LONDON

The Vertical Garden City &
The Transformative Power of Roof Gardens

MA Thesis by Heather Shimmin

LONDON

The Vertical Garden City and the Transformative Power of Roof Gardens

Heather Shimmin

MA in Historical and Sustainable Architecture Thesis

New York University

1 May 2012

Table of Contents

Gardens are about potential, and gardening is a metaphor for the exercise of the imagination.

- TODD LONGSTAFFE-GOWAN

A roof. The lid on a container that keeps the inhabitants dry from the rain, shaded from the sun, protected from the wind, and shielded from the falling snow. Roofs come in all shapes and sizes, made from the softest fabrics to the hardest stone. Roofs are common, ordinary, ever present, and generally not thought of until they leak. But roofs are powerful things, bursting with potential. A roof could be a floor for sleeping on in the summer, a patio for luncheons, a biergarten on weekends, a place to keep carrier pigeons, have an apiary, grow a vegetable garden, install photovoltaic panels, plant a tree...In short, roofs can provide the space for something that is lacking below on street level.

With fifty percent of the world's population living in cities, that something which is lacking below at street level is public parks, gardens, farmland, allotments, and space for clean energy sources. More and more people are occupying less and less space. Cities cannot grow enough of their own food. The air is filled with harmful particulate matter, and energy is generated from carbon-emitting fossil fuels. Spaces for recreating are becoming few and far between. The need has never been greater in London for open spaces, green spaces, beautiful spaces.

The benefits of parks and gardens to urban areas are numerous and affect every aspect of life: social, economic, environmental. Gardens improve the lives of individuals as well as society as a whole. Plants clean the air, lower temperatures, provide habitats for birds and wildlife, and enhance the overall quality of life. Parks are places for people to gather, to socialize, and recreate. Humans have an innate, biological need to connect with nature and other living organisms. The health of individuals as well as cities depend on its parks and green spaces.

London's green spaces are at risk. The disappearance of London's parks, gardens, and open spaces is more than just aesthetics, more than just the loss of a bit of grass, a football field, or a few flower beds. These vital patches of verdure are being sold and developed. It is putting London in a vulnerable place in the face of climate change and is exacerbating the growing problem of the lack of public space.

The overlooked and underutilized roof has the capability of replacing the green space that has been lost on the ground. London is a sea of vacant rooftops filled with rubbish, air conditioning units, ventilation shafts, and water tanks. Lack of public space, diminishing wildlife, shrinking agricultural land, and London's vulnerability to the effects of climate change are not elusive, unsolvable problems. Planting roof gardens in the form of both intensive, extensive, and everything in between, can help solve these and other serious problems London faces. London has the potential of becoming what Ebenezer Howard called a "Garden City" - part town, part country - usurping the benefits of country

living in an urban setting without bringing down a single building. Roof gardens can turn London into a Vertical Garden City, a sustainable city, a city which actually improves the health of its inhabitants rather than harms it, by embracing Britain's love for gardening and creating thoughtful and more aggressive green roof policies.

A BRIEF HISTORY OF ROOF GARDENS

Gardeners instinctively know that flowers and plants are a continuum and that the wheel of garden history will always be coming full circle.

- FRANCIS CABOT LOWELL

There is something magical about a roof garden. Parks and backyard gardens are wondrous places, but when they are placed high above the earth on a rooftop, where they are not supposed to be, the experience becomes invigorating and unforgettable. In a roof garden, the air seems fresher, the grass appears greener, the city feels further away than it actually is.

From the beginning of recorded history, people have been building gardens on their roofs. From the famous Hanging Gardens of Babylon to the Rockefeller Centre in New York, the roof garden has been a part of civilized society. Roof gardens have been used as extensions of living rooms, displays of wealth and social status, gathering grounds for the elite, and places to escape the summer heat. They have also been used as insulation, a means of flood control, a place to grow food, and as camouflage. Green roofs have been an essential feature of vernacular architecture and in many instances has been vital to human survival. "Modern" civilisation is slowly rediscovering the astonishing benefits of vegetated roofs.

THE ZIGGURATS OF ANCIENT MESOPOTAMIA

The earliest known record of roof gardens are the ancient ziggurats of Mesopotamia. These massive stone structures were built between 4,000 - 600 BC. A series of stairs along the outside perimeter of the stepped pyramid provided access to the various tiers of the

Figure 1: A ziggurat which closely resembles that in Nanna built by the first king of the Ur Dynasty, Ur-Nammu. The tiers of trees provided shade from the blazing Babylonian sun.

structure. As there were no interior rooms, trees and flowers on each terrace of the enormous ziggurats would provide a cool, shady place for the visitor to rest from the blazing Babylonian sun. The best preserved example of a ziggurat roof garden is found in Nanna, built by the first king of the Ur

Dynasty, Ur-Nammu (who ruled from 2,113 - 2,095 BC) in an attempt to out do the splendor of the ziggurat Etemenaki, believed to be the Biblical Tower of Babel which had a base of 100 feet and was over 100 feet tall. The 700 room palace was protected by the Ishtar Gate, found in present day Iraq. Fragments of the gate are kept at the Pergamonmuseum in Berlin, Germany.

The Hanging Gardens of Babylon

The Hanging Gardens of Babylon are one of the Seven Wonders of the Ancient World and

Figure 2: Artist's rendition of the Hanging Gardens of Babylon, one of the Seven Wonders of the Ancient World.

perhaps the most famous of roof gardens. King Nebuchadnezzar, a famous general in his time, built the Hanging Gardens for his wife, Amytis, who longed for her mountainous homeland of Media.[1] The ziggurat had a 400 ft[2] base, with landscaped terraces eventually reaching the grand roof garden at the top, 75 feet above the ground.[2] It was an engineering marvel, a living mountain in the middle of a desert. The terraced layout explains the phrase "hanging garden," where the vegetation hung over the walls to the level below.

The weight of the garden was supported by a series of arcades whose walls were sixteen feet thick. The garden was watered through a complex irrigation system fed by "machines" hidden from public view that pumped water from the river Euphrates eighty feet below to the top of the roof garden.[3] The structure supported a forest of trees, exotic plants, wildlife, and perpetually green grass. Some trees grew to be as tall as 50 feet.

The Villa of Mysteries, Pompeii

Little was known about Roman day to day life until the accidental discovery of the city of Pompeii, near Naples, in 1749. Pompeii was covered in thirteen to twenty feet of ash and pumice from the volcanic eruption of Mt Vesuvius in AD 79, preserving almost perfectly for all time the people, activities, and lifestyle of the Roman town like a candid snapshot from a Polaroid Instamatic. From this snapshot

[1] This point is not agreed upon by scholars. Diodorus Siculous (c. 50 BC), an oft-quoted writer describing the Hanging Gardens in detail, believed that the gardens were not built for Nebuchadnezzar's wife, but for his concubine, a Persian woman who missed her mountainous homeland.

[2] Diodorus Sinulous' writings on the Hanging Gardens describes the gardens as being 50 cubits above the ground. Using the standard UK cubit to foot conversion, 50 cubits is about 75 feet.

[3] Peter A. Clayton and Martin Price Seven Wonders of the Ancient World (London: Routledge, 1988) 43-44.

archaeologists have discovered that roof gardens were an essentail part of Roman life. They were an extension of the living room, a place to seek refuge from the heat, a place to socialize and to dine. One such roof garden was found in the Villa of Mysteries, near the northwest gate of Pompeii on the road to

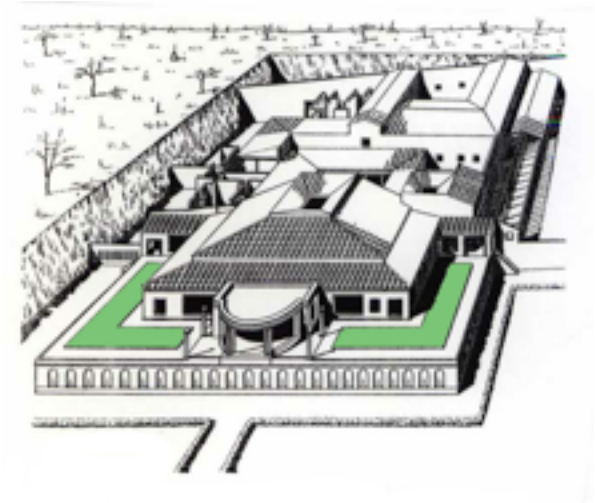

Figure 3: Reconstruction of the Villa of Mysteries, near Pompeii, Italy, which sits on the Road to Herculaneum. The luxurious villa was preserved after the eruption of Mt Vesusius in AD 79. The roof garden (in green) functioned as an outdoor living room and was the centre of social activity. The garden was supported by an arched stone colonnade.

Herculaneum. The Villa was a U-shaped terraced arcade where plants were grown directly in the soil on the roof.

Palazzo Piccolomini, Pienza, Italy

The Palazzo Piccolomini was the private summer residence of Pope Pius II. The palazzo was part of a wider development plan Pope Pius envisaged for Pienza, his home town, which was in a dreadful state. The scheme for Pienza is one of the first examples of Renaissance town planning. The project has been celebrated as a successful creation of an ideal town, a masterpiece of human creative genius.[4]

The design of Pienza marks the transition from the organic, haphazard jumble of the medieval town to the planned Renaissance city. The most ingenious and innovative feature of the scheme was the introduction of the piazza, a central square on which people could gather,

Figure 4: Garden loggia atop the Palazzo in Poccolomini, Pienza overlooking the Val D'Oria. It was commissioned in c. 1463 by Pope Pius II. This is one of the first examples of concept of "landscape" as something manmade.

socialize, and enjoy the delicious Italian summer sun. In Pienza, the piazza was surrounded by public buildings, including the town hall and cathedral. The piazza was a physical representation of the Pope's humanistic values and the desire to increase the quality of life for Everyman.

[4] "Historic Centre of the City of Pienza" UNECSO World Heritage List, 11 March 2012, http://whc.unesco.org/en/list/789.

In 1463, Pope Pius II commissioned Bernardo Rossellino to design a palazzo for his personal summer residence. Atop this palazzo, a magnificent roof garden filled with sculpted trees and manicured parterres overlooked the Val D'Oria, a manufactured agrarian landscape designed to be both functional and beautiful. The carefully planned and executed Val D'Oria was the perfect backdrop to the exotic roof garden, a seamless transition for the eye from the landscape above street level to the valley below, as if looking down from a mountaintop. This is the first known example of the then new concept of "landscape" being something controlled and manipulated by man.

Norwegian Sod Roofs

Not all roof gardens were designed to impress. Sod roofs, roofs topped with soil and planted with grasses and other plants to stabilize the earth on the roof, were part of the Norwegian vernacular. Sod roofs provided insulation, mitigated damage to the roof from the rain, prevented the roof from rotting, and the root system bound and strengthened the roof structure. A layer of birch bark was laid down as a sealing membrane, followed by a layer of twigs for drainage, then covered in sod. A similar sod roof technique was brought to the United States and Canada by Norwegian immigrants.

Figure 5: A sod roof in Milton, North Dakota, built by Ole Myrvik, a Norwegian Immigrant, c. 1896. Sod roofs were common in Norway because they added an additional layer of insulation and protection to the house. Norwegian immigrants brought the technique with them to the US and Canada.

