# PROJECT EXAMPLE

SAGICOR
VISIONARIES
CHALLENGE

## Online summary

Our school is situated in a metropolitan area that is void of green space. We are inundated with smog and gasoline perfumes our air. The classrooms are extremely hot so the windows are left open and in the rainy months our walkways are transformed into wading pools. Overall, this creates an ineffective learning and working environment. We would like to build green areas at our school, which will lower air pollution and ambient temperatures while increasing soil drainage around the community.

## Background

Our school is in the heart of Kingston, Jamaica, a densely populated low-lying area with high traffic flow. Kingston is protected by hills on 3 sides, and surface water run-offs lead directly into Kingston harbour, the seventh-largest natural harbour in the world [4]. Our school is surrounded by condominiums as well as a few high-rise office and hotel buildings, with main roads to our west and north borders. Evidence of smog is visible by the dark depositions on the walls of buildings facing the main road and the thick smell of gasoline permeating the air. Both the school and surrounding communities contain little or no green areas. With the exception of the hockey field and an unused area in front of the school, the grounds are paved with asphalt or concrete, which means the slightest showers cause pooling. The area is extremely hot, especially in June, July and September, which are exam periods and when students head back to school, respectively. The combination of heat and smog makes our learning environment uncomfortable, especially when we return to school and when we should be concentrating on exams. Currently, three buildings are fitted with air-conditioning units, which are always on, and the thermostats are kept very low, but despite this, the buildings are still hot.

Previous studies report that urban areas where the majority of the population lives will warm more than rural ones because buildings absorb heat. There are significant temperature differences between city centres and the surrounding countryside, and surface temperatures can be up to 6 $^{o}$C greater in high-density areas compared to low density areas. The concentration of buildings due to urbanisation leads to the formation of specific climate characteristics, including wind restriction, which disperses pollutants and increases run-off, i.e. urban heat islands [1, 5]. The creation of green areas, i.e. such as planting trees to the east and west of a building, creating green walkways, driveways and roofs, and shading air-condition condensers with trees, is one observable way of mitigating the problems associated with urbanisation. Green areas along walls and roofs have been shown to reduce surface temperature by 11–25 $^{o}$C. [2], resulting in cooler buildings and lower energy costs. Plants utilise 70% of solar heat to manufacture food during photosynthesis, and heat captured by leaves reduces the surface heat absorbed by walls. The rate of evapotranspiration, when water transpires from plants and evaporates from the soil and

consequently facilitates atmospheric cooling, is significantly lower in urbanised and desert areas, leading to a much higher surface temperature of 67 °C (153 °F) [1]. Lowered air pollution is also observed as a result of evapotranspiration as plant leaves are capable of trapping pollutants, and their bacteria is capable of breaking down deposited compounds [2]. Cars parked in green areas emit less volatile organic compounds (VOCs) due to trees' shade cooling vehicle gas tanks, which reduces the evaporation of petrol and VOCs into the atmosphere [1]. Hard surfaces such as concrete, asphalt and compacted earth increase the rate and volume of pooling and rain water run-off, resulting in flash flooding [1, 3] and pollution of surrounding large water bodies [2]. Green walkways can improve drainage by providing a permeable surface, reducing settling and surface run-off, and therefore lowering the risk of flooding during peak flows. In addition, they allow water to filter down and replenish groundwater. Vegetation also intercepts falling water and provides a greater area for water to evaporate from than flat surfaces. Well-trafficked areas in urban cities tend to suffer from noise pollution, but thick foliage from trees can buffer the sounds produced by vehicle horns and engines [6].

We propose that increasing green space around the school by creating green walkways and driveways, growing vines on walls facing east, west and north, affixing window boxes to windows, shading air-condition condensers, and creating a roof garden will reduce heating, air and noise pollution as well as improve soil drainage, making our environment more friendly and sustainable. Based on the literature reviewed, increased foliage in the vicinity of the school will capture pollutants and utilise excess $CO_2$ in the atmosphere that normally contribute to greenhouse effects, thus lowering air pollution. Wind circulation and evapotranspiration would be increased, contributing to increase cooling. The wall vines will absorb excess heat to manufacture their food, and water evaporated from leaves during this process will remove excess heat as water has a high heat capacity. These green spaces will also assist in buffering sounds from the traffic just outside the school. By creating green walkways and driveways, soil drainage will be greatly improved, which will alleviate settlement and flooding at the school and for the surrounding communities during the rainy season. Condensers for air-conditioning units are situated low to the ground and therefore planting shrubs and placing planter pots around them is possible. The combination of green space on the building and the shading the units will contribute to lower cooling costs. Money spent on cooling the buildings and repairing walkways and driveways from gradual water damage may be redistributed to purchasing much-needed supplies for our library or science labs to further enhance our learning facility.

