. These two factors contribute to reducing the impact of climate change. Here a present of some of these plants as mentioned from the results of the experiments carried by Koriesh [17].

The shrubs should be carefully selected by specialists so that they can play their role and function to the fullest extent in terms of preventing dust, dust and carbon dioxide.

Afforestation of the suburbs and residential neighborhoods has become an important point in the process of beautifying the cities and making the inhabitants abler to enjoy the outdoor atmosphere and to practice their sport activities without problems or inconvenience.

Taking the simple engineering design to walk at one pace in the decoration and beautification of the streets of the neighborhoods, For the formation and flowering throughout the year, with the existence of green spaces are not enough to be a station to sit on and enjoy with nature.

The use of Hedera helix climbers and Bougainvillea *shrubs which find scattered and abundant in this type of street ornamental agriculture, since they are evergreen and are up to 6 m long, they are suitable as a climber or a shrub.*

They are very sparse, and their leaves are evergreen, simple, reciprocating, oval, full-edged, dark green. Also, *Hedera helix* has a good role in formaldehyde pollutant abatement. The flowers of *Bougainvillea* are multicolored including white, red, purple, orange and sometimes double colors. *Bougainvillea* includes more than 20 varieties, and we find some varieties of hybrid that come in different sizes, and be attractive with flowers that radiate joy and beauty. It increases its coordination value and favors warm, humid climates, but it can withstand high temperatures and grow under direct sunlight and withstand moisture while resisting drought.

13.1 Dodonaea viscosa

Except for Bougainvillea bush, the *D. viscosa* shrub can be cultivated for its low water requirements and high transpiration rate (plants used about 2% for metabolism and transpiration and evaporate the rest [157], beauty and their role for reducing CO_2. It can be cultivated in the form of shrubs and hedges that appear in their natural, drooping and arched shape.

13.2 Schinus terebinthifolius

Brazilian pepper-tree is a shrub or small tree that reaches over 30 feet in height, typically with a short trunk hidden in a thicket of branches. Some trees can live over 30 years. Brazilian pepper is widely grown as an ornamental plant for its foliage and fruit.

Brazilian pepper is hard to control because it produces basal shoots if the trunk is cut. Trees also produce abundant seeds that are dispersed by birds and ants. This same hardiness makes the tree highly useful for reforestation in its native environment, but enables it to become invasive outside of its natural range.

Transpiration of high amounts of water through plants contributes to the reduction of ambient air temperatures. Its efficiency is relatively high in the absorption of CO_2, making it suitable for reducing climate change.

13.3 Lantana camara

A comparative response of *lantana camara* and *Bauhinia variegata* to elevated $CO_{2.}$ Raizada et al. [158] showed that these plants are likely to emerge more competitive in the global change scenario [159].

The rise in CO_2 availability directly impacts photosynthetic processes, evoking a wide range of physiological and morphological responses in plants. These vary among species, depending on differences in photosynthetic pathways, intrinsic growth rates and other properties. Prominent responses include changes in growth rates [160], water use efficiency [161] and nutrient uptake rates [162].

Elevated CO_2 significantly promoted the growth of seedlings of different plants. At the end of experiment carried by Raizada et al. [158], maximum percent enhancement was observed in *L. camara,* meanwhile, *B. variegata* responded least to elevated CO_2. *L. camara* shrubs are therefore more efficient to remove carbon dioxide than *B. variegata* (Table 1). Also, maximum mass was allocated to roots in *L. camara* under both ambient and elevated CO_2. Increased mass allocation to stem was observed for *L. camara* under elevated CO_2.

NAR ($mg\ mg^{-1} d^{-1}$) of *Lantana camara* increased in response to elevated CO_2, but NAR of *Bauhinia variegata* was not affected, negatively or positively, by increasing the concentration of carbon dioxide in the environment around plants. These studies of Raizada et al. [158] showed that growth responses of ornamental trees and shrubs plants to elevated CO_2 varied among species, some showing greater increases in shoot length and biomass accumulation than others. However, biomass accumulation under elevated CO_2 was greater in *Lantana camara* than in the woody trees as *Bauhinia variegata*. Other studies have also shown an increase in overall biomass of *Lonicera japonica* [159]. NAR as well as RGR increased under elevated CO_2 in *Acacia catechu*, *Bauhinia variegata*, *Dalbergia latifolia*, *Tectona grandis*, *Hyptis suaveolens* and *Lantana camara*.

In conclusion, under the elevated CO_2 in future, photosynthesis and growth of plants increased [163].

Trees also used for afforestation include other types of plants, *Ficus religiosa, Bauhinia variegate, Cassia nodosa, Eucalyptus camaldulensis* and *Khaya senegalensis* (Table 2).

Afforestation and Environmental Gardens and Their Impact on Climate Change

The environment is the framework in which man's life. Human behavior, air quality and the emission of responsible gases affect the warming of the atmosphere and the consequent effects of changes in the global map.

13.4 Climate Change and Changes in the Global Map

The climate is changing as a result of global warming. Many areas will become warmer and fewer will be colder. The countries where the temperature will rise are Russia, Scandinavia, Canada, Egypt and others. The climate will be adjusted to moderate and suitable for the growth of many crops, strategic or otherwise, for positive feedback cycles.

We do not deny that many countries are warming the world in their favor, so they will not do anything seriously to reduce the accumulation of carbon dioxide, even though it is responsible for the pollution that increases the temperature of the earth which increases the melting of not less than the ice sheet on the southern continent.

14 The Impact of Industrial Development and Agricultural Development on the Environment

We have to ask ourselves why the land has been suitable for life for more than three billion years, despite its vulnerability to many disasters. Nevertheless, it maintains balance through feedback through the rotation of elements in the food chain to preserve its existence. What is now suffering from pollution is due to the industrial boom and the economic growth rate of many countries, in addition to changing the pattern of consumption of the population. The industrial boom has caused many pollutants, whether in air, water or as solid wastes. Agriculture and technologies try to cover the high requirements required by growth have also affected the hectic race by using fertilizers to increase crop rates, as well as the use of pesticides.

Tree or plant leaves filter pollutants from the air. After Wang [164] one urban park, tree cover detached 48 lb of PM, 9 lb of NO_2, 6 lb of SO_2, 0.5 lb of CO and 100 lb of carbon—daily. Beside other pollutants including ozone and methane through the most important in the World photosynthesis. Trees sucking carbon dioxide (greenhouse gas) and releases oxygen in air. Trees store or sequester the carbon dioxide, and—depending on the size of the tree—can hold between 15 and 350 kg of carbon dioxide each year [25, 165]. Many trees take decades to reach full size, and in this fast-paced world, not everyone has the patience to wait that long. The impact of climate change on many countries in the world, particularly those in North Africa, including Egypt, is rapidly increasing due to the rapid deterioration of the global environment. Trees contribute to reducing global climate degradation. So, gardeners are looking for the fastest growing and efficient trees with high efficiency in CO_2 or other GHG. It is also best to have an efficiency in improving air temperature to help reduce the effects of CO_2 on climate change.

14.1 Fast Growing Trees

Some scientific views say trees that grow quickly should be avoided, because of weak wood, numerous pests and diseases, invasive roots, a short life span, or other undesirable qualities. Meanwhile, environmental protection workers say that fast-growing trees have high absorption efficiency in their early growth and the old trees often have very few vegetative parts that can clean pollutants. Here are some of the fastest growing trees that grown in Egypt.

1. *Albizia* (Mimosa Tree)
2. *Morus* spp. (White and Red Mulberry)

3. *Pinus* spp. (Pine)
4. *Populus* (Lombardy poplar)
5. *Paulownia tomentosa* (Empress Tree)
6. *Salix matsudana*
7. White willow (*Salix alba*)

14.2 Shrubs

Cultivable shrubs vary in different areas. In landscaping, the best to help in climate change reduction factors should be chosen. All are always looking for the most CO_2 absorption plants for either the leaf area unit or the hole mature plant. We also look for the most plants that have evaporation of water that requires energy taken by the plant from the air. Taking into account the rest of the contaminants (Tables 1 and 2).

Tree crown size is a key variable in this context as it correlates with the space. A tree occupies as well as with the physiological tree functions. Crown prolongation area and crown volume, can be used as proxy variables for leaf area and leaf biomass [166].

14.3 Benefits of Planting Trees

Planting trees is massively beneficial to the world in the face of hastening climate change [167]. There is nowadays a strong international scientific agreement that human activity is beginning global warming. A considerable drop in the planet's forest cover over last and recent centuries is a major sponsor to this climatic change [137]. As trees grow they absorb carbon dioxide (CO_2), the first main 'greenhouse gas' responsible for global warming, thereby reducing the concentration of this gas in the atmosphere. Methane is the second greenhouse gas responsible for global warming, some trees can reduce the concentration of this gas in the atmosphere.

Carbon absorption rates in trees depend on the species and the location. Fast-growing species in tropical climates can sequester CO_2 many times faster than the average European forest, and plantation projects aimed at earning carbon credits are typically designed to maximize the sequestration potential.