Casino Theatre, New York City

Gardens on rooftops started popping up in New York City in the 1890s. Investors believed roof gardens would overshadow all other forms of summer entertainment and would become a necessity part of life for New Yorkers.[5] The first roof garden in New York City was built on the Casino Theatre at 39th and Broadway in 1882. This project was conceived by conductor and musician Rudolph Aronson, who was enchanted by the Parisian summer theatre gardens he had experienced during his visit to Europe the previous summer. The price of land in New York was too expensive to duplicate the European garden stage model on the ground, so Aronson incorporated the idea of a stage surrounded by plants and trees on the roof. By adding the roof garden, the Casino Theatre could extend its productions all through the summer months in the heart of New York's theatre district. At this time, theatres in New York would only run during the winter months. Summer theatres would open in the suburbs and less populated areas in the state. The Casino Theatre quickly

[5] Paul Van du Zee "New York Roof Gardens," Godey's Magazine July to December 1894: 201.

Figure 6: The Casino Theatre, New York City, as seen on a postcard stamped March 1909. The Casino Theatre was the first theatre to install a roof garden in New York City, extenting its shows through the summer months.

became the most successful theatre in New York, spurring other theatres to add gardens to their roofs. The most well known examples are Madison Square Gardens and Winter Gardens, both of which get their names from their roof gardens.

Wright, Le Corbusier, & Modern Architecture

Architecture changed dramatically in the early 20th century. Modernists such as Frank Lloyd Wright and Le Corbusier broke free from the bonds of historical architecture, introducing a completely new form of design that had no reference to the past. Le Corburiser's *Cinq Points de l'Architecture Moderne*[6] became the new model for architectural design and theory. The 5th Point, the roof garden or terrace, was a flat roof intended to be an outdoor living room, a place to exercise and to enjoy the fresh air, rather than a literal garden with plants and trees. Le Corbusier considered the roof to be an "exterior room, a place to be within and to look without."[7] Modern architecture's flat roof provides the perfect platform on which to build a vegetated roof. In the 1930s, Le Corbusier was brought on as a consultant on two projects in Brazil - the Ministry of Education building in Rio de Janeiro (1938) and the Brazilian Press Association building (1940) - where landscape architect Roberto Burle Marx designed the roof gardens.

[6] Le Corbusier's Cinq Points are: pilots, an open plan, a free façade, ribbon windows and a roof garden (flat roof). Le Corbusier never went so far as to recommend an actual garden of trees and flowers be planted on the roof, however, he did see the roof terrace as an important part of everyday life. The terrace was designed for the pleasure of the residents of the building to exercise, take in fresh air, and enjoy the sunshine.

[7] Osmundson 125

THE ENGLISH GARDEN

The lesson I have thoroughly learnt, and wish to pass on to others, is to know the enduring happiness that the love of a garden gives.

- GERTRUDE JEKYLL

Gardens have been an important part of English life since Roman times. However, with the growing population, the rising cost of land, less available open space, inflated home prices, and smaller municipal budgets, the English Garden is under threat. Front yard gardens are being paved over for car parks, boroughs are selling off parks and open spaces to private individuals for development, and the untouchable Greenbelt is dangerously close to being touched by greedy developers.

What would Britain look like if the government hadn't the foresight to designate the Greenbelt in the 1940s? London's uncontrolled growth and expansion was eating up the countryside at an alarming rate. The Greenbelt was established to contain growth and preserve the landscape. "For [the Greenbelt's] supporters it has preserved cherished landscapes and the British way of life. Its critics claim it has hindered development, stifled growth and fuelled house price inflation."[8]

The Greenbelt has prevented London from turning into the senseless, hideous, urban sprawl that affects the majority of the United States. Many Britons fiercely protect their countryside, seeing it as invaluable and necessary, as important a part of English culture and identity as tea time, the Tower of London, or the double decker bus. Britons are afraid Greenbelt development will turn London into US-style low-rise sprawl,"[9] devoid of character and fundamentally changing the appearance of what is left of the English landscape. Arguments over building on London's sacred Greenbelt are heated and ongoing. The future of the Greenbelt is uncertain and it is questionable how long it will remain undeveloped.

A BRIEF HISTORY OF THE ENGLISH GARDEN

The English have always had an affinity for nature and gardening. Gardens were common during Roman occupation but did not play an important role in English life until the Middle Ages. Monastic kitchen and herbal gardens providing food and medicine were commonplace in Medieval Times. During the Reformation in the 16th century, landowners enclosed common land with fences or hedges to keep in deer and cattle. This "natural landscape" became very popular amongst wealthy landowners who built grand houses in

[8] Jon Kelly, "What Would Britain Look Like Without a Green Belt?" BBC News Magazine 15 September 2011.

[9] Kelly

the country surrounded by their own piece of hedged countryside. The "natural landscape" garden gave way to the Italian-inspired formal English Garden near the manor house with manicured parterres and hedges. In Tudor times, the garden aligned itself with the house, creating an elegance and symmetry that the medieval garden lacked.[10] House and garden were no longer two separate entities. One was the extension of the other. The 18th century brought a return to the "natural landscape," a reflection of the *Enlightenment* and an interest in all things natural. Gardens were no longer straight paths, grand avenues lined with conic trees, and precisely edged lawns, but instead winding trails, rolling hills, clusters of trees, and small ponds mimicking the natural landscape.

Figure 7: The front garden of this house in the conservation area of Queen's Park, London, has been paved over, without planning permission, for car parking. This increase in hard surfacing contributes to flooding, poor air quality, and the Heat Island Effect. Nearly half of London's front gardens have been paved over for car parking, an area equivelant to 22 times the size of Hyde Park.

Many of London's greatest green spaces were created as or designated to public spaces during the Victorian era including Green Park, Hyde Park, The Italian Terraces at Crystal Palace, and Hampstead Heath.[11] Public Parks and Squares became the vogue during Victorian London. The Victorians believed that parks would solve the ills of society, bring culture to the masses, cure drunkenness, and put an end to cock fighting, prostitution and all other "brutalizing pleasures."[12] The fresh air, the green grass, the cool shade of a tree were thought to be an elixir to Victorian Britain's post-industrial environmental and social woes.

The 20th century looked with nostalgia to the past and simpler times. The cottage garden, gardens laid out in color schemes with herbaceous borders and creepers trained on trellises and walls, became popular again. The movement was lead by Gertrude Jekyll, one of the most influential landscape designers of the 20th century.

---

[10] No surviving example of a Tudor Garden exists, however, the closest one can find in the spirit of the Tudor Garden can be found at Hampton Court Palace where a recreation of a Tudor Knot Garden can be seen (created in in the 20th century).

[11] Victorian Parks, Cemeteries, and other Green Spaces. The Victorian Web, 25 May 2011, http://www.victorianweb.org/art/parks/index.html.

[12] Reynolds 44

Despite Britain's long history and love for the natural landscape, the English garden is under threat. Sir Martin Doughty, chairman of Natural England, stated that nearly half of all London's front gardens had been paved over for car parking, an area 22 times the size of Hyde Park. The loss of these front gardens have reduced havens for wildlife, increased the impact of flash flooding and contribute to climate change.[13]

EBENEZER HOWARD AND THE GARDEN CITY

In 1898, Ebenezer Howard published *To-morrow: a Peaceful Path to Real Reform* (reissued in 1902 as *Garden Cities of To-morrow*), a Utopian vision of what cities should be like - part town, part country - with all of the conveniences of city life in a country setting. The Garden City is surrounded by farms, fruit trees, allotments, and cow pastures. Howard's theories addressed London's continuous and rapid growth that was unplanned, unorganized, and gobbling up the English countryside. His idea of planned communities surrounded by open land quickly became part of Britain's town planning ethos and inspired the New Towns Act of 1946.

Figure 8: Sketch of the Garden City model by Ebenezer Howard. The city is a series of conentric rings, surrounded by green space for parks, arguculture, cow pastures, and fruit trees. Howard felt his Garden City plan would provide the best features of town and country living.

It is impossible to turn London into Howard's vision of a Garden City, however, it is not impossible to turn London into a garden city. The garden will be just a little bit higher than Howard envisioned - on the roof.

LONDON SMOG

Since the 13th century, London has used sea-coal as its primary energy source.[14] As the demand for coal grew, particularly during the 18th and 19th centuries, so did London's smog, pollution, and filth. People moved *en masse* to London and other European capital cities during The Industrial Revolution.[15] With the surge in London's population came an increase of pollution, disease, and overcrowding. By the 19th century, London had the worst reputation in Europe, known for its "filth, air pollution, and squalor."[16]

---

[13] "England's Garden's 'Under Threat.'"BBC.18 July 2007, http://news.bbc.co.uk/2/hi/uk_news/england/6904260.stm.

[14] Soft and inexpensive coal transported from the sea.

[15] The English Industrial Revolution is generally accepted to be between 1750-1850.

[16] Audrey le Lievre "Gardens Among the Chimneypots" Country Life. 16 March 1989: 120.

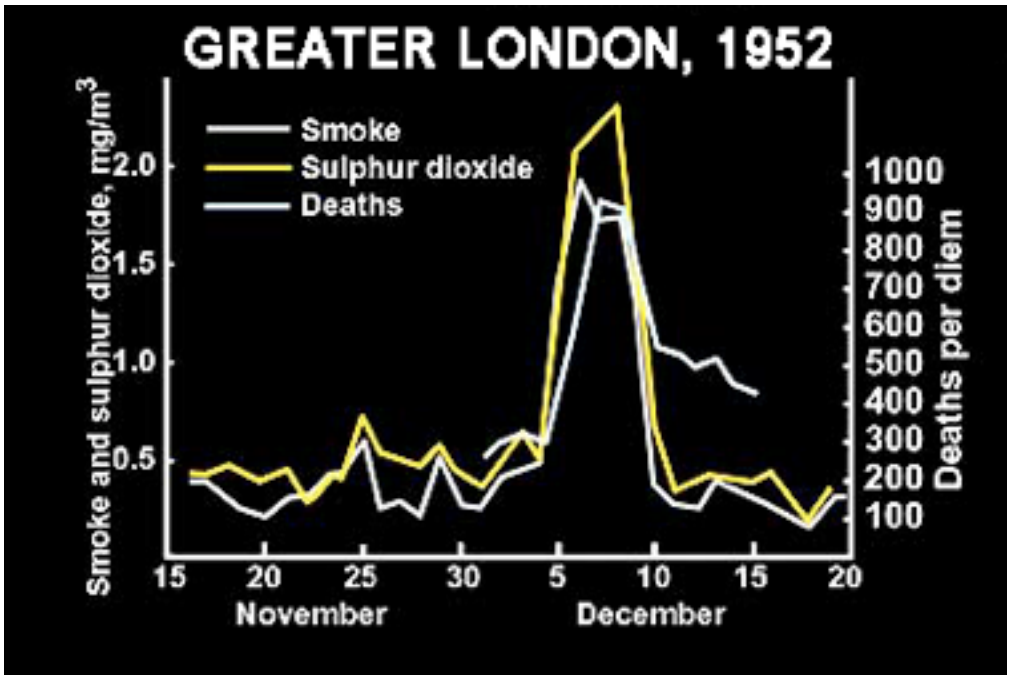

Figure 9: The smoke and sulphur dioxide present in the air in Greater London, and the number of deaths per diem between 15 November and 20 December 1952.

The wealthy dealt with the undesirable aspects of London by retreating to their country estates where the air was fresher, the temperatures cooler, and the landscape filled with trees, plants, and wildlife. These grand country houses had sprawling, natural landscaped gardens, and provided an escape from the dirty, overcrowded streets. The air quality was so poor in London that outdoor plants had to "overwintered in [the] country air before facing another London summer."[17] The majority of Londoners, however, did not have the option of going to the country to escape the dangerously polluted city air and had no choice but to suffer through it.