**The Experiment**

We would like to use our school as a pilot project to make our community aware that greener spaces in an urban setting are environmentally friendly, cost effective, sustainable and will improve human lives.

In order to ascertain whether our project is truly necessary, we will be using two types of experiments:

1. A mini-experiment

Objective: To investigate the cooling effect of green spaces compared to non-green areas.

Design: We carried out a daytime temperature comparison between a house in our neighbourhood that has green spaces and 5 classrooms at our schools with varying sun exposure. The experiment was carried out using a regular thermometer, and the daily temperatures were measured and recorded over a one-month period. A roster was created for each representative of the group to collect data at 12 noon from each room, and a parent arranged for the data to be collected from the house at 12 noon. The average temperature per classroom was averaged and presented as a graph. The temperatures per room in the house were quite similar and thus results were pooled and represented in a graph.

2. An investigative approach

We examined the literature available on the matter, assessing the benefits to greening urban areas. Every weekend, we visited the library at UWI, Mona as a group to view their catalogues of online journals or use the Internet to access articles that deal with sustainability and addressing problems associated with urban heat islands and urbanisation. The findings were discussed and summarised, and the information was presented in the form of a chart.

The information gathered from these two experiments addressed:

1. Cooling effects
2. Air pollution
3. Drainage
4. Greening methods

**Results**

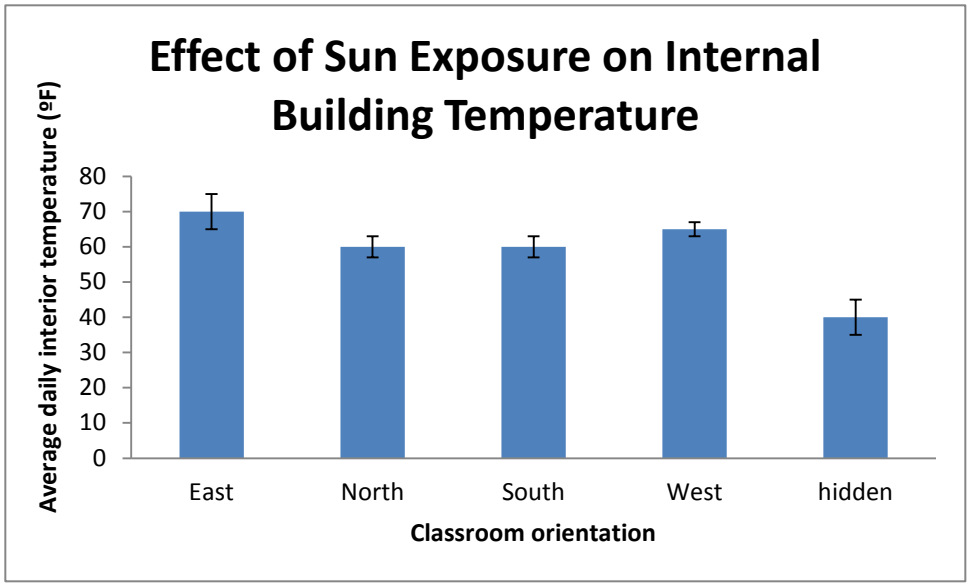
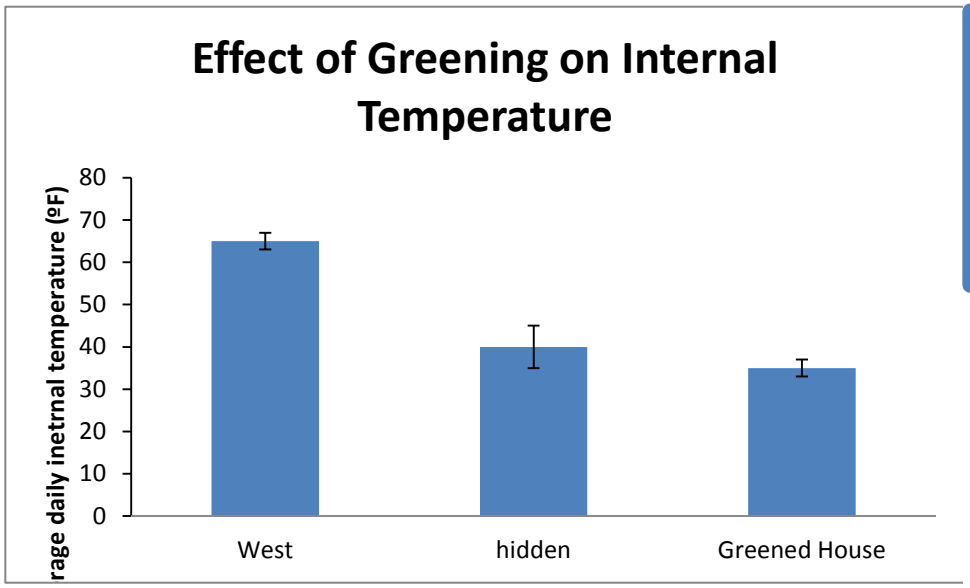



