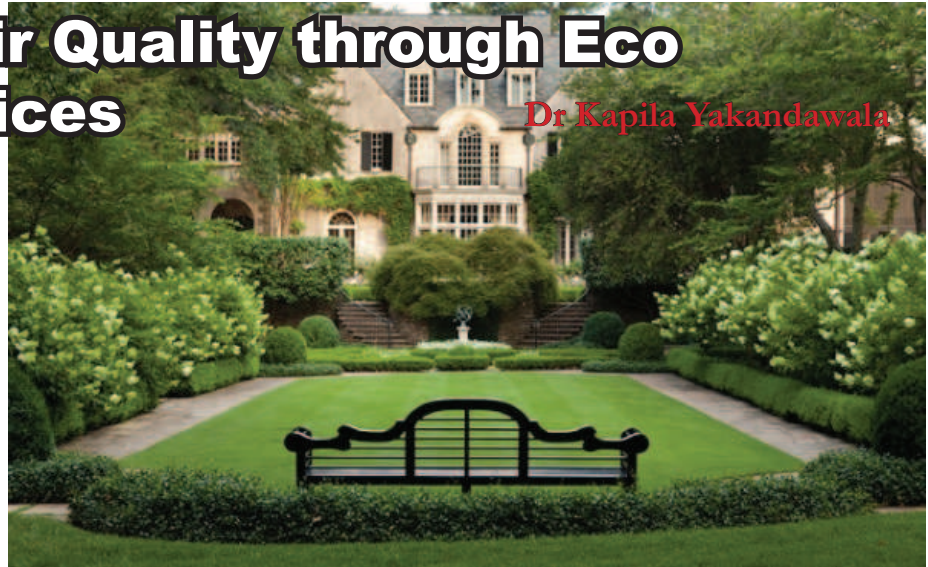


# Enhancing Air Quality through Eco System Services

Dr Kapila Yakandawala



Human health and wellbeing depends upon the services provided by ecosystems and their components: air, water, soil, nutrients and organisms. Ecosystem services are the processes by which the environment produced resources are utilized by humans such as clean air, water, food and other materials. The continued delivery of these resources remains essential to our economic prosperity and other aspects of our welfare. Ecosystem services provide large scale benefits at several levels (local, regional and global) and to different groups (individuals, commercial firms and public bodies). Despite this, ecosystem services tend to be significantly undervalued by the society. Reasons being lack of adequate information and knowledge about ecosystem functions and the benefits they generate for the society. As no formal market for ecosystem services exists, these services are not allocated a price that would give some indication of their economic value to the society.

Although the most obvious threats to biodiversity, and in consequence to ecosystems services, come from direct human action including land

use change and agriculture, there are also indirect threats from environmental pollution. Air pollution alone plays a part in this and this article will provides a review of current understanding of the interactions between air quality and plants and explore the routes towards the wise use of plants in combating air pollution.

## What is air quality?

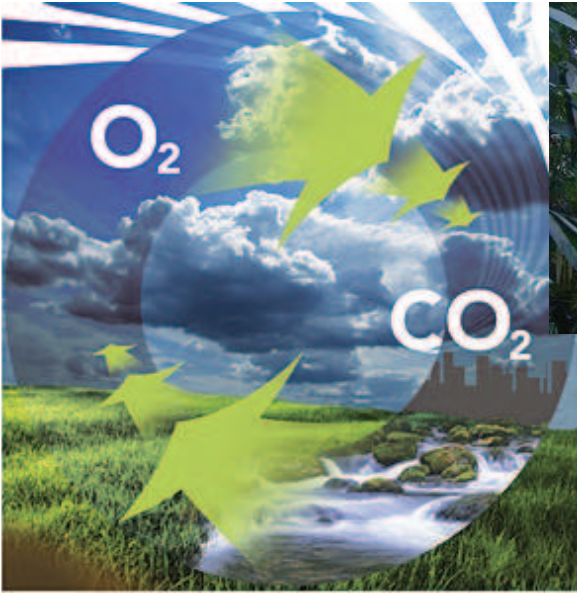
The term air quality means the state of the air around us. Good air quality refers to clean, clear, unpolluted air. Clean air is essential to maintain the delicate balance of life on this planet not only for humans, but also for other animals, vegetation, water and soil. Poor air quality is the result of a number of factors, including emissions from various sources, both natural and

human induced. Poor air quality occurs when pollutants reach concentrations high enough to endanger human health and the environment. Air quality improves with increased percent of vegetation cover.