Those who were lucky enough to have a space for a small garden beside their homes in London would make that their country retreat, an escape to nature. The plot would also be used as a kitchen garden to grow fresh herbs and produce for the family.

Londoners have been campaigning for more trees, parks, and green space in the city for decades. In 1838, John Loudon suggested garret be converted to greenhouses as a way to combat London smog.[18] Jacob Först's proposed

[17] Ibid

[18] Ibid

solution to London's polluted air was to plug up all the chimneys, remove the roofs, and replace them with greenhouses and the dingy, filthy brick should be covered up with creepers and flowers.[19] W Bridges Adams' 1859 article

Figure 10: The Terrible London Fog of 1952. A traffic cop and double decker bus on 4 December 1952, the day that thousands of Londoners died from air pollution so thick one could hardly see one's hand in front of one's face.

"How to Convert London into a Garden" reminds the reader of the air purifying qualities of plants and vegetation, as well as their

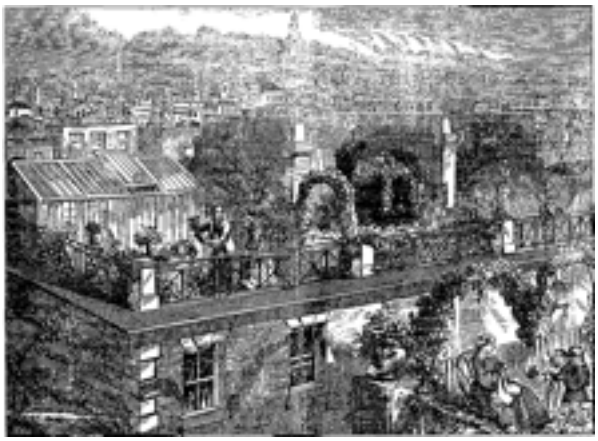

Figure 11: The idealised world of roof gardens, envisoned by W Bridges Adams in 1859. Bridges thought that roof gardens would clean the air as well as be an extension to the living room.

aesthetic qualities. Cities need more gardens, Adams insisted, but where to put them? "The space for gardens in [London] is equal to that of the whole city, less the streets and passages; in short, it is the whole space occupied by the buildings. So then the buildings are to be cleared away to convert the whole city into a garden? Not so, only the roofs of buildings."[20] He saw the roof as the ideal place for a garden. "Scarcely anything could be conceived more beautiful than the enormous expanse of London roofs covered with shrubs and flowers."[21]

But the pollution was not bad enough to evoke change. It was only when 4,000 Londoners died in four days in December 1952 from London smog that Parliament realised that something

[19] Ibid

[20] Adams 521

[21] Ibid 522

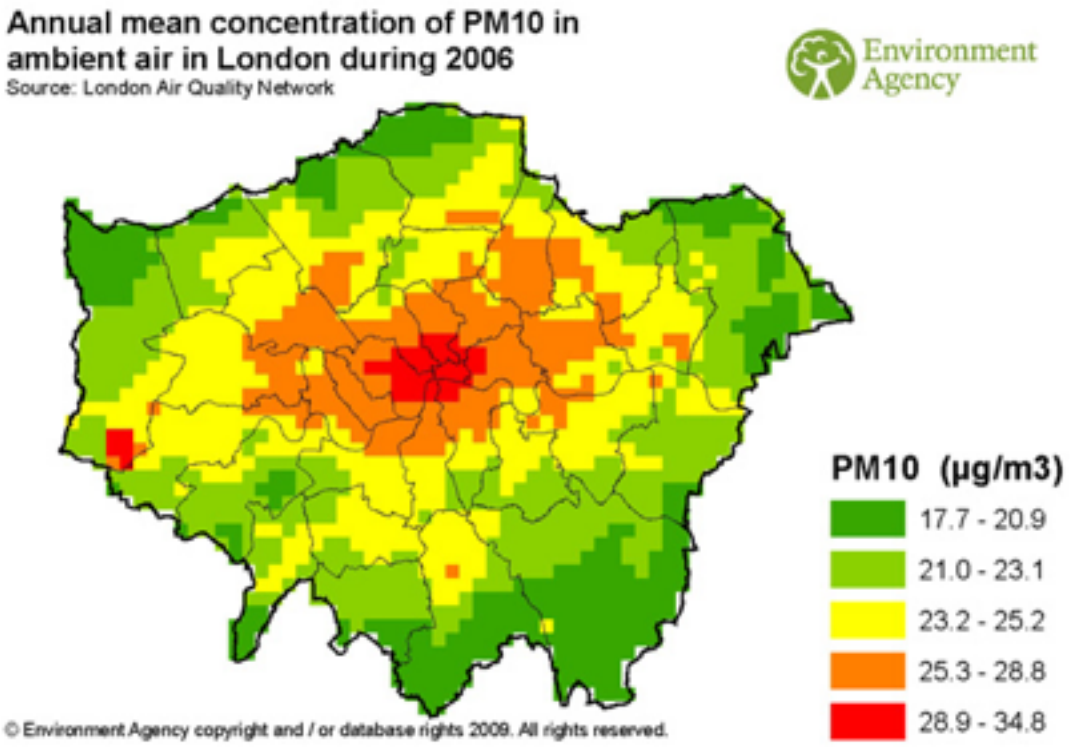

Figure 12: The concentration of PM_{10} levels in London in 2006. Since then, the levels of PM_{10} have actually *increased,* not decreased. London has been granted three extensions by the EU to meet air quality standards. No more extensions will be given and London has until June 2012 to bring PM_{10} levels down by more than 30 micrograms/m^2. In March of 2012, London's air quality was dangerously high and the only worry on the Lord Mayor's mind was the Olympics and how the air would effect the "world class atheletes."

ought to be done about London's air quality.[22] Four years later, Parliament passed the Clean Air Act of 1956, limiting the amount of coal burned in the city, followed by the 1968 Clean Air Act.

London's air quality today is not that much better than it was in the coal burning days of Charles Dickens.[23] London's air pollution is higher than any other city in Europe and is even worse than Los Angeles, California.[24] According to a 2008 study sponsored by the

[22] It is estimated that another 8,000 people died in the weeks following the "Great Smog" from respiratory complications.

[23] The first law passed regarding air quality in England was the Clean Air Act of 1956, The EU has also established an extensive body of legislation to improve overall air quality throughout Europe.

[24] According to James Thornton, CEO of Client Air (LBC "LBC Interview: Clean Earth's Clean Air for London Campaign," 29 July 2009).

GLA, an average of 50,000 people die in Britain annually from poor air quality-related health problems, 4,000 in London alone.[25] The number of reported deaths in London as a direct result of air pollution can be as high as 500 in a single day.[26] London has failed to meet any of the EU clean air standards and can no longer apply for an extension. The Mayor of London claims that air quality will improve in time for the 2012 Olympic Games in London, which seems unlikely considering that London's air pollution was at a record high in March of 2012.

Areas near London's busiest roads, such as Piccadilly and Marylebone, have the highest percentage of particulate matter (PM), harmful particles from dust, smoke, chemicals, and other pollutants that enter the lungs and bloodstream and cause many health problems, even death.[27] Reports from the the World Health Organization (WHO) show that a decrease in particulate matter (PM_{10}) from 70 to 20 micrograms/m^2 would reduce deaths in London by 15%. The average PM_{10} level in London is 50 micrograms/m^2, 30 points higher than what is deemed "safe" by the WHO.[28]

Countless studies have been conducted on the effects plants and trees have on air quality, especially in dense, highly polluted urban areas. In October 2011, a study on London's trees and their ability to remove atmospheric pollutants was published in the journal *Landscape and Urban Planning*. It concluded that "urban trees of the Greater London Authority (GLA) area remove somewhere between 850 and 2,000 tonnes of particulate pollution (PM_{10}) from the air every year."[29]

To help mitigate air pollution, London has created the "Big Tree Plant" initiative which intends on planting a variety of trees, including evergreen oak and pine, along the streets of Central London. Planting different types of evergreen trees not only creates biodiversity, but increases the amount of PM_{10} taken out of the air. Evergreen trees retain their leaves year round and are thus able to clean the air the entire year, as apposed to deciduous trees

---

[25] Brian G Miller Quality. *Report on Estimation of Mortality Impacts of Particulate Air Pollution in London*, June 2010.

[26] Greater London Authority "What Effects Does Air Pollution Have on Londoners' Health?" n.d. London.gov.uk, http://www.london.gov.uk/air-quality/health.

[27] Particulate matter (PM): also referred to as particulate pollution, is a mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Particulate pollution can harm the human respiratory and cardiovascular systems, and is linked to asthma and mortality. Research shows that particles with a diameter of ten microns and smaller (PM_{10}) are likely to be inhaled deep into the respiratory tract. As smaller particles can penetrate deeper, the health impacts of $PM_{2.5}$ are especially significant.

[28] LBC Interview: Clean Earth's Clean Air for London Campaign.

[29] University of Southampton. "How trees clean the air in London." *ScienceDaily*, 5 Oct. 2011, http://www.sciencedaily.com/releases/2011/10/111005110800.htm.

which lose their leaves annually. The Big Tree Plant's goal is to plant 1 million trees by 2015.

In conjunction with the program, the GLA is offering £4.2m in free trees to civic groups and communities in the Greater London area. The program has great intentions, however, Central London simply does not have the space to plant thousands of trees. If one assumes that each tree in this scheme costs £100, then 42,000 trees are available for planting. Conservatively, a tree needs about $2m^2$ to grow, which means that $84,000m^2$ of available land is needed to plant these trees in London. The good news is, 26,000 hectares ($260,000,000\ m^2$) are available on the roofs of Central London.[30]

AN ATTACK ON PUBLIC SPACE

Cities have the capability of providing something for everybody, only because, and only when, they are created by everybody.

- JANE JACOBS

Public space represents democracy, the common good, and stands in opposition to private space with private interests. Public space should be open to all, known to all, and available to all. It represents the right to gather, to interact, exchange ideas, hold meetings, and voice opinions. By being open to all, public space embraces a city's diversity, promotes understanding and acceptance, and exposes others to different ways of seeing and doing things. "Public space serves as [a] barometer of the democratic well-being and inclusiveness of our present society."[31] Like art, public space parallels society - what it values, how it thinks and treats others, its ethos. How public space

Figure 13: A New Yorker passing through the "tighest security in recent memory" as he tries to go the 9/11 Mermorial, a public park, in Manhattan.

is perceived, handled by those in control, and viewed by the citizens around it is a direct reflection upon society.

Despite its betterment of society, public space is under threat. Since 9/11, governments have used terrorism, homeland security, and public safety as an excuse to assert their authority and control of public spaces. Visitors wishing to see "public" areas such as the 9/11 Memorial in New York City or the Reichstag in Berlin, must pass through metal detectors and scanners, presenting a valid form of photo ID (at the Reichstag only a passport is accepted) in order to enter. Guards and officers mill about these public buildings and squares intimidating

[30] Gyongyver Kadas "Rare Invertebrates Colonizing Green Roofs in London" *Urban Habitats* (December 2008), 66.

[31] Hov 16

and bullying guests all in the name of anti-terrorism measures and public safety. The level of security in airports are dwarfed by comparison.