**Figure 1.**

The graph shows the relationship between sun exposure and internal building temperatures. Buildings directly facing the sun were much hotter than those facing away. Notice that the class to the east, the direction where the sun rises, is the hottest of all classrooms investigated, while the class that is hidden from the sun has the lowest internal temperature.

Cooling effect




*Notice the 30° difference in temperature between non-greened and greened space*

**Figure 2.**

The greened-house in our study was positioned in a westerly direction. A comparison between the west classroom and the greened house was carried out. We also found similarities in the temperature of the hidden classroom to that of the greened house. This experiment clearly shows that buildings not exposed to the sun, and those covered and surrounded by trees have lower internal heat.

This is in keeping with our findings that showed greening to reduce surface heat on walls and rooms by 6 degrees.

**Figure 3**

Picture of house examined

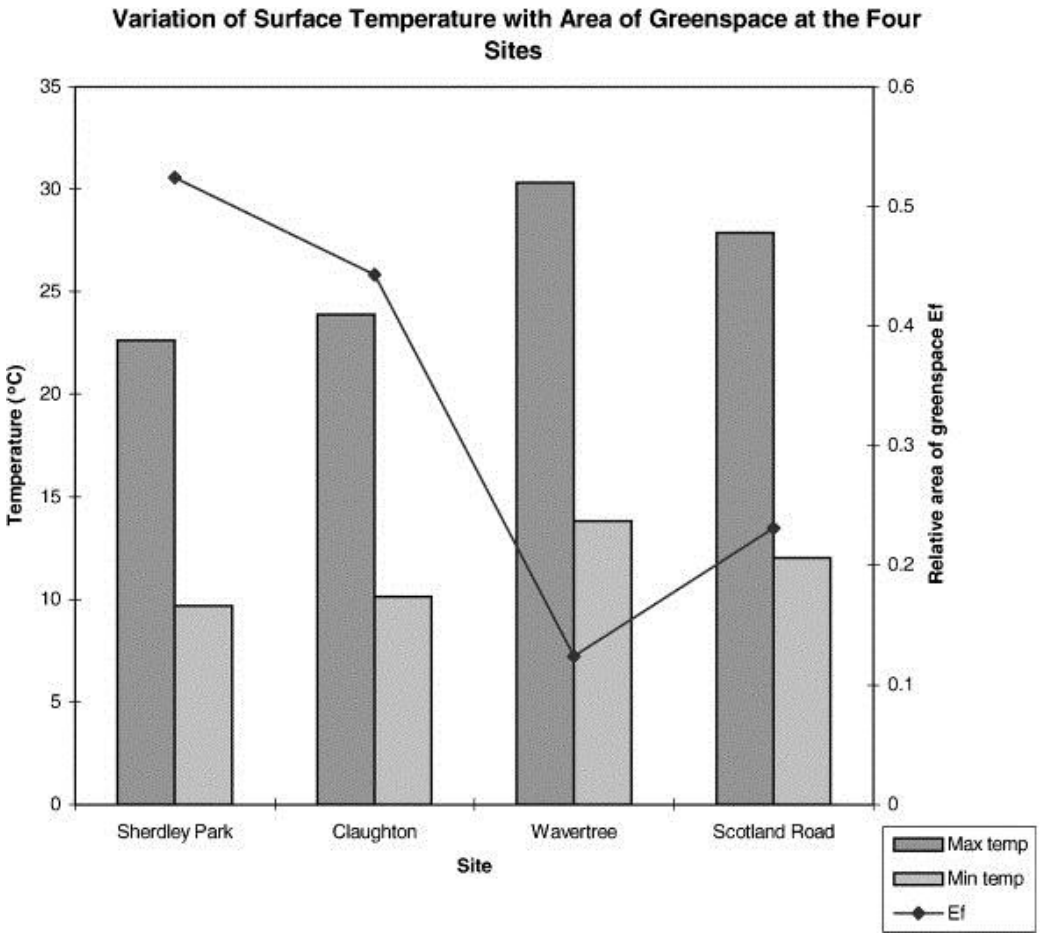



**Figure 4**

Houses in **Sherdley Park, which have ample green spaces,** show **lower** wall surface **temperatures** than houses in **Wavetree,** which have smaller green spaces.

The graph clearly shows a correlation between size of green space (right y axis) and wall surface temperature (left y axis) [7].

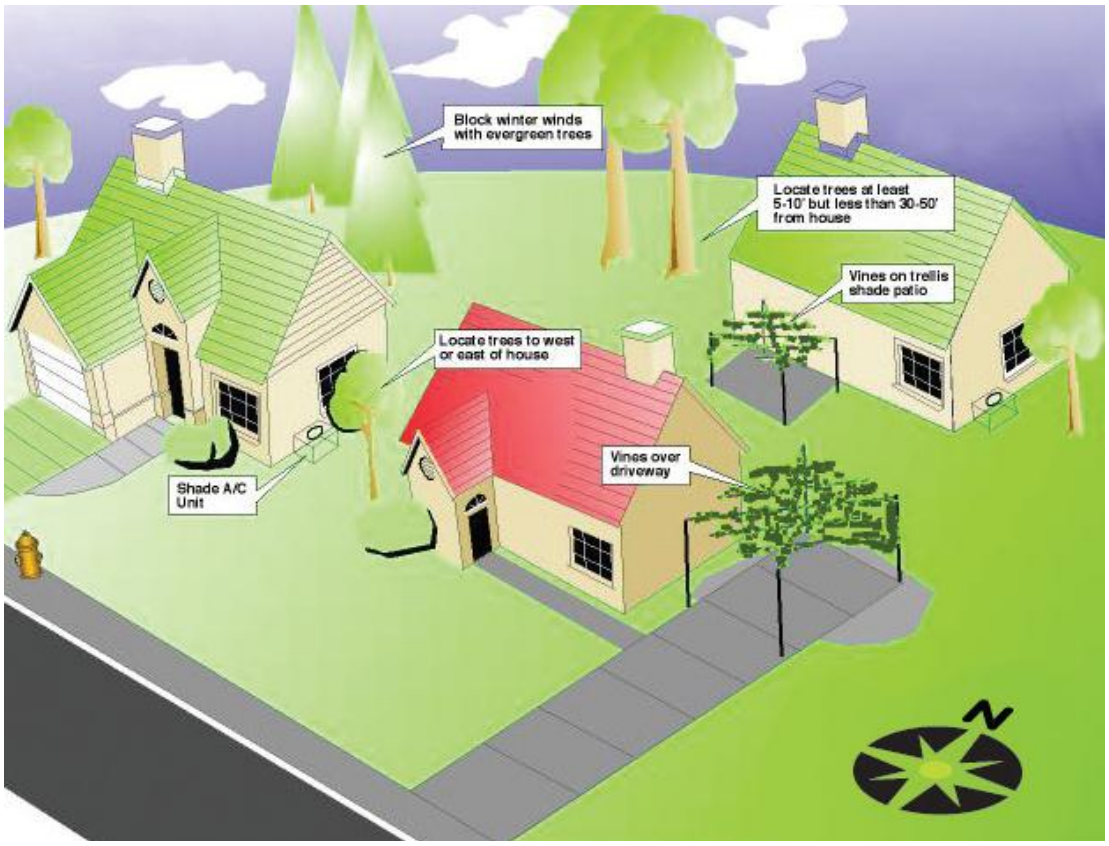



**Figure 5**

According to www.epa.gov/hiri/resources/pdf/TreesandVegCompendium.pdf, picking the right trees and putting them in the right location will maximize their ability to shade buildings and lower energy cost throughout the year, as surface temperatures will be lowered by 25–77 ºF.