Over a 20-year lifecycle, the right species in the right conditions can absorb over 40,000 tons of CO_2 per km^2. So, a plantation of 100 km^2 can absorb 4 million tons of CO_2 over 20 years. That is equivalent to taking 50,000 cars or more off the road during that time (based on annual emissions of 3–4 tones for the average car and its usage).

15 The Foundations and Rules of Environmental Afforestation in Cities

15.1 Introduction

1. Governments are doing a great deal to increase afforestation, parks, public parks, children's playgrounds and the multiple services needed to improve the environment.
2. Some home owners also contribute to this work.
3. Afforestation and the increase of green areas are among the most important facilities that municipalities compete to show their care for the city especially in areas that subjected to high temperatures, dust and sand storms.
4. This is due to the importance of plants in preserving the environment and adapting the local climate and its diversity.
5. It is important to choose the most efficient plant species adapted to the environment.
6. The scientific foundations of the afforestation within the cities should be followed and the plants should be distributed in the streets and parks.
7. Be careful not to plant useless plants in the streets and parks that may cause harm such as species that produce positive ions [168–170].
8. For afforestation foundations and controls must be observed in the gardens of the streets and the islands and the middle and in front of houses, parks and public parks to achieve the environmental role, climate change and health of plants and increase environmental efficiency in cities.

15.2 Some Characteristics of Local-Friendly Species

The environmental conditions of the area to be cultivated should be identified in order to select appropriate and suitable plant species to be cultivated for planting

When selecting these trees, the following characteristics shall be met:

a. Have a high capacity to withstand the local environmental conditions of the area where they are grown in terms of high temperature and pollution.
b. Its high efficiency in carbon dioxide absorption.
c. The wood has a high density, which indicates efficient storage of carbon dioxide.
d. High efficiency in lowering the temperature in the surrounding air.
e. It has high resistance to insect and pathogenic infections or worms.
f. Fast and dense growth and abundant branch.
g. It has a deep root and is not spread horizontally so as not to hinder the growth of other plants and does not affect neighboring facilities.
h. The nature of its growth, the shape of its crown and height, corresponds to the place where it is grown and the purpose of its cultivation.

i. Plant seedlings are of sufficient size and age at planting to ensure their success
j. Its condition is good in terms of vegetative and root growth and sound from fractures and pests.
k. Are locally available and require minimal care and costs during their cultivation and growth. Reproduce easily.

15.3 Plant Cultivation and Use Functions: Environmental Function

Plants have great value in the urban environment. Its lack or lack of numbers harms the environmental balance in the region. This role can be summarized in the following points:

- The plant absorbs carbon dioxide and is one of the main causes of pollution and the release of oxygen gas. This process is the most important process in the universe.
- Reduce pollution levels from most types of pollutants by absorbing them.
- Plants emit oxygen in the atmosphere through photosynthesis, thereby reducing the proportion of pollutants.
- Optimizing the atmosphere through the process of transpiration and improvement of the climate the presence of plants in a place to reduce the temperature, especially during the summer. It is known that every 1 g of water lost by the plant requires 633 kcal, which the plant withdraws from the surrounding medium, thus lowering the temperature.
- Relieve the glare of the sun and dazzle the eyes with intense light. Where the leaves of the trees intercept sunlight, absorbing part of it and reflect some of the other rays.
- Contribute to the absorption of sounds and reduce the noise, especially in crowded places in cities and succession.
- Stop sand crawling and reduce desertification.
- Protect cities from severe winds and break their limits.

The studies we conducted in Egypt showed that the shrubs cultivated in Egypt differ in their application to get rid of carbon dioxide, and some shrubs have greater efficiency (Table 1).

Bougainvillea glabra is superior to all shrubs that have been studied in the disposal of carbon dioxide after 5, 10 and 15 min of exposure to this pollutant. The efficiency value was more than twice that of *Hedera helix* and thrice as *Lantana camara* and 4 times as *Malvaviscus mollis* and 10 times as *Nerium oleander*.

From this, it is important to plant shrubs intensively in the city parks:

1. Fast growth
2. High efficiency of some varieties to get rid of carbon dioxide that causes global warming

3. Its efficiency in transpiration rate as mmol m^{-2} min^{-1} is higher than the trees (Table 2), which has a high effect, at least theoretically, in the absorption of atmospheric temperature.

Shrubs, generally, are evergreen and may reach a height of four meters at full growth. They are usually planted in small gardens instead of trees. The shrubs are used in many coordination purposes, which can be summarized as follows:

(a) Cultivation in groups close together to form a single vegetable mass used in the design of natural parks such as *Schinus* and *Lantana*.
(b) Cultivation as individuals each with its characteristic and specific and attractive to look like Queen of the night.
(c) Cultivation in front of buildings such as jasmine.
(d) Cultivation in the corners to fill spaces such as *Duranta*.
(e) Cultivation to establish gradient between trees and grasses, such as Lantana
(f) Cultivation for hytonocides as roses.
(g) Cultivation as groundcover plants such as *Dodonaea.*
(h) Cultivation to give the color of the gardens.
(i) Cultivation as Plant fencing.

16 Future Roles and Regulations in Urban Afforestation

It is best to cultivate the streets of all types of plants, taking into account the relationship with the type of coordination and nature of plant growth.

The types of plants grown in a street or garden that have been established in a specific area of a particular city vary according to the following criteria:

1. Plants planted on a street or a specific area shall be suitable for the quantity and quality of pollution in the area
2. Be resistant to diseases and insect pests
3. The distance of agriculture depends on the amount of pollution and the number of cars and street view
4. The distance between each tree depends on the nature of tree growth and the value of LAI
5. Highly polluted areas can be cultivated more than a row or the use of high-efficiency shrubs
6. Take into account the pruning of trees in a scientific manner sound where there is a difference between pruning and cutting used in many cities in Egypt
7. All trees have a lifetime to give them the highest efficiency of their functions, so must work out a plan for replacement and continuous renewal to ensure their role environment
8. Some of the older trees can be renewed or vaccinated with new, more active branches

9. All trees are not renewed at the same time to ensure the safety of the environment
10. Some falling leaf species such as *Ficus religiosa* can be used to ensure that there is sufficient vegetation
11. Scientifically known that carbon dioxide in the air is about 18–20% lower in the winter
12. The streets were planted inside the cities according to the specialists and each case separately
13. It is better not to use high trees in VOC emissions
14. The importance of tree planting in Egypt should be eliminate and store the largest amount of carbon dioxide
15. Reduce the temperature in the surrounding environment provide adequate shade in different places. The other objectives then come
16. The nature and size of plant growth must be consistent with the size and nature of the street and the conditions of the site in which it is grown and the surrounding facilities
17. The branches of trees shall not be exposed to intertwining with wires and others
18. In terms of protecting the environment, it is best to plant each street with more than one type of tree, which will vary in efficiency in combating pollution
19. In my view, the use of organic fertilizers reduces the cultivation of trees in the streets for the following reasons. Reduce the presence of a host of microbes
20. It is scientifically known that organic matter in the agricultural environment is a source of methane emissions and is more dangerous to climate change than CO_2.

16.1 Central Islands

1. Planted with high soil coverings to increase the absorption efficiency of CO_2 or dense dendritic groups
2. The central islands are an important means of increasing the number of plants on the streets
3. It is usually planted with shrubs, long grass plants, soil coverings and green areas
4. The type of plant depends on the presentation of the place
5. If it is broad, it can be planted with trees and shrubs of environmental importance
6. If they are narrow, they are planted with vegetative structures that can be formed and are environmentally beneficial.
7. If the islands are of great lengths and wide as in the roads between cities or different sectors can be planted with types of trees with water needs converged to be easy to maintain, and preferably trees flowering to beautify the streets.

Regulations to Consider When Selecting and Growing Plants in the Central Islets:

1. The intensity of plant cultivation depends on the density or amount (number) of contaminants that may be present in the area

2. It is preferable to be specially planted trees in the middle of the islands with high legs and fork high so as not to hinder the movement of pedestrians or cars
3. Do not grow large trees at the intersection of roads or at the top of the islands in the streets so as not to impede the path of sight of drivers, noting that leave at least 30–50 m around the road crossings without planting trees or large plants
4. This area can be cultivated with low-altitude grass plants and soil coverings
5. It is preferable to cultivate medium-sized islands using high-growth plants that are highly efficient in absorbing pollutants and low in water and contribute to heat reduction (Fig. 8)
6. It is enough to plant hedges or soil reservoirs with a height of not more than 50 cm for the roads that are being constructed and to re-examine the previously created roads and remove trees obstructing the vision.

16.2 Main Steps for Afforestation Within Cities

1. Determine the objective of agriculture.
2. Determine the location of agriculture Is it a street or a middle island.
3. Is the chosen location close to industrial areas?
4. Determine the appropriate plant quality according to the pollution intensity and temperature.
5. Implementation of the process of agriculture according to sound scientific basis and according to the type and nature of plant growth.