Development is also threatening public space. Land values are too high to be "wasted" on public space. For this reason, public parks, gardens, and playing fields are all at risk of being sold as city budgets get thinner and thinner. As cities become more and more dense, the temptation for civic municipalities to sell off open land for development is irresistible. In March 2012, *The Londonist* revealed that over the past three years, London burrough councils have been quietly selling off public land to private developers. A total of 471,902 m^2 of green space, including playing fields, gardens, playgrounds, allotments and public parks, were sold to private developers for £69m.[32] Borough Councils were presented with an opportunity to make money and they took it - at the public's expense.

It is not just public parks that are at risk. Cases that were fought (and thought to have been won) over green space years ago are being opened again. The Newcastle City Council has just approved a massive housing development scheme in Newcastle-upon-Tyne. It is proposed that 600 homes be built in and around the Gosforth Park Nature Reserve, a protected wildlife habitat providing an urban refuge to deer, birds, and other local wildlife since 1929.[33] The City Council has gone to great lengths to keep this scheme quiet. Protests from local residents and members of the Gosforth Park Nature Reserve and other wildlife protection organizations are still ensuing and a final decision has not be reached at the time of this writing. It appears that no land is safe or secure from being sold and developed, regardless of how long it has been "protected."

Pseudo-Public Spaces

Cities are desperate to generate revenue and boost their local economy. When budgets are tight, one of the first areas to suffer is the upkeep of parks and green spaces. In many cases, cities turn to corporate ownership and the privatization of these public spaces as a way to keep and maintain them. The government, and even the corporations themselves, defend this migration of public land into private hands by using scare tactics; the government simply does not have the resources to properly maintain the public realm; the properties are being neglected and would do much better in the hands of private ownership; under private

---

[32] Other types of public land that was sold include: docks, parks, football pitches, a museum garden, "overgrown land," grassy areas, and grazing areas. Barnet council sold the most land - 147,298 square meters. Bethph "London's Great Green Space Sell-Off" *The Londonist,* 7 March 2012, http://londonist.com/2012/03/londons-great-green-space-sell-off.php.

[33] Gosforth Park Nature Reserve," Natural History Society of Northumbria. n.d., http://www.nhsn.ncl.ac.uk/resources-gosforth-nature-reserve.php.

ownership there will be "less litter, less chaos;" citizens will be safer.[34]

By privatising public space, control over these spaces is transferred from the city (the people) to a corporation (private hands). This practice has been increasing in popularity over the last few decades. "The control of public space is now a worldwide phenomenon that shows how *form follows capital*."[35] The privatization of public space in the name of public good, where downtown and suburban areas are turned into themed malls, festival markets, and trendy shopping areas, is an attempt to emulate the successful "public space" model of the past, hoping to capitalise on the success of Medieval markets, pedestrian only promenades, windy streets and corner pubs, fromageries and butcher shops. But "as streets, neighbourhoods, and parks become malls, gated communities, and corporate venues, public spaces become subjected to new forms of ownership, commodification and control."[36] These areas are segregated from rest of the community in order to suggest that the area is safe and secure. These corporate-sponsored urban spaces are open to the public so long as they spend their money, behave in a prescribed manner, and do not loiter. With this transfer of ownership comes an increase in control, new rules, regulations, and restrictions which make public spaces anything but public. The little details of public spaces that give a place personality are being erased by globalized commerce, planning rules and codes of conduct, and cookie cutter landscaping. "Public space is increasingly anodyne - the role of people, our role, is expected to mimic that of the stick men glued to an architect's model. We are inert decoration, only allowed to spend time in public space if we have money to spend there too."[37] The privatization of public spaces is creating large, soulless developments devoid of personality and freedom. This is occurring at a rapid rate across the UK and the United States, all in the name of public safety, economic growth, job creation, and the public good.

Figure 14: The *No No No* sign put up in front of City Hall by the Space Hijackers as part of their "I'm a Photographer not a terrorist" campaign. Londoners are becoming more and more vocal about how poorly they are being treated in these pseudo public spaces. The sign reads in part, "Welcome. Please be aware that this is private property. No smoking, no photography, no ball games, no drinking, no skateboards, no heavy petting, no OAPS, no begging, no loitering...Enjoy your visit!"

[34] According to Mark Field, MP, Conservative, Cities of London and Westminster. (LBC)

[35] Hov 6

[36] Ibid

[37] Reynolds 53

Even the Mighty Thames is slipping away from the public. The River Thames does not belong to anyone, however, it is becoming increasingly regulated, restricted, and monitored. The river and the banks along side it should be available to all Londoners, of all types, and all times of day, but this is not the case. The Jubilee Walkway, a 13.2 mile pedestrian promenade along the South Bank of the Thames, as well as the area surrounding City Hall, is not owned by the city, but a corporation. *More London*, a private company contracted by the owners of the waterfront property, manages the area around City Hall, monitoring and enforcing a strict code of conduct regarding what the public can and cannot do in the area. Anyone taking photo or video from the Walkway who looks remotely professional will be accosted by security guards within seconds.[38] A group of peaceful protesters gathered around City Hall could be forced to leave or even arrested. The city is helpless to prevent it because they have sold all their rights to *More London.* Other areas along the Thames are not accessible to the public at all because they belong to private homeowners.

Private companies are allowed to do what they wish with this so-called "public" land because very little is written into the conditions of the sale/transfer of ownership. Nothing is in place which protects Londoners and their access to these spaces. The Lord Mayor's manifesto declares that London's public spaces should be as "unrestricted" and "accessible" as possible. In fact, the opposite is true. Private developers have free reign to do what they please. They view the use of their land by the public as an act of charity and folks should be grateful they have any access at all. Rules such as no skateboarding, no sunbathing, no photography, no videography, and rigid hours of operation are set by the owners of the property who feel that they are doing the public a service, a favor, for allowing them access to the area.

A return to *The Commons,* land owned and managed by the community, would be a step in the right direction in resolving the conflict between public and private space. It would ease the burden of park maintenance from the city whilst protecting public space from being sold and given over to corporate ownership. Applying *The Commons* model to green roofs would ease the financial burden of installation and maintenance from the building owner. The beneficiaries of the green roof, on the other hand, would not be confined to the owner of the building but all the members of *The Commons.* This structure could be replicated again and again on the rooftops of buildings, benefiting all who live near the garden, look down upon it from their flats, or smell the fragrance of its flowers on the streets below.

VICTORY GARDENS & ALLOTMENTS

Vegetables for Victory!
Beans for Bullets!

[38] "When are Public Spaces not Public?" *The Politics Show,* 24 January 2012.

Cloches Against Hitler!

These are some of the slogans put out by the Ministry of Information and the Ministry of Agriculture Production during World War II as part of Britain's wartime effort.[39]

Once Britain was blockaded, food supplies were in very short supply or cut off entirely. Money and resources for the war were a priority over the transportation of food into Britain. Print and media campaigns were created to encourage people to grow their own vegetable garden on any available plot of land to help the people feed themselves. Queues at the fruit and vegetable stand were long and supplies ran out quickly. Fresh produce was in high demand and in short supply. A propaganda film produced by the Ministry of Information told Brits that "food [was] just as important a weapon of war as guns."[40] Every available inch of land was seen as a potential vegetable garden; the flower garden, an abandoned lot, the roof. The *Dig for Victory* garden campaign continued through the end of war and into the rationing period that did not end until 1954. At their peak in 1944, *Victory Gardens* produced 42% of the country's fresh vegetables.[41]

Allotments were also used during the war for food production. It is estimated that 1.3

Figure 15: A woman in Clapham, South London, waters her vegetables on the roof of an Anderson shelter during WWII.

million tonnes of food were produced from 1.4 million allotments.[42] The number of available allotments, however, have been diminishing since 1943, being swept away in favor of development. In 1943, there were 1.4 million allotments available in England. In 1990, there were just 297,000, albeit the demand has not diminished. Since 1996, there has been an

[39] Allotments in Britain were very popular during the First World War as Germany cut off England's food supply then, as well.

[40] Dig for Victory, prod. Ministry of Information and the Ministry of Agriculture Production, film, 1942.

[41] Reynolds 38

[42] John Harrison "Allotment History: A Brief History of Allotments in the UK" n.d. *Allotment Vegetable Growing.* 20 March 2012 <http://www.allotment.org.uk/articles/Allotment-History.php>.

allotment resurgence. Increased food prices, genetically altered food, the use of harmful chemicals and pesticides, a desire for organic produce, self-sufficiency, and healthier eating have all contributed to the increased demand for allotments and growing one's own produce. For the first time since the War, vegetable seed sales outnumber that of flower seeds in Britain.[43] The interest is such that 13,000 people are on a waiting list for 297,000 allotments.[44]

As green fields, orchards, allotments, and agricultural land are being cleared and developed for housing, retail, and office space, less and less land is available for produce, cotton, grains, and other organic goods humans need to survive. The remaining bits of land are under tremendous pressure to produce as much as possible. Farmers have no choice but to use harmful chemicals, pesticides, and genetically altered crops in order to increase output. Decreased farmland means food must travel further before arriving at the table. Food in the local grocery store has traveled hundreds, perhaps thousands of miles. More additives and preservatives need to be pumped into the food to extend shelf life and stay fresher, longer.

The lack of available land, limited number of allotments, apartment living, and an overall interest in "going local" has given birth to creative and ingenious movements and ideas to cope with this problem. Some apartment buildings in England are designating land on the property to be used as allotments as a way to attract tenants. Urban farms are popping up all over London and abandoned lots are being used to grow produce. But there simply is not enough land in and around London to satisfy demand. An area 300 times the size of the Greater London Area is required to sustain it, to provide London with its food, electricity, clothing, shoes, heat, petrol, and all the other things Londoners require.[45] Roofs, however, can provide the space to help London cope with these problems. Roofs can be used for allotments, farm land, orchards, cotton fields, etc. In short, roofs can provide the land on which London can provide for itself. If allotments had the power to provide 42% of Londoners' produce, imagine what could done with 26,000 hectares of available land on the rof. Food from the Sky and Farm:Shop are two innovative organisations that see the potential and are using roofs as farmland.

Food from the Sky is providing a "template for the future," by combining permaculture, food production, and education all on the roof of Thornton's Budgens Supermarket in Crouch End, North London. Hundreds of organically grown fruits, vegetables, greens, mushrooms, and herbs are grown on the roof and sold on Fridays in Budgens Supermarket on street level,

---

[43] Reynolds, 22

[44] Margaret Campbell and Ian Campbell "A Survey of Allotment Waiting Lists in England" National Society of Allotments and Leisure Gardens, June 2009.

[45] Tim Beatley "Green Cities: Urbanism and Advancing Sustainability" University of Virginia, 15 April 2010.

Figure 16: Azul Thome, co-founder of Food from the Sky, stands on the roof of Thornton's Budgens Grocery store where food is grown on the roof and sold in the grocery store eight metres below.

eight metres below. Food from the Sky also teaches the community about farming and sustainability. Growing food on the roof of the grocery store that sells it uses less fossil fuels for transportation, displaces no green or open space, encourages wildlife and biodiversity, and most importantly, is sustainable and replicable.

Another approach to using roofs as farmland is Farm:Shop in Dalston, East London. The entire shop is an experiment in how humans feed themselves and use space.[46] Farm:Shop has created a complex chain of ecological systems under (and on) one roof growing produce, mushrooms, herbs and raising pigs, chickens, and fish. Every space has been analysed for its growing potential. Plants are going everywhere, including the roof, which is also being used to raise chickens. "The idea here is to grow the maximum amount of food as efficiently as possible, keeping labour to a minimum," says Paul Smyth, one of the co-founders.[47] The Farm hopes to inspire Londoners to grow their own food and create direct links between farms and cities.