## Forests: huge 'oxygen factories'

Today the earth's atmosphere contains about 21 percent of oxygen. However, early in earth's history, the atmosphere contained no oxygen but was rich in water vapour and other





gases. That situation began to change about three billion years ago when the first living organisms appeared. Among the first life forms were simple blue-green algae, which through the process of photosynthesis absorbed carbon dioxide from the atmosphere and chemically converted it into nutrients, releasing oxygen as a by-product. Over time the simple life forms developed into complex plants that also continued to produce oxygen. Most plants largely absorb carbon dioxide and produce oxygen during the day through photosynthesis and consume oxygen and produce carbon dioxide during the night through respiration. Between production and consumption, oxygen levels stay in balance today. The following statements give a clear idea about the importance of trees or forests in the production of clean air (Oxygen) and absorption of carbon dioxide.

“One acre of forest absorbs six tons of carbon dioxide and puts out four tons of oxygen. This is enough to meet the annual needs of 18 people.” - *U.S. Department of Agriculture*

"On average, one tree produces nearly 260 pounds of oxygen each year. On this basis mature trees can provide enough oxygen for a family of four." - *Environment Canada, Canada's national environmental agency*

"One acre of trees annually consumes an amount of carbon dioxide equivalent to that produced by driving an average car for 26,000 miles. That same acre of trees also produces enough oxygen for 18 people to breathe for a year." - *New York Times*

### **Plants to intercept particulate matter**

Particulate matter (PM) is an air pollutant consisting of a mixture of particles suspended in the air. These particles are emitted into the atmosphere through man-made processes including combustion from car engines; burning of solid-fuel;

combustion in households; industrial activities (building, mining, manufacturing of cement, ceramic and bricks); erosion of the pavement by road traffic and abrasion of brakes and tyres; and work in caves and mines or natural processes. Among air pollutants, PM is of considerable concern for public health. According to the aerodynamic diameter, PM can be divided into fine ( $PM_{2.5}$  /  $<2.5\mu m$ ) and coarse particles ( $PM_{10}$  /  $<10\mu m$ ). The fine particles are capable of penetrating into the lungs and are therefore an important matter of concern regarding human health.

Urban vegetation can be successfully used to reduce air pollution caused by PM. Research has shown that atmospheric dust over wooded areas can be 75% lower than over relatively non-vegetated, populated areas. Plants can remove PM pollution by intercepting airborne particles. Some particles can be absorbed into the plant, though most of the particles intercepted are retained on the plant surface. The intercepted particle often is resuspended to the atmosphere,

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washed off by rain, or dropped to the ground with leaf and twig fall.

Recently there has been renewed interest in the use of vegetation to improve air quality, in particular pollution caused by PM. The ability of a vegetation to intercept PM depends on their morphological features such as leaf area, inter-nodal distance, petiole length, leaf orientation, leaf arrangement, presence of hairs, hair type etc. Most of these morphological characters collectively contribute to a dense canopy and others contribute to a coarse leaf texture where both as a whole play an important role in PM interception from air. These morphological characters vary from species to species and studies conducted have identified certain plants with greater potential to intercept PM. Such plants includes shrubs such as *Duranta repens*, *Helicteres isora* (Screw plant), *Bougainvillea glabra* (Bougainvillea), *Murraya paniculata* (Orange Jessamine),

*Acalypha inferno* and trees such as *Terminalia arjuna* and *Mangifera indica* (Mango) are some examples.

Recently, there has been a renewed interest in Sri Lanka to beautify the urban environment. Therefore in landscaping activities such as road side planting, planting for screening purposes and other purposes in school premises, parks, and around office buildings with plants of desirable morphological characters, can be used to obtain health and environment benefits. Therefore, intelligent plant selection based not only on aesthetic aspects (beauty) but also on morphological aspects of plants should be promoted.

### Removal of gaseous air pollutants

Plants are capable of sequestering many gaseous pollutants from the atmosphere, including nitrogen dioxide (NO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>),

ozone (O<sub>3</sub>) and carbon monoxide (CO). They are capable of removing gaseous air pollutants primarily by up taking via leaf stomata, though some gasses are removed by the plant surface. Once inside the leaf, gasses diffuse into intercellular spaces and may be absorbed by water films to form acids or react with inner-leaf surfaces. Studies conducted in USA revealed that air quality improvement in New York City due to pollution removal by trees during daytime averaged 0.45% for ozone, 0.43% for sulfur dioxide, 0.30% for nitrogen dioxide, and 0.002% for carbon monoxide. Therefore, plants in urban areas play a vital role in removing gaseous air pollutants.

### Ornamental plants to clean indoor air

Many of us spend so much time indoors in enclosed spaces, such as the home, schools or at work places, and therefore maintaining a good indoor air quality is very important.