Taken from http://inhabitat.com/trees-for-a-green-la/

**Figure 6**

Adding vines to buildings can reduce surface temperatures by up to 20 ºC [2].

Foliage cover

Studies show that higher foliage coverage varies among plants and affects ground coverage.

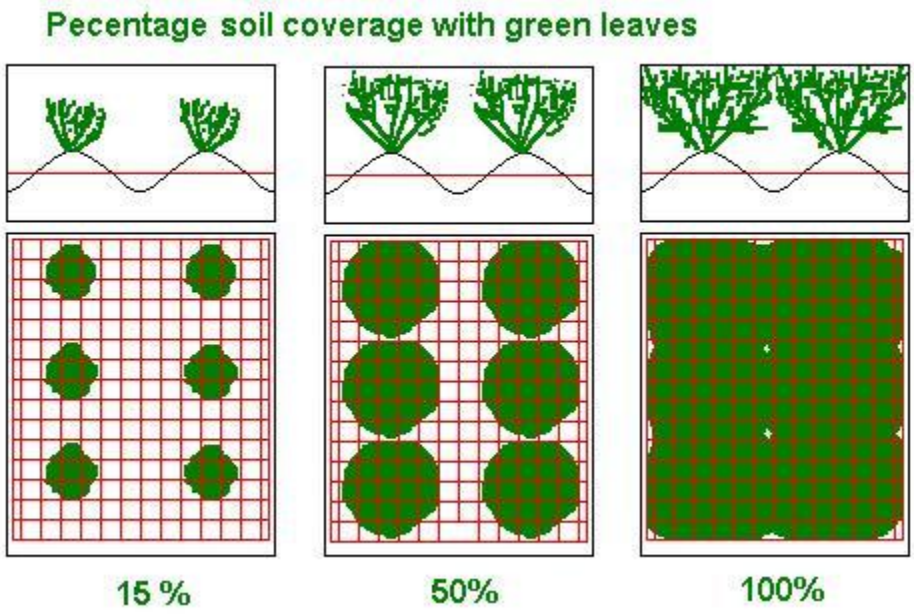



**Figure 7**

**Increase foliage coverage reduces surface heat exposure from the sun.** Plants utilise approximately 70% of the solar energy present on hot summer days, allowing only 30% to reach to the ground [2]. **Increase coverage leads to increased ground cooling and heat loss via transpiration. Pollutants are also reduced as they are trapped by leaves.**

Drainage

**Figure 8**

According to http://lscgreen.files.wordpress.com/2010/07/img_3638.jpg, green walkways offer benefits related to drainage. **They assist in rain-water drainage and soil percolation** in heavily developed urban areas.

Maintainenance

One in five-city study found that on a per tree basis, cities accrued benefits ranging from roughly $1.50 to $3.00 US for every dollar invested. These **cities spent about $15–65 US annually** per tree, with **net benefits ranging from approximately $30–90 US per tree** [2].

**Conclusion**

Based on the findings above, the benefits of greening far outweigh the cost [2].

1. Greening reduces internal temperatures of buildings
    a. By extension, this will reduce cooling costs.
2. Greening walkways improves soil drainage
    a. Reduces pooling
    b. Reduces water runoffs
        i. Reduces water pollution in surrounding waters
3. Greening reduces air pollution

**Implementation strategy**

Given these results, we propose to build green spaces by:

1. Creating rooftop gardens on some of our buildings
2. Affixing window boxes to some classrooms
3. Placing vine trestles on alternating east- and west-facing building walls (it is also possible to create an aesthetically appealing building and less of a jungle look)
4. To have planter boxes/vases in front of buildings facing the sun
    a. To place planter boxes near the air-conditioner condenser of the computer block
5. Planting shade trees near driveways
6. Breaking up fully paved walkways to allow grass to be planted between the tiles

Points 1–5 are according to biology and chemistry. In particular:

- The process of photosynthesis
    - Plants utilises solar energy to capture heat and use it to manufacture food, and thus more heat is absorbed by the plants.
- The importance of trees in the water cycle
    - Plants take up water by their roots and release it into the atmosphere by the stomata as water vapour, which forms clouds and eventually leads to precipitation.