16.3 The Roles or Foundations of Afforestation for Environmental Conditions

A common mistake is to cultivate any plant species before they are studied, especially for important traits such as tolerant type of pollutants, CO_2 absorption efficiency, high heat reduction, drought tolerance and high salinity tolerance.

Existing trees should be reviewed according to recent scientific information related to the efficiency of CO_2 absorption and heat reduction. It may be necessary to change trees or other types of plants because of their lack of success and performance of their local environmental functions or contain a toxic substance or contain some undesirable qualities.

17 Types of Urban Garden Plants that Contribute to the Direct or Indirect Climate Change. Common Problems in Egypt

17.1 High-Temperature Tolerant Plants

Palm trees: *Phoenix dactylifera;* trees: *Tamarix* spp.—*Acacia* spp.—*Poinciana. Delonix regia*—*Opuntia* spp.—*Bogainvillea* spp.—*Nerium oleander*—*Dodonaea viscosa*—*Cupressus* spp.—*Schinus molle*—*Casuarina* spp. —*Albizzia Lebbek*—*Ziziphus spina-christi*—*Hyphaene thebaica*—*Azadirachta indica*—*Eucalyptus* spp. *Parkinsonia aculeata*—*Populs* spp.—*Washtunia palms*—*Creatonia siliqua*—*Melia azedarach*—*Olea europaea*—*Conocarpus erectus;* shrubs: *Lantana camara.*

17.2 Plants Reduce Methane

- *Araucaria* spp.
- Pine.

17.3 Plants for Phytoncides (Aromatic Volatile Substances)

- *Cassia nodosa*—*Bauhinia*—*Acacia farnesina*.

17.4 Plants Resistant to Smoke and Dust

- *Tamarix* spp.—*Nerium oleander*—*Melia azedarach*—*Ficus* spp.—*Hibiscus* spp.—*Eucalyptus* spp.—*Populs* spp.—*Phoenix* spp.

18 Attenuation of Gaseous Pollutants by Greenbelts

Importance of greenbelts in attenuating gaseous pollutants and presents the meteorological, physicochemical, biological, and horticultural dimensions associated with effective greenbelt design [171, 168]. They have presented the gist of a system of methodologies, developed by us, for greenbelt design. A case study demonstrating the applicability of the system has been presented.

18.1 What Is Greenbelt?

Greenbelt (Fig. 9) is a strip of trees of such species, and such a geometry, that when planted around a source, would significantly attenuate the air pollution by intercepting and assimilating the pollutants in a sustainable manner [172].

In reality greenbelts almost always include other vegetation, especially shrubs, which also play some role in capturing pollutants. However, trees are the mainstays of greenbelts, and often greenbelt plantation is simply referred as 'trees' even though other types of vegetation is also established and nurtured.

The concept of greenbelt as a source of pollution abatement was recognised initially by three nations:

1. The U.S.A.,
2. Britain and
3. Kenya [172].

Ebenezer Howard, a British social reformer, advanced the concept of greenbelt in 1898, in connection with the planning of 'new towns' located outside the periphery of London, which was then sprawling far into the countryside. Howard proposed 'garden cities' which would not only be free of pollution but would also be antidote of polluted cities, each of which would be surrounded by an agriculture 'country belt'.

It was British architect and planner Raymond Unwin, a town designer and contemporary of Howard's, who coined the term greenbelt [172].

In Britain, Howard's concept took two forms: the greenbelts surrounding the new towns in rural Britain (the first of these was Letchworth, built in 1903); and, beginning in the 1930s, the application of the idea to London itself.

The London Green Belt Act was passed by the British Parliament in 1938. A more decorative plan was created in 1944 by Patrick Abercrombie, who proposed a belt, five or more miles wide, consisting of both public open spaces and private properties that would be regulated to preclude runaway suburban development [173].

Three such towns were built with Greenbelt, Maryland, being the best known. In the American concept of greenbelt, relatively wide band of rural land or open space surrounded a town or city. The term greenbelt meant. Generally, any swath

Fig. 9 Greenbelt and central islets to reduce air pollutants (Ismailia Governorate, Egypt)

of open space separating or interrupting urban development. A land so designated is controlled through regulation or public or quasi-public ownership (such as the Nature Conservancy) to retain its natural character and provide a resemblance of rural ambience in urban or urbanizing areas [172].

The central goal of Roosevelt's greenbelt programme, an innovative and radical intervention in American city building, was not to create better urban communities, but rather to generate jobs in a declining national economy.

18.2 Air Pollutant Uptake by Vegetation

Vegetation acts as CO_2 sink, and some species can utilize air pollutants effectively. Plants also intercept tones of dust and serve as acoustic screens on busy highways and noisy factory areas. Several plants can collect the dust suspended in the atmosphere and dilute the concentration of toxic and harmful gases like SO_2, CO_2, etc. Trees have been reported to remove air pollutants like hydrogen fluoride, SO_2, and some compounds of photochemical reactions and collect heavy metals like mercury (Hg) and lead (Pb) from the air [174, 175].

After absorbing the air pollutants, trees change them to harmless metabolites through various physiological processes. Of course, every plant can not be an agent of air pollution control; only those which can tolerate pollutants can act as attenuators [176]. All-in-all, increasing vegetation in the cities, towns, and industrial establishments holds great potential to combat air pollution.

Plants remove pollutants from the air in three ways, viz.

1. Absorption by the leaves,
2. Deposition of particulate and aerosols on leaf surface, and
3. Fallout of particulate on the leeward (downwind) side of the vegetation because of the slowing of the air movement [177, 101].

18.3 Removal of Gaseous Pollutants

Amble evidence is available to support the view that plants in general and trees in particular function as sinks for gaseous pollutants (and other pollutants by roots, phytoremediation). The latter are transferred from the atmosphere to vegetation by the combined forces of diffusion and flowing air movement. Once in contact with plants, gases may be bound or dissolved on exterior surfaces or be taken up by the plants via stomata. If the surface of the plant is wet and if the gas is water soluble, the former process can be very important.

When the plant is dry or in the case of gases with relatively low water solubility, the mechanism is assumed to be the most important [178]. Plant uptake rates increase as the solubility of the pollutant in water increases. Hydrogen fluoride, sulphur dioxide, nitrogen dioxide, and ozone which are soluble and reactive are readily sorbet pollutants. Nitric oxide and carbon monoxide, which are very insoluble, are absorbed relatively slowly or not at all by vegetation.

During daylight periods when plant leaves are releasing water vapor and taking up carbon dioxide, other gases, including trace pollutant gases, in the vicinity of the leaf are also taken up through the stomata [178]. The rate of pollutant gas transfer from the atmosphere to interior leaf cells is regulated by the resistance posed by atmospheric, stomatal, and mesophilic factors, more specifically wind speed, leaf size and geometry, gas viscosity and diffusivity. Stomatal resistance is regulated by the stomatal aperture, which is influenced by water deficit, carbon dioxide concentration, and light intensity. Mesophilic resistance is regulated by gas solubility in water, gas-liquid diffusion, and leaf metabolism [179]. Because the rate of pollutant uptake is regulated by numerous forces and conditions, the rate of removal under field conditions is highly variable.

If leaf characteristics, wind speed, atmospheric moisture, temperature, and light intensity are quantified, the pollutant uptake rate can be estimated. Under growth-chamber conditions, wind velocity, canopy height, and light intensity were shown to affect the rate of pollutant removal by vegetation. As previously stressed, light plays a critical role in determining physiological activities of the leaf and stomatal opening, and as such exerts a great influence on the foliar removal of pollutants. Under conditions of adequate soil moisture, however, pollutant uptake by vegetation was judged almost constant throughout the day, as the stomata were fully open. Pollutants were absorbed most efficiently by plant foliage near the canopy surface where light-mediated metabolic and pollutant diffusivity rates were greatest.

Sulphur and nitrogen dioxides were taken up by respiring leaves in the dark, but uptake rates were greatly reduced relative to rates in the light. The Removal of sulphur dioxide is also described by tree uptake process. Because of its high solubility in water, large amounts of sulphur dioxide are absorbed into external tree surfaces when they are wet. In the dry condition, sulphur dioxide is readily absorbed by tree leaves and is rapidly oxidised to sulphate in mesophyll cells [178].

18.3.1 All Plants Absorb Carbon dioxide, but Trees are Best

While all living plant matter absorbs CO_2 as part of photosynthesis, trees process significantly more than smaller plants due to their large size and extensive root structures.

In essence, trees, as kings of the plant world, have much more "woody biomass" to store CO_2 than smaller plants, and as a result, are considered nature's most efficient "carbon sinks". It is this characteristic which makes planting trees a form of climate change mitigation. According to the U.S. Department of Energy (DOE), tree species that grow quickly and live long are ideal carbon sinks. Unfortunately, these two attributes are usually mutually exclusive. Given a choice, foresters interested in maximizing the absorption and storage of CO_2 (known as "carbon sequestration") usually favor younger trees that grow more quickly than their older cohorts. However, slower growing trees can store much more carbon over their significantly longer lives.