Scarcity and Neglect

Land is a finite resource. With the population at 6,840,507,003[48] and increasing by the hour, the amount of available land is in short supply. The almost seven billion souls on this planet are putting tremendous pressure on the surface of the earth to provide the things that make life possible: land for living, food production, recreation, waste storage. Humans demand more than the earth can offer. According to research done by the World Wildlife Fund (WWF), the average global ecological footprint (measuring the demand of humans on the earth's ecosystems) of one person is 2.2

---

[46] David Hawkins "Farm:Shop East London's Radical Experiment in Food Growing and Community Building" The Ecologist. 14 February 2011, http://www.theecologist.org/how_to_make_a_difference/food_and_gardening/724652/farm_shop_east_londons_radical_experiment_in_food_growing_and_community_building.html.

[47] "A Farm in a Shop." Farm:shop, 2011, http://farmlondon.weebly.com/farmshop.html.

[48] Source: World Bank, 2010.

hectares. The earth, however, can only sustain a footprint of 1.8 hectares per person.[49]

Americans are the worst offenders. If everyone on the planet lived the lifestyle of the average American, it would require five planets to support them.[50] Many countries, including Great Britain, look to America for guidance, inspiration, and emulation, believing (falsely) that Uncle Sam knows best. Big cars, big homes, large portions at restaurants. The Texas saying of *go big or go home* is a common attitude across America. Such irresponsible and unsustainable behavior is praised, even aspired to, by countries around the globe. The fact is, the earth simply cannot support the American lifestyle.

Yet, despite the scarcity of land, what little cities do have is often squandered, sitting neglected and unkempt. Land is still considered an abundant resource. Private owners neglect their land, particularly if they do not live close by. Owners are disconnected from their property and feel they owe nothing to the community. This bit of land is an investment, like money gathering interest in the bank. Owners will sit and wait until land prices go up and then they will sell. The difference is that the "land is not parked away like gold bullion and hidden in a vault but is a visible blight to everyone."[51] The land sits neglected, full of weeds and trash, dragging down the morale and aesthetics of the neighbourhood in which it sits.

Rooftops, unlike land, are not scarce. They lie in abundance in every city. They are neglected eyesores that could be put to better use and usurped by the people in the community. Rooftops offer acres and acres of possible public space, parks, farm land, and agrarian space.

One such example of using a roof as public space is the roof terrace of the Lyric Theatre in Hammersmith, West London. It was completed

Figure 17: The roof garden at the Lyric Theatre in Hammersmith, London.

in 2009 and was praised by the Landscape Institute as "a fantastic example of cross-sector partnership working in the community to

[49] Reynolds 40

[50] Global Footprint Network. "Do We Fit on the Planet?" 7 February 2011, http://www.footprintnetwork.org /en/index.php/GFN/page/world_footprint/.

[51] Reynolds 73

deliver a fantastic outcome for local people and visitors to Hammersmith." The park is open to the public and is maintained by "Garden Guardians," residents of the nearby Ashcroft Estate, who look after the garden and keep it in "tip top" condition.[52] The roof is a semi-intensive garden, filled with full-sized trees, including Magnolia and Eucalyptus, and boxed planters on top of a full wooden deck. A six metre high boomerang-shaped pergola covered in creepers, the focal point of the garden, can be seen from street level. Much of the garden can be seen by Londoners exiting the Hammersmith Underground Station, a key element in the roof garden's design. The roof garden provided much needed public space in congested West London where parks and open space are sparse.

THE ECONOMIC & ENVIRONMENTAL BENEFITS OF ROOF GARDENS

We could have saved the earth but we were too damned cheap.

- KURT VONNEGUT, JR.

Roof gardens enhance the quality of life and improve the environment, both aesthetically and ecologically, in which one lives. A roof garden is a vertical getaway to the country, an escape to nature without leaving the city. "There are no disadvantages to roof gardens," says John Little who works with Dusty Gedge, the UK's leading expert on green roofs. They trap rainwater, prolong the life of the roof, provide insulation, clean the air, provide habitats for insects and birds, beautify an area, and best of all, they cheer people up.[53]

The GLA and the Lord Mayor both recognise the value of green roofs and their benefits to society and the environment. Numerous reports have been published detailing the benefits of ecoroofs and London's vulnerability to climate change. In a report on London's Green Roof Policy, the Mayor of London has distilled the benefits of green roofs to London down to:

1. Helping London adapt to Climate Change
2. Lowering $C0_2$ emissions
3. Reducing the Heat Island Effect
4. Enhancing amenity value
5. Improving biodiversity
6. Reducing stormwater runoff[54]

---

[52] Ben Coles "Hammersmith London Roof Garden at the Lyric Theatre" *Groundwork London*, 2010 http://london.groundwork.org.uk/what-we-do/case-studies/2009/hammersmith-london-roof-garden/full-story.aspx.

[53] Interview Dusty Gedge and John Little. *Green Roof Course,* 2010.

[54] Gedge et all 4-5

The greatest perceived "disadvantage" to roof gardens is the cost. Cost is not a disadvantage but a prohibiting factor in the construction of roof gardens. However, this perceived barrier to entry is shortsighted. Green roofs extend the life of the roof membrane and lowers a building's energy cost by providing additional insulation. They provide a fire-resistant top layer because of their low burn heat load.[55] The long-term benefits - environmental, social, ecological, and economical - outweigh the initial cost of constructing a roof garden.

It is horrifying that we have to fight our own government to save the environmnet.

-ANSEL ADAMS

ECONOMIC BENEFITS

The economic benefits of ecoroofs are many. Green roofs create visual diversity that appeal to visitors and residents. Roof gardens enhance property values, both on the building itself and on the buildings around it. Green roofs can be seen as living billboards that beautify a city. In *The Death and Life of Great American Cities,* Jane Jacobs said that "the more successfully a city mingles everyday diversity of uses and users in its everyday streets, the more successfully, casually (and economically) its people thereby enliven and support well-located parks that can thus give back grace and delight to their neighborhoods instead of vacuity."[56]

Flats with a view of Hyde Park, or any other park, are more desirable and have higher market values. But not every apartment building can overlook a park. In cities such as London, open land within the city is simply not available to be turned into city parks, gardens, or squares. Rooftops, however, can be used as replacements for open land, for the creation of mini-Hyde Parks and London squares throughout the city. Roof gardens make it possible to have flats with views of gardens and parks that would never be possible on the land below.

Since parks and gardens increase property values, owners of apartment buildings with roof gardens can charge higher rents because of the added amenity. Similarly, office buildings with roof gardens are very attractive, unique features. The garden can be shown off to clients, used for company functions, rented out to third parties, and attract potential employees.

Hotels with roof gardens can charge more for their rooms. Suites which overlook and/or have direct access to the garden can fetch higher per diem rates. In all of these examples, more can be charged by the simple fact that plants are growing on the roof.

---

[55] Burn Heat Load is the amount of heat generated from an object when it burns. "Green Roof Benefits" *Green Roofs for Healthy Cities.* 26 January 2012, http://www.greenroofs.org/index.php/about-green-roofs/2577-aboutgrnroofs.

[56] Jane Jacobs The Death and Life of Great American Cities (New York: Vintage Books, 1991), 111.

Utility bills can be lowered by having a roof garden. Green roofs provide shade, thermal insulation, and evapotranspiration, all of which decreases the demand for mechanised heating and cooling because soil is a natural regulator of temperature. Structures with a layer of earth on their roofs are cooler in the summer and warmer in the winter due to the relatively constant temperature of soil, as opposed to the extreme fluctuations in air temperature. This low fluctuation in temperature means that less energy is required to heat or cool the ambient air within the building. The insulating quality of green roofs is so great that it can decrease a building's heating and cooling needs by 75%.[57]

"The environmental and economic benefit to London of living roofs and walls is hard to ignore," begins a 2008 report sponsored by the GLA. The report concluded that of the approximately 10 million m^2 of roof surfaces in Central London, 3.2 million m^2, or 32%, had the potential to be greened. This would result in potential energy savings of 19,200 MWh per year, and 8,256 tonnes of CO_2.[58] If the GLA did indeed built ecoroofs on 32% of the structures in Central London, they would save approximately **£2,976,000 per year** on energy costs.[59]

Vegetated roofs last longer than non-vegetated ones. Fluctuations in temperature wreak havoc on roofs. During the day, an exposed roof membrane absorbs solar radiation and the roof's surface temperature rises. During the night, the heat is released and the surface temperature drops. These daily increases and decreases in temperature break down a roof's structural membrane, causing it to deteriorate and leak. Every 6ºF increase in a roof's membrane temperature increases the rate of degradation by 50%.[60]

According to the National Research Council of Canada, the average annual fluctuation in thermal temperature on a non-green roof is 81ºF, whilst on a green roof it is only 11ºF. The small variance in surface temperature on a green roof prevents the membranes from deteriorating, requiring less maintenance and fewer repairs.

Roof gardens are economically beneficial, not only for property owners, but to cities, as well. Vegetated roofs can assist in urban regeneration schemes. Roof gardens atop theatres, shopping malls, conference centres, restaurants, and libraries can attract visitors and keep them there longer, spending more, and coming back in the future, generating tax revenue for the city and revitalizing the

[57] K. Liu and B. Baskaran "Thermal Performance of Green Roofs Through Field Evaluation" National Research Council of Canada May 2003, 4.

[58] Dusty Gedge, John Newton, Carl Cradick, and Phil Cooper "Living Roofs and Walls, Technical Report:Supporting London Plan Policy" Greater London Authority (London:Greater London Authority, 2008), 12.

[59] This figure is calculated based on the average cost of producing one MWh in the UK which is £155.

[60] Docent Folke Björk. *Green Roofs Effect on Durability of Roof Membranes.* (Malmö: EU-Life, 2008), 8.

community. Structures with roof gardens become destinations in themselves. They are unique features to the community that add value and distinction to the neighbourhood. Jane Jacobs said successful cities are places where people *choose* to live. They should be safe, feel like home, and offer something "unique" which residents feel would be impossible to find elsewhere. Cities should be full of diversity, a variety of people, uses, activities, and visual stimuli. "Dull, inert cities, it is true, do contain the seeds of their own destruction and little else. But lively, diverse, intense cities contain the seeds of their own regeneration, with energy enough to carry over for problems and needs outside themselves."[61] In nature, complex environments do better than simple ones. Roof gardens not only create complex systems through biodiversity, but they can create uniqueness, that attachment so vital in vibrant, attractive cities.

Environmental Benefits

The environmental benefits of increasing the amount of plants and vegetation on the planet, specifically in urbanized areas, is substantial. It avails everyone to have greener cities. Vegetated roofs mitigate two major problems associated with the changes in climate as a direct result of more people and less vegetation: the increase in violent storms and subsequent flooding, and the elevated temperatures in urban areas from atmospheric pollution and diminished green space. Roof gardens do this by controlling the rate of water runoff, reducing the risk of flooding, cleaning pollutants from the air (especially important in urban areas where air pollution is the highest), cooling air and surface temperatures via evapotranspiration, and providing an additional layer of insulation thereby reducing energy usage. Green roofs also provide habitats for birds, insects, and other wildlife, reduce noise pollution, create a fire-resistant layer, and make cities more enjoyable.

The London Climate Change Partnership (LCCP) recognizes the rapid change in the earth's climate and the effects it will have on London. London is particularly vulnerable to the effects of climate change because of its geographic location, population size and density, ageing Victorian infrastructure, place in the global economy, and reliance on imports. London is particularly in danger of increased flooding, drought, and warmer temperatures. Rather than addressing the problem directly, the LCCP is promoting "climate change adaptation" strategies,[62] taking an attitude of

[61] Jane Jacobs , The Death and Life of Great American Cities (New York: Vintage Books, 1992), 448.