Point 5 is according to chemistry and physics, and points 4–6 are according to the laws of thermo-cooling, namely:

- Kinetic energy and gas laws
    - As temperature rises, the volume of gas increases.
    - As gases expand, they display random movement and can escape from their container.
- Point 6 deals with absorptive materials and water percolation.

The overall cost of this project is minimal, apart from point 6, considering that the forestry department constantly gives away plants on Tree Planting Day.

The improved contribution to the environment and individuals attending the school will pollution is reduced, students are comfortable and classes are taught in a better learning environment. Studies have also shown that trees tend to create a calming effect.

**Reference**


1. Climate Change and Urban Green Spaces retrieved from www.communities.gov.uk

2. Reducing urban heat islands: Compendium of strategies trees and vegetation (2012) retrieved from www.epa.gov/hiri/resources/pdf/TreesandVegCompendium.pdf

3. Water cycle (2012) retrieved from http://en.wikipedia.org/wiki/Water_cycle

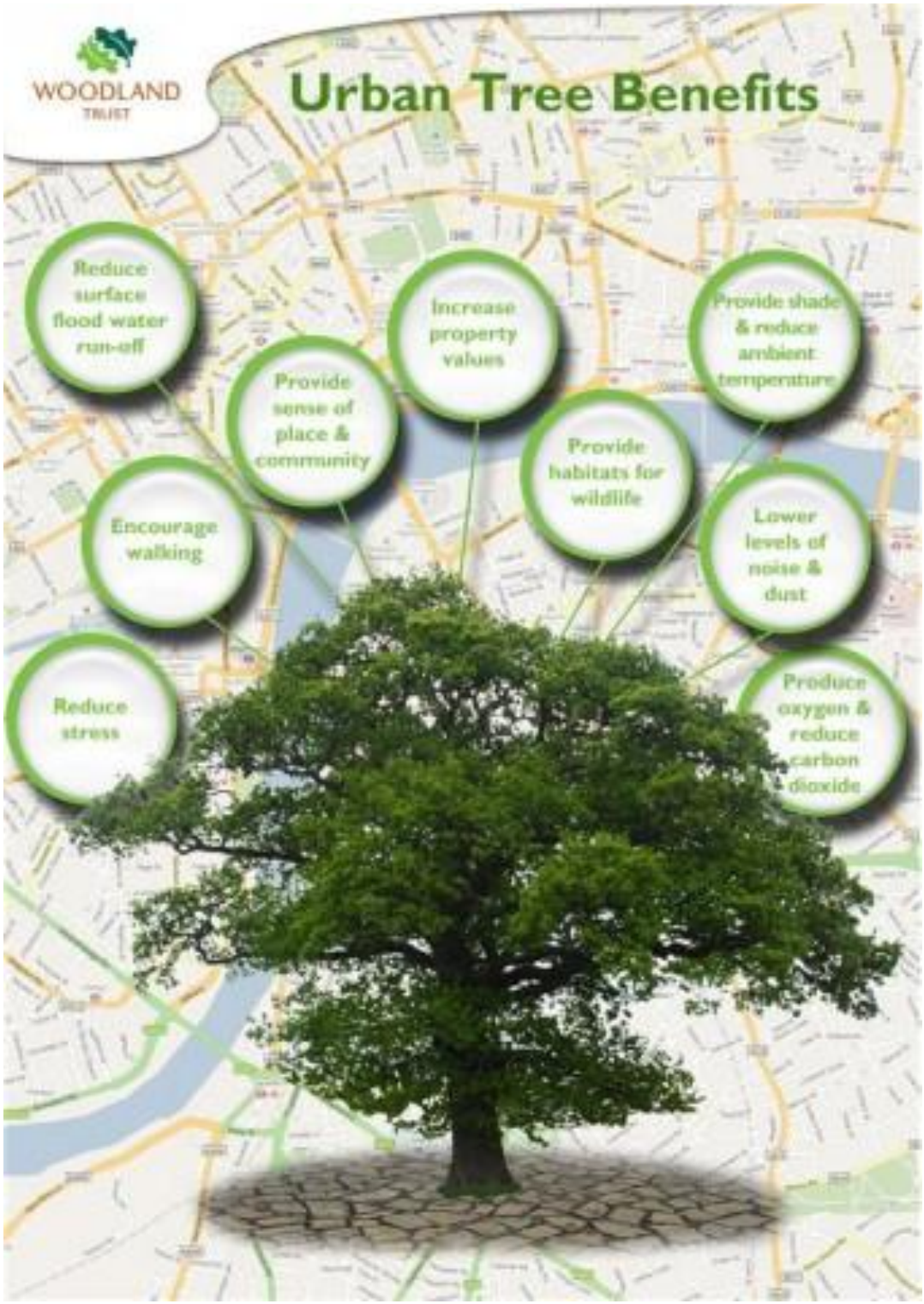
4. http://en.wikipedia.org/wiki/Kingston,_Jamaica