18.4 Fastest Growing Trees (Ideal as Carbon Sink According to [180])

1. Royal Empress, *Paulownia* (growth per year: 3–5 m);
2. Willow Hybrid, *Salix* (growth per year: 3–4 m);
3. Lombardy Poplar, *Populos* (growth per year: 2.5–3 m);
4. Eucalyptus Tree, *Eucalyptus* (growth per year: 2–3 m);
5. Red Rocket Crape Myrtle, *Lagerstroemia* (growth per year: 1–2 m);
6. Cleveland Flowering Pear, *Pyrus calleryana* (growth per year: 1–2 m) and
7. River Birch, *Betula nigra* (growth per year: 0.5–1 m).

Plant the Right Tree in the Right Location

Scientists are busy studying the carbon sequestration potential of different types of trees depending, besides the species, upon location, climate, and soils.

Dave Nowak, a researcher at the U.S. Forest Service's Northern Research Station in Syracuse, New York has studied the use of trees for carbon sequestration in urban settings across the United States.

A 2002 study he co-authored lists the Common Horse-chestnut, Black Walnut, American Sweetgum, Ponderosa Pine, Red Pine, White Pine, London Plane, Hispaniolan Pine, Douglas Fir, Scarlet Oak, Red Oak, Virginia Live Oak and Bald Cypress as examples of trees especially good at absorbing and storing CO_2. Nowak advises urban land managers to avoid trees that require a lot of maintenance, as the burning of fossil fuels to power equipment like trucks and chainsaws will only erase the carbon absorption gains otherwise made.

19 Conclusion

Trying to save our global, urban or city gardening as a sort of horticultural strategies can dealing with climate change. We want to begin thinking now not just about what used to be, but what may be, generally contributing the city regions to be sustainable socially, economically and environmentally. Climate change goes to pressure us to paintings difficult at something *Homo sapiens* has never been good. An urban gardens like our own family's is a great location to begin. Climate change is a international problem, but its remedy begins with people or communities. Measures to combat climate change encompass 2 primary titles:

1. Removal of the maximum greenhouse effective gases, specifically methane, carbon dioxide, sulfur oxides, nitrogen oxides, particulates and nucleoids
2. Decreasing causes of greenhouse gas emissions.

Urban gardens, including street trees, public gardens, recreation parks and greenbelts especially that designed around the industrial areas can help mitigation of climate change. Additionally, include non-public gardens of a wide variety in or outside residential privacy, and modern or new gardens along with one-of-a-kind sorts of vertical gardens. New plant species stand up in these situations. The soil in gardens is a reminder that things can change.

20 Recommendations

Based on the identification of the United Nations of factors affecting climate change, and the scientific information on the modern environmental roles of plants, both in the elimination of one or more of the causes of global warming in addition to absorption of different radiation and its role in reducing air temperature. Also, water professionals count on rapidly increasing water stress and water scarcity. To cope with those demanding situations, there may be a need for the creation of social corporations so one can work in partnership with governments and the international community on mitigating climate change by way of growing sustainable urban gardens. Urban agriculture additionally provides social, environmental and educational advantages to residents.

So, the main recommendations of this work is to place out the advantages of urban agriculture for reducing climate change and preserving sustainable urban environments, and a few advisees, briefly are below:

1. Municipality planning and landscape gardeners in conjunction with the Ministry of the Environmental Affairs have to review planning methods and undertake scientific foundations while choosing garden plants and verifying non-emission farming structures that may be harmful to the environment when dealing with soil during soil preparing for agriculture.
2. Look for ways or means to change the plants that are not environmentally friendly plants, with no harm to the soil.
3. Climate change affects and is affected by all countries, but its treatment must begin with the actions of individuals, which requires the provision of appropriate means of awareness in urban communities.
4. Gardeners should not lose sight of the importance of reducing water consumption, at least through selecting C_4 and CAM plants for their low water needs. Taking into consideration their environmental importance and their efficiency in eliminating greenhouse gases.
5. Reduces climate change as urban agriculture contributes to the prevention of the over-heating of city environments (Urban Heat Islands).
6. Urban agriculture offers proper land control and use for urbanized areas.

7. Social and psychological benefits, such as food security in home gardens, personal psychological effects, community cohesion and well-being; and ecological benefits, such as air quality, soil quality.
8. Urban agriculture has contributed for a long-time to keep all kinds of pollutants inside the metropolitan inside positive affordable limits.
9. Gardens are one of the maximum valuable legacies that we are able to go away for future generations.

Acknowledgements We would like to express our deepest appreciation to Prof. Dr. Fouad Hassan, Prof. Dr. M. Abd El Mohsen, Prof. Dr. Khaled Ibrahim and Dr. Mahmoud Mokhtar Hefni who provided us with the possibility to complete this chapter.

References

1. World Bank (2009) Training material case study, Egypt: the Nile delta drainage project Agriculture and Rural Development Department. The World Bank, USA Public Disclosure Authorized EGYPT, The Nile-delta drainage project. http://documents.worldbank.org/curated/en/251421468246925594/pdf/UNN1780Box338884B01official0use0only1.pdf
2. El-Shahawi M (2004) Climate change and some potential impacts on Egypt. First national symposium in climate change and its impacts on Environment in Egypt. National IGBP & SCOPE Committee and Suez Canal University, Ismailia, Egypt
3. Abdalla Z, Yunsheng L (2015) Impact of climate change on agriculture sector in Egypt and China. In: 4th International conference on agriculture and horticulture. https://doi.org/10.4172/2168-9881.s1.016
4. NASA (National Aeronautics and Space Administration) (2018) Global climate change. Vital signs of the planet. A blanket around the Earth. Available at: https://climate.nasa.gov/vital-signs/sea-level/
5. UNEP/EWWP (1998). Major environmental assessments. Global environment outlook. United Nations Environment Programme (UNEP). Oxford University Press, New York. http://www.grid.unep.ch/geo2000/
6. Eid MH (1999) Climate change studies on Egyptian agriculture. Egypt–US workshop on Global Climate Change, NARSS, EEAA and USEPA, Cairo, Egypt
7. Knickmeyer E (2008) In Egypt upper crust gets the bread. Published in the Washington Post Foreign Service. http://www.washingtonpost.com/wp-dyn/content/article/2008/04/04/AR2008040403937.html?hpid%253Dmoreheadlines&sub=AR
8. NASA (National Aeronautics and Space Administration) (2019) Global climate change. Warming seas may increase frequency of extreme storms. https://climate.nasa.gov/news/2837/warming-seas-may-increase-frequency-of-extreme-storms/
9. Wang ZP, Han SJ, Li HL, Deng FD, Zheng YH, Liu HF, Han XG (2017) Methane production explained largely by water content in the heartwood of living trees in upland forests. J Geophys Res 122:2479–2489
10. Thomey ML, Ford PL, Reeves MC, Finch DM, Litvak ME, Collins SL (2014) Climate change impacts on future carbon stores and management of warm deserts of the United States. Rangelands 36(1):16–24
11. Darlington (2004) An integrated indoor air biofiltration system for municipal infrastructure. Nedlaw Living Walls, Air Quality Solutions Ltd. University of Guelph, Canada, pp 1–50
12. Sundqvist E, Vestin P, Crill P, Persson T, Lindroth A (2014) Short-term effects of thinning, clear-cutting and stump harvesting on methane exchange in a boreal forest. Biogeosciences 11(21):6095–6105