[62] London Climate Change Partnership "A Summary of Climate Change Risks for London" ClimateUK. 2012, http://www.london.gov.uk/lccp/docs/London_summary.pdf.

defeat and acceptance rather than prevention. This does not need to be the case. Research by the Tyndale Centre for Climate Change suggests that just a 10% increase in [London's] green space would combat climate change.[63]

London is also facing serious environmental issues directly related to climate change and population. London air pollution reached at record high on Thursday, 15 March 2012 from car fumes, factory smoke, and dirty air blown in from Northern England and France.[64] Also in March, the BBC reported that London is facing its worst drought since 1976.[65] The negative effects of climate change in London are not a list of possible problems that can be dealt with sometime in the future, but are presently posing real, life-threatening issues that are effecting Londoners today.

The Heat Island Effect

Cities around the world are getting warmer. The reduction of green space for urbanization and the increase of hard surfaces with high thermal mass are to blame. When buildings and roads replace green space the "thermal, radiative, moisture and aerodynamic properties of the surface and the atmosphere are altered."[66] Concrete, asphalt, and pavement absorb and trap heat from the sun. The heat is released back into the atmosphere at night when the temperature drops, the result of which is noticeably warmer temperatures in the cities than in the surrounding countryside. This difference between urban and rural temperatures is called the Heat Island Effect (or Urban Heat Island Effect (UHIE)). A city is an island of heat amidst a sea of cooler, rural temperatures.

Warmer temperatures in cities mean more air conditioning, more energy, more carbon dioxide and pollution released into the atmosphere, which creates more heat, exacerbating the problem. Increased heat also means increased humidity, smog, and concentrations of particulates. This increase in temperature and decrease in air quality is not only uncomfortable, but causes a plethora of respiratory and circulatory health problems. In New York City, the difference in temperature between the city and the countryside due to the Heat Island Effect results in an additional $100m in energy costs per year.[67]

---

[63] "Introduction to Green Roof Benefits" *Living Roofs* n.d., http://livingroofs.org/2010030565/green-roof-benefits/greenroof-benefits.html.

[64] Adam Vaughan "London Air Pollution at Record High" The Guardian 15 March 2012.

[65] "South East Latest Part of England Officially in Drought" BBC 20 February 2012.

[66] Greater London Authority " London's Urban Heat Island:A Summary for Decision Makers," October 2006, 6.

[67] Sam Williams "Cool(er) Roofs" *Gotham Gazette,* October 2005.

Rooftops significantly contribute to the Heat Island Effect. The hard, dark materials used to pave roofs absorb the sun's heat like a sponge. NASA satellite images of four US cities (Chicago, Houston, Salt Lake City, and Sacramento) revealed that roofs occupied an average of 25% of the land cover. The temperature samples taken in these cities confirmed that rooftops were the hottest (reaching 160ºF) whilst green space and vegetation were the coolest (between 75ºF and 95ºF).[68]

London is already suffering from the Heat Island Effect with its unusually warm summers, early springs, decreased summer rain, and a reduction in sticking snowfall.[69] Currently, temperatures in London are an average of 6ºF higher than the surrounding rural areas due to the UHIE and will only intensify in the future. The UK's heatwave of 2003 broke records and killed over 600 people.[70] The suffering was the highest in London where deaths across all ages rose 42% and nighttime temperatures reached a high of 100.2ºF.[71] A survey performed by the GLA during the same heatwave found temperature differences between London and the surrounding rural areas to be as much as 18ºF.[72]

Green roofs can help mitigate the Heat Island Effect. Plants and vegetation cool air and surface temperatures through evapotranspiration.[73] Both evaporation and transpiration require solar energy. As a result, the energy from the sun is trapped in the water vapor and is prevented from being released as heat on the earth's surface. Therefore, the more plant life and vegetation there is in a city, the cooler the temperature, the less energy required to heat and cool the city, and the greater the combative power against the Heat Island Effect will be. Also, of all land surfaces, open water has the greatest cooling effect. By combining water features, shallow pools or

---

[68] Nigel Dunnett and Nöel Kingsbury, Planting Green Roofs and Living Walls. (London: Timber Press, 2008) 65.

[69] Greater London Authority

[70] London Climate Change Partnership "High Temperatures and the Urban Heat Island" n.d, http://www.london.gov.uk/lccp/ourclimate/overheating.jsp.

[71] "The Impact of the 2003 Heat Wave on Daily Mortality in England and Wales and the Use of Rapid Weekly Mortality Estimates" Eurosurveillance Volume 10, Issue 7, 1 July 2005.

[72] London Climate Change Partnership

[73] Evapotranspiration is the the process of transferring moisture from the earth to the atmosphere by evaporation of water and transpiration from plants.

collecting basins on rooftops, the benefits can be maximized, profiting everyone in the city.

Research done by the New York Heat Island Initiative determined that providing fifty per cent green roof cover within the metropolitan area would lead to an average reduction in surface temperatures of 0.1ºC - 0.8°C. It also noted that for every degree reduction in the UHIE, roughly 495 million KWh of energy would be saved. "There is no reason to doubt that comparable reductions could be achieved in London."[74]

Drought and Flooding

London is already facing water-shortage issues, especially in the summer when demand is highest. Climate change and London's ever-increasing population only exacerbate the problem. Fruit and vegetable prices are soaring this summer as London experiences its worst drought since 1976. In fact, a report from the Environmental Agency announced that the entire southeastern half of England is at "severe risk of drought" after two consecutive dry winters.[75] It is expected that London's summer and winter rainfall will decrease by 30% and 50% by 2080, respectively.[76]

London is also at risk from tidal flooding from the North Sea, fresh water flooding from the Thames and its tributaries, and surface flooding from heavy rainfall.[77] London's high percentage of hard surfacing and inadequate Victorian drainage infrastructure makes it particularly vulnerable to surface flooding.

Vegetated roofs help control surface flooding by reducing the amount of water runoff from roofs. During severe storms, large amounts of water runs off the roofs, streets, and sidewalks into the drainage system in a short period of time. The rush of water is more than the Victorian pipes can handle, resulting in flooding. The vegetation on a green roof can retain as much as 80% of rainfall, which is then slowly released into the system as it perculates through down through the layers, instead of rushing right off and into the storm drains, reducing the strain on city drainage systems and minimising the risk of flooding.

Photovoltaic Panels

Photovoltaic (PV) panels are up to 8% more efficient at temperatures around 80ºF.[78] Temperatures higher than this decrease their efficiency. The average temperature of an asphalt or slated roof is between 160ºF and

---

[74] Dusty Gedge, John Newton, Carl Cradick, and Phil Cooper "Living Roofs and Walls, Technical Report:Supporting London Plan Policy" (Greater London Authority: London, 2008), 4-5.

[75] Jonathan Prynn "Drought to Send Food Prices Soaring" *The Evening Standard,* 12 March 2012.

[76] "Flooding" *Greater London Authority.* n.d.,http://www.london.gov.uk/climatechange/content/flooding.

[77] Ibid

[78] "Benefits of a Green Roof." *Apex Green Roofs.* n.d. Apex Green Roofs. 18 March 2012, http://www.apexgreenroofs.com/green-roof-benefits.html.

180ºF, whilst green roofs maintain a lower, more consistent temperature of 80ºF. Even in the hottest weather, the thermal mass of green roofs keeps the surface temperature much cooler than that of a conventional paved roof. Combining the cooling properties of green roofs with PV panels will generate more clean energy from the sun, reducing $C0_2$ emissions, fossil fuel use, air pollution, and energy costs.

POLICIES & LEGISLATION

I think the environment should be put in the category of our national security. Defense of our resources is just as important as defense abroad. Otherwise, what is there to defend?

- ROBERT REDFORD

The Square, a fenced in private garden surrounded by houses, is London's most distinctive and admired feature and is England's most valuable contribution to European town planning. Roof gardens are vertical Squares and can be London's next valuable contribution to European town planning. London's potential to be a vertical Garden City is not impossible but quite realistic. According to a 2012 GLA report, 32% of central London's rooftops could potentially be greened.[79] London could begin to lower its temperatures, clean its air, save money on heating and cooling costs, along with all of the other benefits of a greener city, by incentivising, even mandating, green roof policies through aggressive legislation. The International Energy Agency declared in its 2011 conference in London that "unless there is a bold change of policy direction the world will lock itself into an insecure, inefficient and high-carbon energy system." Then, the door of opportunity closes forever.[80]

GREEN ROOF POLICIES ABROAD

"The implementation of living roofs and walls is taking place in major cities throughout the world. For at least twelve of these cities, policy drivers and/or financial incentives are why living roofs and walls are being implemented so vigorously."[81] These cities realise that tax breaks, subsidies, and other government incentives are vital in an effort to actualise more green roofs.

Copenhagen, Denmark is the first city in Scandinavia to adopt a mandatory green roof policy as part of their larger scheme to become carbon neutral by 2025. Every new building with a roof pitch less than 30º must be fitted with vegetation.[82] The city hopes that 5,000 m^2 of rooftops a year will be greened.

Basel, Switzerland has the highest concentration of green roofs per capita than

[79] Dusty Gedge "Living Roofs and Walls" Powerpoint Presentation 12 January 2012.

[80] Environment News Service "Irreversible Climate Change Looms Within Five Years," 9 November 2011.

[81] Gedge et all 5

[82] "Copenhagen's Green Roof Ambitions" *Living Roofs*, n.d,. http://livingroofs.org/20100522222/world-green-roof-policies/copenhagen-green-roofs.html.

any other city in the world. This has been achieved through financial incentives from the government and progressive building regulations. Green roofs have been a

Figure 18: As part of its stategy to become carbon neutral by 2025, Copenhagen has created a mandatory green roof policy for all new buildings.

mandatory building requirement since 2002. Basel's incentive for more green roofs in the city has been cost and energy savings as well as wildlife biodiversity and preservation.[83]

Münster, Germany's motivations for green roofs are its severe problem with storm water runoff and the lack of green space in the city. In order to encourage the construction of green roofs, the city imposed a stormwater fee based on the amount of stormwater that runs off a property and into the sewer system. If there is no runoff, there is no fee. The fee is reduced by 80% or more when a green roof is installed. The program was widely accepted by residents and was seen in a positive light. However, the cost of the highly administrative nature of the program led to its discontinuation in 2002. Under the program, however, over 12,000 m^2 of vegetated roofs were created.[84]

Portland, Oregon launched an ecoroof incentive program in April 2012, subsidising $5 per square foot towards the construction cost of vegetated roofs within the city limits. The incentive program is part of Portland's Gray to Green Initiative, which aims to reduce stormwater runoff in a way that mimics natural systems and improves watershed health. Portland is one of a handful of American cities with green roof incentive programs in place.[85]

LONDON'S GREEN ROOF AND LIVING WALL POLICY

The GLA's official green roof and living wall policy is as follows:

> *The Mayor will and boroughs should expect major developments to incorporate living roofs and walls where feasible and reflect this principle in LDF policies. It is expected that*

[83] A Kazmierczak and J Carter Adaptation to Climate Change Using Green and Blue Infrastructure: A Database of Case Studies, 2010.

[84] "Making Green Roofs Happen:A Discussion Paper Presented to Toronto's Roundtable on the Environment," *Toronto City Planning*, November 2005, 13.