5. The Gleaner (2009) retrieved from http://jamaica-gleaner.com/gleaner/20091204/lead/lead6.html

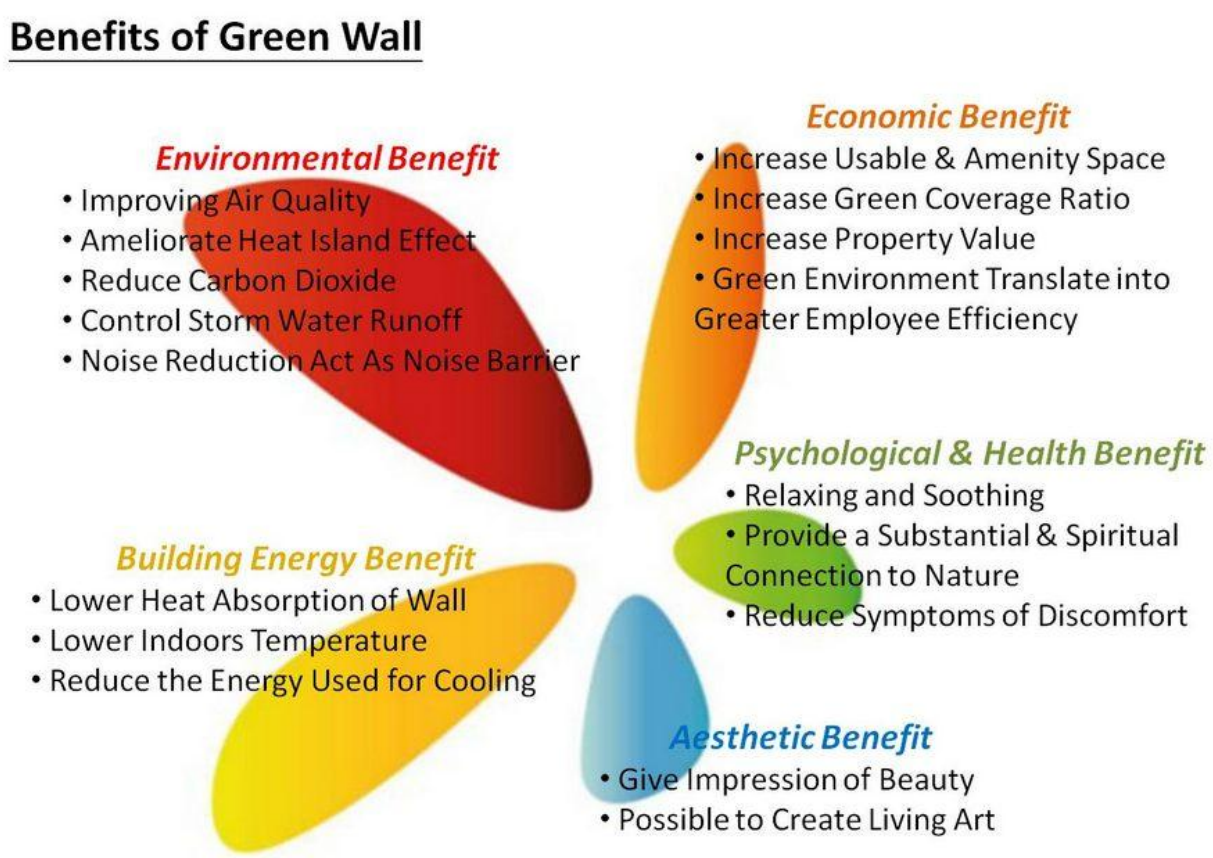
6. http://www.forestry.gov.uk/fr/INFD-8AEFL5

7. Whiteford et al., 2001

Overall benefits to greening




Taken from http://www.sustainablecitiesnet.com/research/greening-the-concrete-jungle-report/




Taken from http://www.innogreen.com.hk/VerticalGreening.php?id=22