13. Sundqvist E, Crill P, Mölder M, Vestin P, Lindroth A (2012) Atmospheric methane removal by boreal plants. Geophys Res Lett 39(21):1–6, L21806
14. Nowers N (2016) The effect of an oregano oil extract in a lactating dairy cow diet on production responses of Holstein cows. Doctoral dissertation, Stellenbosch University, Stellenbosch
15. Hristov AN, Lee C, Cassidy T, Heyler K, Tekippe JA, Varga GA, Corl B, Brandt RC (2013) Effect of *Origanum vulgare* L. leaves on rumen fermentation, production, and milk fatty acid composition in lactating dairy cows. J Dairy Sci 96(2):1189–1202.
16. Kim KJ, Kil MJ, Song JS, Yoo EH, Son KC, Kays SJ (2008) Efficiency of volatile formaldehyde removal by indoor plants: contribution of aerial plant parts versus the root zone. J Am Soc Horticult Sci 133(4):521–526
17. Koriesh EM (2018a) Studies on air pollution 3: evaluation of some ornamental trees and shrubs for transpiration and reducing atmosphere temperature. In: The 8th international Arabic conference, Ismailia, Egypt, Ismailia, Egypt
18. Ralph L, Wood R, Tarran J, Torpy F, Burchett M (2004) Removal of benzene by the indoor plant/substrate microcosm and implications for air quality. Water Air Soil Pollut 157:193–207
19. Abalos D, Sanchez-Martin L, Garcia-Torres L, Van Groenigen JW, Vallejo A (2014) Management of irrigation frequency and nitrogen fertilization to mitigate GHG and NO emissions from drip-fertigated crops. Sci Total Environ 490:880–888
20. Ussiri D, Lal R (2013). The role of fertilizer management in mitigating nitrous oxide emissions. In: Soil emission of nitrous oxide and its mitigation. Springer, Netherlands. 978-94-007-5363-1, 978-94-007-5364-8
21. Ingram DS, Vince-Prue D, Gregory PJ (2008) Science and the garden: the scientific basis for horticultural practice. Blackwell Publishing, Chichester
22. Lou XF, Nair J (2009) The impact of landfilling and composting on greenhouse gas emissions—a review. Biores Technol 100(16):3792–3798
23. Van de Kamp ME, van Dooren C, Hollander A, Geurts M, Brink EJ, van Rossum C, Biesbroeka S, Ede Valkc IB, Toxopeusand, Temme EH (2017) Healthy diets with reduced environmental impact? The greenhouse gas emissions of various diets adhering to the Dutch food based dietary guidelines. Food Res Int 104, 14–24
24. Audsley E, Brander M, Chatterton J, Murphy-Bokern D, Webster C, Williams A (2009) How low can we go? An assessment of greenhouse gas emissions from the UK food system and the scope to reduce them by 2050. WWF-UK
25. EPA (Environmental Protection Agency) (2017) What to plant. EPA Government. Available at: https://www.epa.gov/watersense/what-plant
26. Sutton M, Reis S, Skiba U, Nemitz E, Beier C, Butterbach-Bahl K, Cellier P, de Vries W, Erisman JW (2011) Nitro Europe IP—the nitrogen cycle and its influence on the European greenhouse gas balance. Final Report to the European Commission (Publishable Activity Report), pp 1–44
27. Livesley S, Dougherty B, Smith A, Navaud D, Wylie L, Arndt S (2010) Soil-atmosphere exchange of carbon dioxide, methane and nitrous oxide in urban garden systems: impact of irrigation, fertilizer and mulch. Urban Ecosyst 13:273–293
28. Okano K, Machida T, Totsuka L (1988) Absorption of atmospheric NO_2 by several herbaceous species, estimation by the ^{15}N dilution method. New Phytol 109:203–210
29. Butterbach-Bahl K, Baggs E, Dannenmann K, Zechmeister-Boltenstern S (2013) Nitrous oxide emissions from soils: how well do we understand the processes and their controls? Electronic supplementary material is available at http: http://rstb.royalsocietypublishing.org
30. Signor D, Cerri C, Conant R (2013) N_2O emissions due to nitrogen fertilizer applications in two regions of sugarcane cultivation in Brazil. Environ Res Lett Bristol 8(1):1–9
31. Follett RF, Shafer SR, Jawson MD, Franzluebbers AJ (2005) Main content area research and implementation needs to mitigate greenhouse gas emissions from agriculture in the USA. Soil Tillage Res 83(1):159–166
32. Shcherbak I, Millar N, Philip Robertson G (2014) Global metaanalysis of the nonlinear response of soil nitrous oxide (N_2O) emissions to fertilizer nitrogen. Proc Natl Acad Sci USA 111(25):9199–9204

33. Millar N, Doll JE, Robertson GP (2014) Management of nitrogen fertilizer to reduce nitrous oxide (N_2O) emissions from field crops. In: Climate change and agriculture fact sheet series, MSU Extension Bulletin E, 3152. Available at: https://lter.kbs.msu.edu/wp-content/uploads/2014/12/Nitrogen-fertilizer_climate-fact-sheet_FINAL.pdf
34. Hultgreen G, Leduc P (2003) The effect of nitrogen fertilizer placement, formulation, timing, and rate on greenhouse gas emissions and agronomic performance. Agricult Agr-Food Canada & Prairie Agricultural Machinery Institute, Swift Current
35. Cavigelli MA, Del Grosso SJ, Liebig MA, Snyder CS, Fixen PE, Venterea RT, Leytem AB, McLain JE, Watts DB (2012) US agricultural nitrous oxide emissions: context, status, and trends. Front Ecol Environ 10(10):537–546
36. EPA (Environmental Protection Agency) (2016) Sulfur dioxide (SO_2) pollution. https://www.epa.gov/so2-pollution/sulfur-dioxide-basics
37. Zhang X, Zhou P, Zhang W, Zhang W, Wang Y (2013) Selection of landscape tree species of tolerant to sulfur dioxide pollution in subtropical China. Open J For 3(4):104–108
38. Mohajan HK (2014) Mini review Chinese sulphur dioxide emissions and local environment pollution. Int J Sci Res Knowl 2(6):265–276
39. Han Y, Li Z, Liu R (2002) Potential of purifying SO_2 of main tree species and their planting quota in Shenyang area. Ying yong sheng tai xue bao = J Appl Ecol 13(5):601–604
40. El-Sadek M, Koriesh E, Fujii E, Moghazy E, Abd El-fatah Y (2012) Correlation between some components of interior plants and their efficiency to reduce formaldehyde, nitrogen and sulfur oxides from indoor air. Int Res J Plant Sci 3(10), pp 222–229. ISSN: 2141–5447
41. IPCC (Intergovernmental Panel on Climate Change) (2006) Solid waste disposal. In: IPCC guidelines for national greenhouse gas inventories, vol 5: waste. Online at http://www.Ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_3_Ch3_SWDS.pdf
42. IPCC: Climate Change (2014) Mitigation of climate change, contribution of working group III to the fifth assessment report of the intergovernmental panel on climate change. In: Edenhofer EO, Pichs-Madruga R, Sokona Y, Farahani E, Kadner S, Seyboth K, Adler A, Baum I, Brunner S, Eickemeier P, Kriemann B, Savolainen, Schlömer S, von Stechow C, Zwickel T, Minx JC (eds). Cambridge University Press, Cambridge
43. Ward PL (2009) Sulfur dioxide initiates global climate change in four ways. Thin Solid Films 517(11):3188–3203
44. Smith J (2012) Urban air quality. Woodland Trust. https://www.woodlandtrust.org.uk/mediafile/100083924/Urban-air-quality-report-v4-single-pages.pdf
45. SEPA (Scotch Environment Protection Agency) (2006) Chlorofluorocarbons (CFCs) fact sheet. State of the Scottish Environment 2006. www.sepa.org.uk. http://apps.sepa.org.uk/spripa/pages/substanceinformation.aspx?pid=114
46. Tekippe JA, Hristov A, Heyler K, Cassidy T, Zheljazkov V, Ferreira J, Karnati S, Varga G (2011) Rumen fermentation and production effects of *Origanum vulgare L.* leaves in lactating dairy cattle. J Dairy Sci 94:5065–5079
47. Wilson C, Grubler A, Gallagher KS, Nemet GF (2012) Marginalization of end-use technologies in energy innovation for climate protection. Nat Clim Change 2(11):780–788
48. Zhang W, Wang B, Niu X (2017) Relationship between leaf surface characteristics and particle capturing capacities of different tree species in Beijing. Forests 8(3):92–103
49. Hyvönen R, Ågren GI, Linder S, Persson T, Cotrufo MF, Ekblad A, Freeman M, Grelle A, Janssens IA, Jarvis PG, Kellomäki S, Lindroth A, van Loustau DM, Lundmark T, Norby RJ, Oren R, Ryan MG, Sigurdsson BD, Strömgren M, Oijen MV, Wallin G (2007) The likely impact of elevated [CO_2], nitrogen deposition, increased temperature and management on carbon sequestration in temperate and boreal forest ecosystems: a literature review. New Phytol 173(3):463–480
50. Ball B, Taggart M, Scott A (2004) Mitigation of greenhouse gas emissions from soil under silage production by use of organic manures or slow-release fertilizer. Soil Use Manag **20**:287–295
51. Farming Futures (2009) Climate change: be part of the solution focus on: soil management. Fact Sheet No. 20. Available at: http://adlib.everysite.co.uk/resources/000/241/422/FS20.pdf