Bougainvillea glabra (Bougainvillea)



Terminalia arjuna

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Air in these spaces can also be polluted from pollutants emitted from indoor sources. Poor ventilation systems, sealed buildings and the use of synthetic products in the home are the main causes of indoor air pollution. Newly constructed buildings are better insulated and sealed tightly to conserve air-conditioning. While it does save both money and energy, this new found efficiency has its downside in that pollutants may be trapped indoors and have less opportunity to dissipate to the outside. In fact, in certain instances, air pollution can be worse indoors than outdoors. Chemicals released from synthetic fabrics, furnishings, household products and in personal care products are among the contributors, which includes oxygenated volatile organic compounds (oVOCs) such as benzene, formaldehyde and trichloroethylene. In order to metabolize these chemicals, plants produce increasing levels of enzymes that transform these chemicals into less toxic substances. At the same time, as it turns out, the plant draws down more and more oVOCs, which can be metabolized by the enzymes. Not only oVOCs, some indoor plants are also capable of absorbing other pollutants such as sulfur dioxide, nitrogen dioxide and ammonia.

All ornamental plants are beneficial in this regard, at least to a certain degree, but

some ornamental plants are better at removing these compounds. These plants actively consume certain types of air pollutants, which can have long-term positive health and environmental impacts. NASA has been researching on methods of cleansing the atmosphere in space stations to keep it fit for human habitation over extended periods of time, and they have also found that some ornamental plants help fight pollution indoors.

Some examples of plants commonly used in interior decorations in Sri Lanka which possess higher capabilities in removing indoor air pollutants are *Ficus benjamina* (weeping fig), *Sansevieria trifasciata* (snake plant), *Chlorophytum comosum* (spider plant), *Hedera helix* (English ivy), *Ficus elastica* (Rubber plant), *Dracaena fragrans* 'Massangeana' (Cornstalk dracaena), *Dracaena marginata* (Red-edged dracaena) and *Epipremnum aureum* (Devil's ivy).

Therefore, we can promote using these plants in interior plant decorations over other ornamental plants not only to reap aesthetic benefits but also to purify the air indoors leading to a healthy life as people spend majority of their time indoors.

### Lessening odour pollution of air

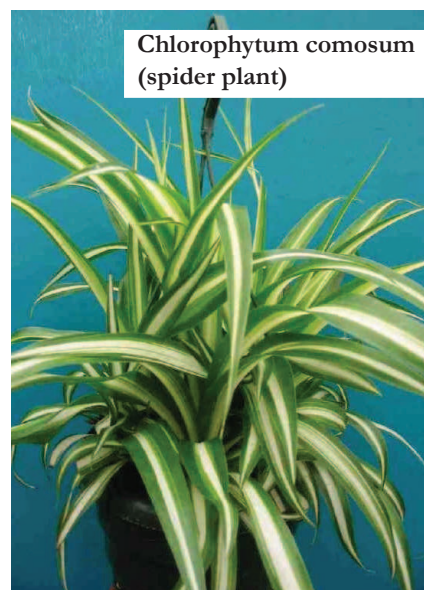
Although odour pollution of air is not directly harmful to



**Dracaena fragrans  
'Massangeana'**



**Dracaena marginata  
(Red-edged dracaena)**



**Chlorophytum comosum  
(spider plant)**



the human health, it can affect mental attitudes and enjoyment of the environment. Livestock facilities such as poultry and swine operations and industrial sources such as, meat, fish and other food processing plants, oil refineries, paint and plastic manufacturers and sewage and domestic refuse processing plants are often responsible for the emission of offensive odours. Emissions of ammonia and other gasses from these facilities/sources could have a negative impact on maintaining good neighbor- relations. Creating a barrier (windbreak) around the sources of these odours by using trees, shrubs, and other vegetation is a technology thought to help reduce odour emissions.

The windbreak provides visual isolation and/or aesthetic enhancement, and also affects airflow near the site. These windbreaks are thought to reduce odour emissions by dilution and dispersion of gas concentrations of odour by a mixing effect created by windbreaks and through physical interception of odour particles and deposition of them on plants. In a wind break approximately 50 percent of the wind should be deflected up and over the wind break and 50 percent should pass through the canopy of the trees.

The effectiveness of ecosystem services provided by plants to enhance air quality depends on species composition,

age, location with respect to habitation of people, and other elements in the landscape. Therefore, effective planning and management of ecosystems is vital to provide a pleasant, healthy and comfortable environment for all of us to live, study and work happily. Plants are on the job 24 hours every day working for all of us to improve our environment and quality of life. Therefore it is our duty to protect them for today and for tomorrow.

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