[85] Other cities in the US with ecoroof incentive programs are Los Angeles,CA, New York City, NY, Boston, MA, Minneapolis, MN and Seattle, WA.

this will include roof and wall planting that delivers as many of these objectives as possible:

- *accessible roof space*
- *adapting to and mitigating climate change*
- *sustainable urban drainage*
- *enhancing biodiversity*
- *improved appearance*

Boroughs should also encourage the uses of living roofs in smaller developments and extensions where the opportunity arises."[86]

Despite the city's awareness of its severe air pollution, its countless publications on air quality-related health problems and deaths in London, and its efforts to present itself as a "green" city, London has been slower to create green roof policies and encourage their construction than most other European cities. London's current green roof and living wall policy is vague and coated with the American "leave it up to businesses to do the right thing" attitude. The policy uses verbiage such as "where feasible" and "as possible," which are meaningless and will accomplish nothing. Businesses will not "do the right thing" unless they are required to by the government. Companies will not voluntarily put ecoroofs on their buildings - very few buildings in London have. In fact, there are only 92,682m^2 of intensive and extensive green roofs in the Greater London Area (see appendix one).

Some Londoners, however, are not waiting for the Mayor's office to release more aggressive green roof and living wall policies. Individuals are producing some very exciting ecoroof projects, from urban roof farms to cocktail lounges that grow their own herbs, to chicken coups and wigwams.

The handful of ecoroof projects in London, however, are not representative of the city or government ethos. There are many excuses from both the government as well as businesses as to the insurmountable difficulties in ecoroof construction. The official perceived barriers preventing the construction of more green roofs in London are:

1. a lack of government incentives
2. little positive policy support
3. increased construction costs
4. a lack of technical knowledge[87]

One of the principle reasons for London's lagging behind the continent in the amount of green roof construction is the mindset of the current administration, despite all of the research, documentation, and publications sponsored by the GLA. Evidence of this lies in the recent actions by the Mayor of London whose changes, or lack thereof, in environmental policies are actually *hurting* the city's ecological health. The Mayor has halved the size of the Congestion Charge Zone

[86] Gedge et all, 5

[87] Ibid

Figure 19: A message to Boris Johnson written on the pavement from soot and the same spray on adhesive the Mayor is coating all over the roads in London to "clean" the air. London faces a €300m fine if air quality is not improved by June 2012.

(CCZ),[88] which increased traffic in Central London by 8% the first twelve weeks after the policy change in January 2011.[89] The Mayor has also ended the mandatory biannual emission check on taxi cabs, which are some of the worst contributors to PM levels in London.[90] Of the next 800 busses to join London's fleet, only 52 will be diesel-electric hybrids, despite the Mayor's promise that "all [bus] newcomers would be hybrids."[91]

The Mayor has cancelled the extension of the third phase of the Low Emission Zone (LEZ),[92] which would have cut harmful fumes and emissions from high polluting vans and lorries. Mayor Boris Johnson's reason for not expanding the zone was that it would have had a "detrimental impact on small businesses during this economic downturn."[93] The Mayor's office came up with a more suitable solution: coating the pavement in the most polluted areas with a spray on adhesive to which the pollution will stick. The Mayor has been "haunting [London's] highways for the past few months, spraying adhesive up and down [London's] worst pollution hotspots and sticking exhaust fumes to the asphalt. Rather than tackling the problem at its source, by

---

[88] The London Congestion Charge is a fee charged for some categories of motor vehicle to travel at certain times within the Congestion Charge Zone (CCZ). The charge aims to reduce congestion, and raise investment funds for London's transport system. Though not the first scheme of its kind in the United Kingdom, it was the largest when introduced, and it remains one of the largest in the world. ("London Congestion Charge" *Wikipedia, the Free Encyclopedia)*

[89] Martin Hoscik, "WEZ Abolition Increased Traffic Levels, Slows Speeds," *Mayor Watch*. 3 June 2011.

[90] LBC "LBC Interview: Clean Earth's Clean Air for London Campaign." 29 July 2009.

[91] David Hill, "London Olympics: Politics, Pollution and Plague," *The Guardian,* 17 January 2012.

[92] The London Low Emission Zone (LEZ) is a charging scheme with the aim of reducing the pollution emissions of diesel-powered commercial vehicles in London, England. Vehicles are defined by their emissions and those that exceed pre-determined levels are charged to enter Greater London. The low emission zone started operating on 4 February 2008. There has been a planned phased introduction of an increasingly stricter regime up to 3 January 2012, when it became fully operational. The scheme is administered by the Transport for London executive agency within the Greater London Authority. ("London Low Emission Zone" *Wikipedia, the Free Encyclopedia)* http://en.wikipedia.org/wiki/London_low_emission_zone (25 March 2012)).

[93] Hélène Mulholland, "London Low Emission Plan Stalled." *The Guardian,* 2 February 2009.

tampering and gluing around air pollution monitors Johnson's aim is to avoid a €300m fine for failing to comply with air quality standards."[94] London has failed to meet air quality standards set by the European Union thrice, each time receiving an extension. No further extensions will be given this time. The Mayor has until June 2012 to clean up London's air or pay the massive fine.[95]

The short-sightedness of the Mayor's office is a symptom of London, the United States, and other cities around the world. The Mayor is concerned with the large fine in June, the 2012 Olympics, and re-election - all short term concerns. Chewing gum is being stuffed into the crack of a leaking dam.

FINAL REMARKS

We have to shift our emphasis from economic efficientcy and materialism towards a sustainable quality of life and to healing of our society, of our people, and our ecological systems.

- JANET HOLMES À COURT

Londoners have had a long and passionate affair with nature, a craving for fresh air, the countryside, a plot of land on which to grow a garden. Such a love of nature has inspired the creation of the London Square with its English plane trees, colorful flowers, and iron railings all surrounded by grand houses. The Garden Square was built for people to use and enjoy, to escape the noise and filth of the city. Even today in the 21st century, London Squares are enjoyed by tourists and cherished by Londoners. They are a defining feature of London and have been called the "ideal of civilised urban living."[96] The London Square is England's most valuable contribution to European urban planning and has made a lasting contribution to the quality of life for Londoners.

The Garden Square inspired people such as Ebenezer Howard to conceive of new developments like the Garden City that combined the convenience of city living with the benefits of country life. But the London Square, along with parks, gardens, farmland, wildlife preserves, and other open spaces, are under threat. Green space is quietly being sold off for private development. Even the future of the Greenbelt is uncertain.

Public space is becoming privatised and visitors are being treated like terrorists. The government is using 9/11 as an excuse to heighten security and bully guests. Allotments are disappearing and front gardens are being paved over for car parking. This is not only damaging the mental, social, and physical health of the city, but it is also increasing London's

---

[94] Siobhan Grimes and Alice Haworth-Booth, "Boris Johnson, Gluing Pollution to the Ground is No Way to Clean up London." *The Guardian, 5 April 2012.*

[95] Grimes and Haworth-Booth

[96] "London Squares," Garden Visit, n.d., http://www.gardenvisit.com/landscape_architecture/london_landscape_architecture/visitors_guide/london_squares

vulnerability to the serious and possibly irreversible effects of climate change. London is susceptible to warmer, drier summers and colder, wetter winters. London is at risk of severe flooding and drought and is already experiencing the Heat Island Effect. London has dangerously high PM_{10} levels, which cause 4,000 deaths per annum in London alone. Yet despite all of the evidence, reports, and information available to the Mayor's office - many conducted by the office itself - the decisions being made are exacerbating the problem: reducing the Congestion Charge Zone, using spray adhesive to clean the air, selling off parks. The effects on the city will be catastrophic.

Londoners do not have adequate space on ground level to recreate, grow food, play football, sit under trees, collect solar energy, or simply enjoy nature. There is not enough space to plant the number of trees required to bring particulate matter down to a "healthy" level or to plant sufficient vegetation to reduce the risk of flooding. In the face of all these problems, green roofs have the power to encourage what is good about London and ameliorate what is bad. They can be London's elixir.

Green roofs are unique in that they provide social, economic, and environmental benefits to London without one compromising the other. Roofs provide space for parks, increase property values, decrease energy consumption, and clean the air. Roof gardens, in the words of John Little, have no disadvantages. By creating thoughtful and aggressive green roof policies, such as requiring all new structures to have green roofs, London will not be *adapting* to climate change, but *stopping* it. A sea of green roofs can be London's next great contribution to European town planning. Like the London Square, they can be used by the people, enjoyed by tourists, and benefit all. The result will be happier, healthier Londoners, a greener city, a more beautiful city, a sustainable city, a Vertical Garden City.

CASE STUDIES

Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only thing that ever has.

- MARGARET MEAD

Figure 20: The stairs leading up to the roof at Dalston Roof Park, London.

FOOD FROM THE SKY

CROUCH END, NORTH LONDON, ENGLAND

ARCHITECT: UNKNOWN
ROOF ARCHITECT: AZULL-VALERIE THOME
BUILDING TYPE: COMMERCIAL
ROOF TYPE: URBAN FARM

Food from the Sky has developed a 12-step DIY template that is taught to educators, college students, supermarket owners, and community groups which can be easily implemented in other boroughs. Free education courses and training sessions are taught on the roof throughout the growing season.

Figure 21: Containers filled with lettuce, carrots, kale, spinach and many other vegetables atop the roof of Thornton's Budgns Grocery Store, Crouch End, North London.

Food from the Sky is "a world's first," combing permaculture, food production, and education all on the roof of Thorton's Budgens Supermarket in Crouch End, North London. Food from the Sky is an organization dedicated to bringing food production as close to the people as possible in the cemented, densely populated urban areas in and about London. Organically grown vegetables, fruits, mushrooms and herbs are cultivated in the community garden on the roof and sold in the grocery store at street level eight metres below every Friday.

Food from the Sky's rooftop garden is also benefiting the local wildlife. Bat researchers have found 3 species of bats flying over the roof farm, one of which stopped and fed on the roof. The Natural History Museum identified 24 different species of insects living on the roof. Food from the Sky has attracted the attention of the BBC, a visit from the Lord Mayor, countless news articles, and was shortlisted for the 2011 London Lifestyle Awards.

ADELAIDE HOUSE

LONDON, ENGLAND

ARCHITECT: JOHN JAMES BURNET (1924-1925)
ROOF ARCHITECT: UNKNOWN
BUILDING TYPE: OFFICE TOWER
ROOF TYPE: RECREATIONAL

especially the views of the 17th century church, St Magnus Martyr, that it blocked entirely.

One hundred and forty feet above the ground on the roof was the only golf course in the City of London. The 18-hole putting green overlooked the Thames and Tower Bridge.

Figure 22: Two gentlemen enjoying a round of golf on the roof of the Adelaide House, the only putting green in the City of London, 1938.

Adelaide House was the tallest office block in London at the time of its completion in 1925. Its steel frame construction and stone, art deco-inspired cladding, though popular in the United States, was new to London. Its sheer size was a major point of controversy,

Also atop the roof were also fruit trees, flowers (including hydrangeas) and over 10,000 honeybees. [97]

[97] *Beehives in Adelaide House.* Prod. WPA. WPA News, 1937.

MEXICAN ROOF GARDEN

LONDON, ENGLAND

ARCHITECT: JON BROOME (1999-2000)
ROOF ARCHITECT: DAVID MATZDORF
BUILDING TYPE: RESIDENTIAL
ROOF TYPE: EXTENSIVE

Figure 23: Extensive Mexican roof garden atop David Matzdorf's single storey residence in London.