52. Whitmore A, Kirk G, Rawlins B (2015) Technologies for increasing carbon storage in soil to mitigate climate change. Soil Use Manag 31:62–71
53. Lockwood A, Filley T, Rhodes D, Shepson P (2008) Foliar uptake of atmospheric organic nitrates. Geophys Res Lett 35(15):1–5
54. Dobbie KE, Smith KA (2003) Impact of different forms of N fertilizer on N_2O emissions from intensive grassland. Nutr Cycl Agroecosyst 67(1):37–46
55. Forum for the Future (2009) Climate change, foreign policy, and higher education by Levi M, Mullinix J. Forum for the future of higher education. Cambridge, MA. http://forum.mit.edu/articles/%EF%BB%BFclimate-change-foreign-policy-and-higher-education/
56. Singh SK, Rao DN, Agrawal M, Pandey J, Naryan D (1991) Air pollution tolerance index of plants. J Environ Manage 32(1):45–55
57. Awad YM, Blagodatskaya E, Ok Y, Kuzyakov Y (2013) Effects of polyacrylamide, biopolymer and biochar on the decomposition of 14C-labelled maize residues and on their stabilization in soil aggregates. Eur J Soil Sci 64(4):488–499. https://doi.org/10.1111/ejss.12034
58. Yousaf B, Liu G, Wang R, Abbas Q, Imtiaz M, Liu R (2017) Investigating the biochar effects on C-mineralization and sequestration of carbon in soil compared with conventional amendments using the stable isotope (δ13C) approach. Gcb Bioenergy 9(6):1085–1099
59. Wu J, Guo W, Feng J, Li L, Yang H, Wang X, Bian X (2014) Greenhouse gas emissions from cotton field under different irrigation methods and fertilization regimes in arid northwestern China. Sci World J. 407832–407832
60. Glaser B, Lehmann J, Zech W (2002) Ameliorating physical and chemical properties of highly weathered soils in the tropics withcharcoal—a review. Biol Fertil Soils 35:219–230
61. Lehmann J, Gaunt J, Rondon M (2006) Bio-char sequestration in terrestrial ecosystems—a review. Mitig Adapt Strat Glob Change 11:403–427
62. Oertela C, Matschullat J, Zurba K, Zimmermann F, Erasmi S (2016) Greenhouse gas emissions from soils—a review. Chem der Erde-Geochem 76(3):327–352
63. Anonymous (2013) Surface runoff, percolation, total runoff and evaporation from precipitation. Published by: Senate Department for Urban Development and the Environment. No. 02.13, (2013 edn.). Available at: www.stadtentwicklung.berlin.de/umwelt/umweltatlas/e…/ekc213.doc
64. ENPAA, English National Park Authorities Association (2009) Climate change mitigation and adaptation in national parks, London, EC2A 3NW, England. http://www.nationalparksengland.org.uk/__data/assets/pdf_file/0010/767467/ENPAA-Statement-on-Climate-Change-in-National-Parks.pdf
65. Sanderson K (2008) Plants that reduce air nitrous oxide: trees eat pollution products. Nature. https://doi.org/10.1038/news.2008.1046
66. Pouyat RV, Yesilonis ID, Nowak DJ (2006) Carbon storage by urban soils in the United States. J Environ Qual 35(4):1566–1575
67. Hopkin M (2005) Tree planting not always green. Forests can suck up water and change the soil. Nat Mag. Published online 22 Dec 2005. Available at: https://doi.org/10.1038/news051219-14
68. Hunsberger A, Alison F, Angela M, Barbra L, Bart S, Niemann B (2010) The Florida-friendly landscaping guide to plant selection & landscape design. University of Florida publications. Available at: https://fyn.ifas.ufl.edu/pdf/FYN_Plant_Selection_Guide_2015.pdf
69. Boone L (2017) These 7 fire-retardant plants may help save your home (Yucca, Lemonade berry, Oak, Woolly blue curl, Catalina cherry). Available at: http://www.latimes.com/home/la-hm-firescaping-20170930-htmlstory.html
70. Dickie G (2015) Plants that burn fastest in a wildfire. Available at: https://www.hcn.org/issues/47.13/after-a-record-setting-wildfire-a-washington-county-prepares-for-the-next-one/plants-that-burn-fastest-in-a-wildfire
71. Cameron RW, Blanuša T, Taylor JE, Salisbury A, Halstead AJ, Henricot B, Thompson K (2012) The domestic garden—its contribution to urban green infrastructure. Urban For Urban Green 11(2):129–137

72. Wilson M (2007) New gardening: how to garden in a changing climate. Mitchell Beazley and the Royal Horticultural Society. MITCH Publisher, London
73. Cross R, Spencer R (2009) Sustainable gardens. CSIRO, Collingwood. ISBN 9780643094222
74. Walker J (2011) How to create an eco garden: the practical guide to greener, planet-friendly gardening?. Aquamarine, Wigston
75. Clifford DP, Eckbo G (2017) Garden and landscape design. Encyclopædia Britannica, inc. https://www.britannica.com/art/garden-and-landscape-design
76. Haynes J, McLaughlin J, Vasquez L, Hunsberger A (2001) Low-maintenance landscape plants for South Florida. Environmental Horticulture Department, Florida Cooperative Extension Service, University of Florida-IFAS Publication ENH854, Florida, USA
77. Hussein M (2018) Sustainable regeneration of urban green areas in Egypt's desert cities adopting green infrastructure strategies in New Borg El-Arab City. M.Sc. Master of Science in Resource Efficiency in Architecture and Planning Hafen City University, Hamburg, Germany February, available at: http://edoc.sub.uni-hamburg.de/hcu/volltexte/2018/428/pdf/Hussein_Mahmoud_Master_thesis_2018.pdf
78. Prieur D (2016) Environment, topics. Perennial plants can fight climate change, says Dr. Jerry Glover, Medill New Service. Available at: http://dc.medill.northwestern.edu/blog/2016/08/04/perennials-fighting-climate-change/#sthash.lZXd0d2L.DtR9oOsK.dpbs
79. SENES Consultants Limited (2005) NWT environmental audit status of the environment report air quality, climate and climate change. Available at: https://www.aadncaandc.gc.ca/DAM/DAM-INTER-NWT/STAGING/textetext/soeaq_1316619536106_eng.pdf
80. Sawidis T (1988) Uptake of radionuclides by plants after the Chernobyl accident. Environ Pollut 50(4):317–324
81. Itoh S, Eguchi T, Kato N, Takahashi S (2014) Radioactive particles in soil, plant, and dust samples after the Fukushima nuclear accident. Soil Sci Plant Nutr 60(4):540–550
82. Gupta DK, Chatterjee S, Datta S, Voronina AV, Walther C (2016) Radionuclides: accumulation and transport in plants. In: Reviews of environmental contamination and toxicology, vol 241. Springer, Cham, pp 139–160. Gupta DK, Walther C (eds) (2014) Radionuclide contamination and remediation through plants. Springer, Berlin
83. Mimura T, Mimura M, Kobayashi D, Komiyama C, Sekimoto H, Miyamoto M (2014) Radioactive pollution and accumulation of radionuclides in wild plants in Fukushima. J Plant Res 127:5–10
84. Hu N, Ding D, Li G (2014) Natural plant selection for radioactive waste remediation. Radionuclide contamination and remediation through plants. Springer, Cham, International Publishing Switzerland, pp 33–53
85. Pulhani VA, Dafauti S, Hegde AG, Sharma RM, Mishra UC (2005) Uptake and distribution of natural radioactivity in wheat plants from soil. J Environ Radioact 79(3):331–346
86. Li G, Hu N, Ding DX, Zheng JF, Liu YL, Wang YD, Nie XQ (2011) Screening of plant species for phytoremediation of uranium, thorium, barium, nickel, strontium and lead contaminated soils from a uranium mill tailings repository in South China. Bull Environ Cont Toxicol 86:646–652
87. Juszak I, Schaepman-Strub G (2015) The impact of vegetation type on the shortwave radiation balance of the Arctic tundra. In: EGU general assembly conference abstracts, vol 17. April, Bibliographic Code: 2015EGUGA.17.9051J. Available at: http://adsabs.harvard.edu/abs/2015EGUGA..17.9051J
88. Donohoea A, Armour KC, Pendergrass AG, Battisti DS (2014) Shortwave and longwave radiative contributions to global warming under increasing CO_2. Proc Natl Acad Sci 111(47):16700–16705
89. UNFCCC (2012) United Nations framework convention on climate change handbook. https://unfccc.int/resource/docs/publications/handbook.pdf
90. Wang K, Liang S (2009) Daytime net radiation from shortwave radiation measurements and meteorological observations. J Appl Meteorol Climat 48:643–648

91. Heo HK, Park CY, Yang B, Lee DK (2018) Heat stress mitigation of urban trees—fine scale assessment based on terrestrial LiDAR data. Geophysical Research Abstracts 20, EGU2018-11878. Available at: https://meetingorganizer.copernicus.org/EGU2018/EGU2018-11878.pdf
92. Kuusk A (1992) Absorption profiles of shortwave radiation in a vegetation canopy. Agric For Meteorol 62(3–4):191–204
93. Galluzzo G (2012) Particulate matter and climate change. University of Iowa. Available at: https://now.uiowa.edu/2012/03/particulate-matter-and-climate-change
94. Shi J, Zhang G, An H, Yin W (2017) Quantifying the particulate matter accumulation on leaf surfaces of urban plants in Beijing, China. Atmos Pollut Res 2017:1042–1309
95. Chen X, Pei T, Zhou Z, Teng M, He L, Luo M, Liu X (2015) Efficiency differences of roadside greenbelts with three configurations in removing coarse particles (PM10): a street scale investigation in Wuhan, China. Urban Forestry and Urban Greening 14(2):354–360
96. Chen X, Zhou Z, Teng M, Wang P, Zhou L (2015) Accumulation of three different sizes of particulate matter on plant leaf surfaces: effect on leaf traits. Arch Biol Sci 67(4):1257–1267
97. Walling DE, Moorehead PW (1989) The particle size characteristics of fluvial suspended sediment: an overview. Sediment/water interactions. Springer, Dordrecht, pp 125–149
98. Ankers C, Walling D, Smith R (2003) The influence of catchment characteristics on suspended sediment properties. Hydrobiologia 494(1–3):159–1616
99. Krein A, Petticrew E, Udelhoven T (2003) The use of fine sediment fractal dimensions and colour to determine sediment sources in a small watershed. CATENA 53(2):165–179
100. Ingold CT (1971) Fungal spores. Clarendon Press, Oxford, p 302
101. Tewari DN (1994) Urban forestry. Indian For 120(8):647–657
102. Bond TC, Doherty SJ, Fahey DW, Forster PM, Berntsen T, DeAngelo BJ, Flanner MG, Ghan S, Kärcher B, Koch D, Kinne S, Kondo Y, Quinn PK, Sarofi MC, Schultz MG, Schulz M, Venkataraman C, Zhang H, Zhang S, Bellouin N, Guttikunda SK, Hopke PK, Jacobson MZ, Kaiser JW, Klimont Z, Lohmann U, Schwarz JP, Shindell D, Storelvmo T, Warren SG, Zender CS (2013) Bounding the role of black carbon in the climate system: A scientific assessment. J Geophys Res Atmos 118:5380–5552
103. Silva RA, West JJ, Zhang Y, Anenberg SC, Lamarque JF, Shindell DT, Collins WJ, Dalsoren S, Faluvegi G, Folberth G, Horowitz LW, Nagashima T, Naik V, Rumbold S, Skeie R, Sudo K, Takemura T, Bergmann D, Cameron-Smith P, Cionni I, Doherty RM, Eyring V, Josse B, MacKenzie IA, Plummer D, Righi M, Stevenson DS, Strode S, Szopa S, Zeng G (2013) Global premature mortality due to anthropogenic outdoor air pollution and the contribution of past climate change. Environ Res Lett 8(3):1–11
104. EEA (European Environmental Agency) (2007) Air pollution in Europe 1990–2004. Report No 2. European Environmental Agency Report No. 2/2007. Available from: http://www.eea.europa.eu
105. Volk HE, Lurman F, Penfold B, Herz-Picciotto I, McConnell R (2013) Traffic-related air pollution, particulate matter and autism. JAMA Psychiatry 70:71–76
106. Gawrońska H, Bakera B (2015) Phytoremediation of particulate matter from indoor air by *Chlorophytum comosum* L. plants. Air Qual Atmos Health 8(3):265–272.
107. Beckett KP, Freer-Smith P, Taylor G (1998) Urban woodlands: their role in reducing the effects of particulate pollution. Environ Pollut 99:347–360
108. Fuzzi S, Baltensperger U, Carslaw K, Decesari S, Denier Van Der Gon H, Facchini MC, Fowler D, Koren I, Langford B, Lohmann U, Nemitz E, Pandis S, Riipinen I, Rudich Y, Schaap M, Slowik JG, Spracklen DV, Vignati E, Wild M, Williams M, Gilardoni S (2015) Particulate matter, air quality and climate: lessons learned and future needs. Atmos Chem Phys 15(14):8217–8299
109. Ban-Weiss GA, Collins W (2015) Aerosols: role in radiative transfer. Encyclopedia of atmospheric sciences, 2nd edn, pp 66–75. https://doi.org/10.1016/b978-0-12-382225-3.00053-0
110. Lagzi I, Mészáros R, Gelybó G, Leelőssy Á (2014) Atmospheric chemistry. Eötvös Loránd University

111. Kim MJ, Yeh SW, Park RJ (2016) Effects of sulfate aerosol forcing on East Asian summer monsoon for 1985–2010. Geophys Res Lett 43(3):1364–1372
112. Ji J, Wang G, Du X, Jin C, Yang H, Liu J, Yang Q, Si N, Li J, Chang C (2013) Evaluation of adsorbing haze PM2. 5 fine particulate matters with plants in Beijing-Tianjin-Hebei region in China. Scientia Sinica Vitae, 43(8):694–699
113. Wang L, Gao S, Liu L, Ha S (2006) Atmospheric particle-retaining capability of eleven garden plant species in Beijing. Chin J Appl Ecol 17:597–601
114. Zhang ZD, Xi BY, Cao ZG, Jia LM (2014) Exploration of a quantitative methodology to characterize the retention of PM2.5 and other atmospheric particulate matter by plant leaves: taking populous tomentosa leaves as an example. J Appl Ecol 25:1–5
115. Prusty BA, Mishra PC, Azeez PA (2005) Dust accumulation and leaf pigment content in vegetation near the national highway at Sambalpur, Orissa, India. Ecotoxicol Environ Safety 60:228–235
116. Freer-Smith PH, El-Khatib AA, Taylor G (2004) Capture of particulate pollution by trees: a comparison of species typical of semi-arid areas (fichus nitride and Eucalyptus globules) with European and North American species. Water Air Soil Pollut 155:173–187
117. Zhang W, Wang B, Niu X (2015) Study on the adsorption capacities for airborne particulates of landscape plants in different polluted regions in Beijing (China). In: Bhamidiammarri R, Tota-Maharaj K (eds) Int J Environ Res Public Health 12(8):9623–9638
118. Li Y, Zhao M, Mildrexler DJ, Motesharrei S, Mu Q, Kalnay E, Zhao F, Li S, Wang K (2016) Potential and actual impacts of deforestation and afforestation on land surface temperature. J Geophys Res Atmos 121(24):14372–14386
119. Wheeler M (2011). Effects of fertilizer on nitrogen cycling in residential cape cod lawns. M.Sc. thesis, Harvey Mudd College, Brown University. http://www.mbl.edu/ses/files/2014/09/Wheeler-Megan.pdf
120. Nowak DJ, Crane D (2002) Carbon storage and sequestration by urban trees in the USA. Environ Pollut 116(3):381–389
121. Ni Y, Eskeland GS, Giske J, Hansen JP (2016) The global potential for carbon capture and storage from forestry. Carbon Balance Manag 11(1):3–8
122. Akbari H (2002) Shade trees reduce building energy use and CO_2 emissions from power plants. Environ Pollut 116:S119–S126
123. USEPA (2017) United States Environmental Protection Agency. Sulfur Dioxide (SO_2) Pollution. https://www.epa.gov/so2-pollution/sulfur-dioxide-basics
124. EPA (Environmental Protection Agency) (2009) Composting. Online at http://www.epa.gov/waste/conserve/rrr/composting/index.htm
125. Johnson J (2014) Methane's role in climate change. Chem Eng News 92(27):10–15
126. Brassard P, Godbout S, Raghavan V (2016) Soil biochar amendment as a climate change mitigation tool: Key parameters and mechanisms involved. J Environ Manage 181:484–497
127. WCD (Wildlife Center Drive) (2007) Gardeners can play an important role in reducing global warming. Source: National Wildlife Federation. Available at: https://www.sciencedaily.com/releases/2007/05/070519084046.htm
128. Favoino E, Hogg D (2008) The potential role of compost in reducing greenhouse gases. Waste Manag Res 26(1):61–69
129. Termorshuizen AJ, Moolenaar SW, Veeken AHM, Blok WJ (2004) The value of compost. Rev Environ Sci Bio/Technol 3(4):343–347
130. University of Minnesota (2006) Grass plant growth and its relationship to lawncare. Sustainable urban landscape information series. Available at http://www.sustland.umn.edu/maint/grasspla.htm
131. Falloon P, Jones CD, Cerri CE, Al-Adamat R, Kamoni P, Bhattacharyya T, Easter M, Paustian K, Killian K, Coleman K, Milne E (2007) Climate change and its impact on soil and vegetation carbon storage in Kenya, Jordan, India and Brazil. Agr Ecosyst Environ 122(1):114–124
132. Zirkle G, Augustin B, Lal R (2009) The potential for soil organic carbon sequestration in home lawns. Presented at the ASA-CSSA-SSSA International Annual Meetings. Hemenway, Toby. Gaia's garden: a guide to home-scale permaculture. Chelsea Green Publishing

133. Zirkle G, Lal R, Augustin B (2011) Modeling carbon sequestration in home lawns. HortScience 46(5):808–814
134. Palmer C (2012) To what extent could planting trees help solve climate change? This article was written by Dr. Charles Palmer of the Grantham Research Institute on Climate Change and the Environment at LSE in collaboration with the Guardian. https://www.theguardian.com/environment/2012/nov/29/planting-trees-climate-change
135. Hasan R, Othman N, Ismail F (2017) Tree species selection in street planting: it's relationship with issues in urban area. Environ Behav Proc J 2(6):185–194
136. Sjöman H, Gunnarsson A, Pauleit S, Bothmer R (2012) Selection approach of urban trees for inner city environments: larning from nature. Arboricult Urban For 38(5):194–204
137. FAO "Food and Agriculture Organization" (2010) Adaptation of forests to climate change. Global Change 11:403–427
138. Hemenway T (2009) Gias's garden. A guide to home-scale permaculture, 2nd edn. Chelsea Green Publishing Company, USA
139. Koriesh EM (2018b) Studies on air pollution 4: evaluation of some ornamental trees and shrubs for reducing atmosphere carbon dioxide. In: The 8th international Arabic conference, Ismailia, Egypt, Ismailia
140. Doherty C (2012) Ficus religiosa—new crop summary and recommendations. New floricultural crops: formulation of production schedules for wild, non-domesticated species. University of Minnesota. https://conservancy.umn.edu/bitstream/handle/11299/143450/Ficus%20religiosa%20Paper%20Colin%20Doherty.pdf;jsessionid=3B3618BE0BB5D32CB95878FD99DC1DE3?sequence=2
141. Padhy PK, Varshney CK (2005) Emission of volatile organic compounds (VOC) from tropical plant species in India. Chemosphere 59(11):1643–1653
142. El-Hadidi M, Boulos L (1989) Street trees in Egypt. American University Press, Cairo, vol 3, pp 337–349
143. Shaltout K (2004) An updated flora of Egypt. Divers Distrib. https://onlinelibrary.wiley.com/doi/full/10.1111/j.1472-4642.2004.00065.x
144. Dunnett N, Kingsbury N (2008) Planting green roofs and living walls. Timber Press Inc., Oregon, USA
145. Safikhani ST, Abdullah AM, Ossen DR, Baharvand M (2014) Thermal impacts of vertical greenery systems. Environm Climate Technol 14(1):5–11
146. Mwendwa M (2016) Vertical gardens technology to help reduce climate change stress. Clim Change. http://www.talkafrica.co.ke/vertical-gardens-technology-to-reduce-climate-change-stress/
147. Blanc P (2008) The vertical garden. From nature to the city. W. W. Norton and Company Inc., New York
148. Manso M, Castro-Gomes J (2015) Green wall systems: a review of their characteristics. Renew Sustain Energy Rev 41:863–871
149. Susorova I (2015) Green facades and living walls: vertical vegetation as a construction material to reduce building cooling loads. Eco-efficient materials for mitigating building cooling needs, design, properties and applications. Elsevier Ltd., Amsterdam, pp 127–153
150. Koriesh EM, Moghazy EI, Abdel Salam AM, Abd El-Mo'omen A (2018) Raising the efficiency of some ornamental plants to get rid of formaldehyde. In: The 8th international Arabic conference, Ismailia, Egypt
151. Fassden G (2018) Wall greening. Available at: https://www.fassadengruen.de/en/wall-greening.htm
152. Koriesh, EM (1998) Ornamental horticulture (translated), 2nd edn. King Saud University Publications. 19/0818 ISBN:9960-05-759-3. Original text: Prentice-Hall, Inc. Englewood Clifts
153. Sharp R, Sable J, Bertram F, Mohan E, Peck S (2008) Introduction to Green Walls: technology, benefits & design. Green Roofs for Healthy Cities, Toronto. Available at: http://greenscreen.com/docs/Education/greenscreen_Introduction%20to%20Green%20Walls.pdf

154. Littlewood R (2008) Living roofs and walls-technical report: supporting London plan policy. Published by Greater London Authority, p 12. Available at: https://www.london.gov.uk/sites/default/files/living-roofs.pdf
155. Turgeon N, Le Bihan Y, Buelna G, Bourgault C, Verreault S, Lessard P, Nikiema J, Heitz M (2011) Application of methanotrophic biofilters to reduce GHG generated by landfill in Quebec City (Canada). In: Brebbia CA, Longhurst JWS, Popov V (eds) Air pollution XIX (transactions on ecology and environment), vol. 147. WIT PRESS, UK
156. McPherson EG (1994) Cooling urban heat islands with sustainable landscapes. In: Platt Rutherford H, Rowntree Rowan A, Muick Pamela C (eds) The ecological city: preserving and restoring urban biodiversity. University of Massachusetts Press, Amherst
157. Chavarria G, Santos HP (2012) Plant water relations: absorption, transport and control mechanisms. In: Montanaro G (ed) Advances in selected plant physiology aspects. InTech. Available from: https://www.intechopen.com/books/advances-in-selected-plant-physiology-aspects/plant-water-relations-absorption-transport-and-control-mechanisms
158. Raizada P, Singh A, Raghubanshi AS (2009) Comparative response of seedlings of selected native dry tropical and alien invasive species to CO_2 enrichment. J Plant Ecol 2(2):69–75
159. Dukes JS, Mooney HA (1999) Does global change increase the success of biological invaders? Trends Ecol Evol 14:135–139
160. Keenan TF, Prentice IC, Canadell JG, Williams CA, Wang H, Raupach M, Collatz G (2016) Recent pause in the growth rate of atmospheric CO_2 due to enhanced terrestrial carbon uptake. Nat Commun 7:13428
161. Nowak DJ, Kuroda M, Crane DE (2004) Tree mortality rates and tree population projections in Baltimore, Maryland, USA. Urban For Urban Green 2:139–147
162. Hasegawa S, Macdonald CA, Power SA (2016) Elevated carbon dioxide increases soil nitrogen and phosphorus availability in a phosphorus-limited Eucalyptus woodland. Glob Chang Biol 22(4):1628–1643
163. Lotfiomran N, Köhl M, Fromm J (2016) Interaction effect between elevated CO_2 and fertilization on biomass, gas exchange and C/N ratio of European Beech (*Fagus sylvatica* L.). Plants 5(3):38–50
164. Wang L (2016) Assessment of benefits of urban forests under the ecosystem services framework: a literature review. B.Sc. dissertation. The University of British Columbia, Bachelor of Science in Forest Resource Management, Faculty of Forestry. The University of British Columbia (Vancouver)
165. Whitehead D (2011) Forests as carbon sinks—benefits and consequences. Tree Physiol 31(9):893–902
166. Binkley D, Campoe O, Gspaltl M (2013) Light absorption and use efficiency in forests: why patterns differ for trees and stands. For Ecol Manage 288:5–13
167. Charlton A, Hamilton I (2008) Tree planting: a key weapon against global warming. Carbon Posit. Available at: http://forestindustries.eu/de/content/tree-planting-key-weapon-against-global-warming
168. Koriesh EM (2001) Studies on air pollution. 2. Effects of greenbelts. In: The Fifth Arabian Horticulture Conference, Ismailia, Egypt, vol 2, pp 315–320
169. Koriesh EM, Moghazy EI (2013) Studies on indoor air pollution. 9- air ions, oxygen evolution & air pollution tolerant index (APTI) of some indoor plants. In: The seventh international conference for horticulture, Held at Suez Canal University from 24–26 March 2013. Hortsci J Suez Canal Univ 1:339–34
170. Koriesh EM, Abd El-Fattah YM (2008) Studies on air pollution. 3: Evaluation of some shrubs to their oxygen, negative air ions evolutions and air pollution tolerance index in relation to some fertilization treatments. Agric Res J 8:63–68
171. Khan FI, Abbasi S (2000) Attenuation of gaseous pollutants by greenbelts. Environ Monit Assess 64:457–475
172. Ruth AE, William RE (1994) The encyclopedia of the environment. The Rene Dubor Centre for Human Environments, Houghton Miffin Company, U.S.A

173. Larkham A, Adams R (2011) The post-war reconstruction planning of London: a wider perspective. Planning Birmingham School of the Built Environment, Birmingham City University. ISBN 978-1-904839-54-5. http://www.bcu.ac.uk/cmsproxyimage?path=/_media/docs/cesr_working_paper_8_2011_larkham_adams.pdf
174. Hill AC (1971) Vegetation: a sink for atmospheric pollutants. J Air Pollut Control Assoc 21:341–346
175. Lin DA (1976) Air pollution-threat and responses. Adison Wesley Publishing Company, London
176. Smith WH (1990) Forest as sinks for air contaminants: vegetative compartment. Air pollution and forests: interactions between air contaminants and forest ecosystems, 2nd edn. Series on environmental management. Springer, New York, pp 147–180. https://link.springer.com/content/pdf/10.1007%2F978-1-4684-0104-2.pdf
177. Rawat JS, Banerjee SP (1996) Urban forestry for improvement of environment. J. Energy Environ Monitor 12(2):109–116
178. William HS (1990) Interaction between air contaminants and forest ecology. In: Air pollution and forest, 2nd edn. Springer, New York, pp 618
179. Kabel RL, O'Dell RA, Taheri M, Davis D (1976) A preliminary model of gaseous pollutant uptake by vegetation. Center for Air Environment Studies, Publ. No. 455–76
180. Earth talk, Social Sciences (2018) Which trees offset global warming best? https://www.thoughtco.com/which-trees-offset-global-warming-1204209