The Mexican Roof Garden is a 15m x 5.5m extensive roof atop the private residence of David Matzdorf. The garden is an experimentation in drought resistant plants and shallow soil (the growing membrane is only 100mm thick). The roof is mono pitched with a flat top. The roof's steepest point is 22º. The area receives a variety of sun exposure, from full sun to full shade, greatly varying the types of vegetation planted on the roof. The roof has no irrigation and relies solely on rain water. In times when there has been little precipitation, the plants have been hand watered with a bucket by Matzdorf on his ladder. Hundreds of plants, including cacti, sedum, aloe, succulents, bromeliads, cistus, fifteen varieties of agave and culinary herbs such as rosemary and thyme, fill the 232.5 metres of roof space.

Plant choice was based on survival probability and aesthetics, not what plants were "native" to Britain.[98] Including such a wide variety of species encourages biodiversity, in plants and in wildlife. Desert plants, while at first seem out of place in rainy London, are actually quite

[98] David Matzdorf "A Mexican Roof in London" *Living Roofs.org,* 30 August 2008.

practical and do very well, especially of late as London is experiencing its worst drought since 1976.

The extensive Mexican roof is continuously undergoing changes and revisions. An enormous variety of species are planted to test which ones can survive the changing environmental conditions. Many of the desert plants die during cold winter nights when temperatures drop below freezing. Matzdorf plans on creating varying substrate depths on the roof to increase biodiversity and encourage wildlife, especially birds, to come and make use of the habitat.

DALSTON ROOF PARK

DALSTON, LONDON, ENGLAND

ARCHITECT: ZECTOR ARCHITECTS (FOR WAREHOUSE CONVERSION)
ROOF ARCHITECT: GORT SCOTT
BUILDING TYPE: FORMER WAREHOUSE
ROOF TYPE: INTENSIVE WITH ALLOTMENTS AND PHOTOVOLTAIC PANELS

building, has been working towards improving the quality of life for people in Dalston since 1977. Bootstrap hosts public events on the roof during the good weather (April-October) such as film festivals, lectures, concerts, wine and food tastings, and comedy nights. Allotments are available for members of the community. At any given time, one can find

Figure 24: London's largest installation of PV panels (left), planters, and space for summer events such as film screenings and live music.

The largest installation of Photovoltaic Panels in London, half a dozen allotments, yoga classes, concerts, and wine tastings can all be found on the roof of the Print House at 18 Ashwin Street, Dalston. Bootstrap, Co, a non-profit organisation who leases the tomatoes, spinach, kale, gerberas, daisies, and native grasses growing in the raised boxed gardens four storeys above the street. The garden is tended mainly through volunteers, including a special program for the youth in Dalston.[99]

[99] "Dalston Roof Park" *Bootstrap, Co.* 27 February 2012, http://www.bootstrapcompany.co.uk/13_dalston_roof_park,

QUEEN OF HOXTON

SHOREDITCH, LONDON, ENGLAND

ARCHITECT: UNKNOWN
ROOF ARCHITECT: UNKNOWN
BUILDING TYPE: COMMERCIAL
ROOF TYPE: SEMI-INTENSIVE

Figure 25: Wigwam on the roof of the Queen of Hoxton put up during the winter months to extend the usability of the roof.

The Queen of Hoxton is part bar, part music venue, part art gallery in the heart of the East End. The Queen of Hoxton's summer film series on its rooftop terrace was so successful that it has installed a giant heated wigwam on the roof during the chilly winter months (December - March). Strands of small christmas lights sweep down from the ceiling and the smell of bratwürst wafts through the air emanating from the large 1.5 metre grill in the centre. Outside of the wigwam, the roof is lined with seating, a small bar, and dozens of planters filled with trees, flowers, and shrubs. Stacks of rectangular flower boxes filled with begonias, petunias, and creepers line an entire wall.

DERRY AND TOMS

KENSINGTON, LONDON, ENGLAND

ARCHITECT: B. GEORGE
ROOF ARCHITECT: RALPH HANCOCK (1936-1938)
BUILDING TYPE: DEPARTMENT STORE
ROOF TYPE: INTENSIVE

Figure 26: The English Garden at Derry and Toms. The stream is stocked with fish and flamingos mill about in the finest roof garden still in existance in the world.

Derry and Toms Roof Garden (also known as The Roof Gardens and Kensington Roof Gardens) were designed by Ralph Hancock from 1936-1938. The roof garden is the largest in Europe, covering 1.5 acres. The garden is comprised of three themed gardens (the Tudor Garden, the Spanish Garden, and the English Garden), a stream stocked with fish, over 70 full grown trees including oak and fruit, vine-covered walkways, ponds, and hundred of plants. Flamingos were introduced to the gardens in the 1950s.

The design for the garden was inspired by the roof gardens at Rockefeller Centre in New York and RCA's art deco "Rainbow Room." The roof garden was envisaged by Trevor Bowen, vice president of Bakers, the department store giants who constructed and owned the building. Bowen saw the advantage of a rooftop garden because there was no "loss of commercial space" and it improved "rental

values by improving [the] quality of the visible environment."[100]

Despite the multiple changes in ownership, changes in tastes, and London's capricious weather, The Roof Gardens are still thriving today (unlike the roof gardens at Rockefeller Centre, where very little remains).

The building was bought by Sir Richard Branson in 1981 and the gardens were Listed Grade II in 1978.

[100] Fridy Duterloo-Morgan "Kensington's Babylon: Derry & Toms Roof Garden." *London Gardener* .Vol. 4, 1998/1999, 42.

LYRIC THEATRE

HAMMERSMITH, LONDON, ENGLAND

ARCHITECT: UNKNOWN
ROOF ARCHITECT: ADAM WHITE AND ANDREE DAVIES
BUILDING TYPE: THEATRE
ROOF TYPE: INTENSIVE

The roof garden atop the Lyric Theatre Hammersmith is a public park, providing much needed green space to the dense, concrete jungle of West London. One of the aims of the garden was to be seen by people coming out of the nearby Hammersmith Underground Station.

The garden was partially funded through the 5p carrier bag charge at Marks & Spencers, who also donated a large number of flowers to the roof garden. The roof was landscaped by Groundwork London, a non-profit organisation, with the help of volunteers and children from a local school. The garden is maintained by residents at the nearby Ashcroft Estate who have been named "Garden Guardians," who are responsible for the garden's upkeep.

A six metre high boomerang-shaped pergola covered in creepers is the focal point of the garden, also visible from street level. The garden is filled with trees, including Magnolia and Eucalyptus, raised boxed gardens with Carex, Nepeta, Heuchera, and Sarcococca, and is surrounded by oak seating.

The roof garden was commended by the 2010 Landscape Institute Awards who said that "the project is a fantastic example of cross-sector partnership working in the community to deliver a fantastic outcome for local people and visitors to Hammersmith."[101] The Lyric Theatre's garden was also listed as one of Elle Décor's *Ten of the World's Most Unusual and Enchanting Public Gardens.*[102]

Figure 27: Actors from the Lyric Theatre dressed up as human planters to kick off the opening of the roof garden to the public. The roof garden's modern and playful design has quickly won the hearts of local residents in Hammersmith.

[101] Ben Coles "Hammersmith London Roof Garden at the Lyric Theatre" *Groundwork London,* n.d., http://london.groundwork.org.uk/what-we-do/case-studies/2009/hammersmith-london-roof-garden/full-story.aspx.

[102] Leah Konen and Tory Marlin "Ten of the World's Most Unusual and Enchanting Public Gardens" Elle Décor. n.d., http://www.elledecor.com/entertaining-travel/articles/ten_worlds_most_unusual_and_enchanting_public_gardens.

APPENDIX ONE

AUDIT OF LIVING ROOFS IN LONDON (2012)*

EXTENSIVE					
SITE	PLANNED (M^2)	COMPLETED (M^2)	TYPE	MANUFACTURER	DESIGNER
Southbank Youth Resource Centre, SE1		195		Bauder	
Positive Place, SE8		35		Bauder	
Laban Dance Centre, SE8		460	Biodi-verse	Trocal	Living Roofs.org
Payne/ Borthwick, Watergate St. SE8	900				
Convoys Wharf, SE8	8,000				
Deals Gateway, SE8		900	Biodi-verse	Alumasc Exteriors	
Deal's Gateway, SE8		1,100	Biodi-verse		
Greenwich Meridian, SE8		1,500	Biodi-verse		

EXTENSIVE					
Kent Wharf, SE8	?		Biodi-verse		
Greenwich Reach 2000, SE8	?		Biodi-verse		
Creekside Centre, SE8	100		Biodi-verse		
Seager's Distillery, SE8	?		Biodi-verse		
Greenwich Ecology Park, SE10		100	Sedum Mat		
Greenwich Penisula, SE10	?		Biodi-verse		
Lewisham Town Centre, SE13	?				
Mast Pond Quay, SE18		600	Biodi-verse		Living Roofs.org
Woolwich Arsenal, SE18	?				
287 Crystal Palace Road, SE22		60	Sedum Mat	Bauder	

EXTENSIVE					
Shaws Cottage, SE23		250	Biodi-verse		Eco-schemes
Cue Building, Horniman Museum, SE23		250	Meadow		
Charter School, SE24		250	Sedum Mat	Bauder	
Herne Hill, SE24		180	Sedum Mat	Bauder	
Soames Centre, E3		150	Lime-stone Grit		
Chingford Pumping Station, E4		626	Biodi-verse		
Homer Road, E9		160	Sedum Mat	Bauder	
New Providence Wharf, E14		1,700	Sedum Plugs	Alumasc Exterirors	
New Providence Wharf, E14		600	Sedum Mat	Bauder	
New Providence Wharf, E14	2,700				

EXTENSIVE					
FSA Canary Wharf, E14		250	Sedum Plugs		
Canary Wharf, E14		5,100	Sedum Mat	Bauder	J&L Gibbons
Canary Wharf, E14		180	Substrate /Seeded	Alumasc Exteriors	Living Roofs.org
Canary Wharf, E14		180	Substrate /Seeded	Alumasc Exteriors	Living Roofs.org
Barclays HQ, E14	460		Substrate /Seeded		Living Roofs.org
Wood Wharf, E14	?				
Mudchute Farm, E14	140		Sedum Mat	Bauder	
Tower Hamlets College, E14	100		Sedum Mat		
Peruvian Wharf, E16	?				
London Zoo, NW1		?	Sedum Mat		
London Zoo, NW1		180	Substrate /Seeded	Alumasc Exteriors	Living Roofs.org

EXTENSIVE					
Komodo Dragon House, London Zoo, NW1		360	Biodi-verse	Sarnafil / Days Aggregate	
100 Drayton Park, N5		500	Sedum Mat	Bauder	
Lea Valley Athletics, Pickets Lock, N9	1,000		?		
Repton and Forsyth, SW1		500		Bauder	
St Leonard's School, SW16		170		Bauder	
St. Martins School, Tulse Hill, SW2		1,500	Sedum Plugs/ Mat		
Gold Lane, HA8			Sedum Mat	Sarnafil	
Bedzed					
Beaufort Court / Lillee Road		625			
BBC White City		?	Sedum Mat		

EXTENSIVE					
Calthorpe Project, WC1		120	Sedum Allium		
17 Holland Villas, W14		100			
London Wildlife Garden Centre, East Dulwich		100	Sedum Mat		
90 Grove Park, Camberwell		120	Sedum Mat	Bauder	
King's Cross	?				
Basinghall Street, EC1	?				
Stock Ex-change Buildings, EC1	?				
Bishopsgate	?				
St Martin Le Grand / Cheapside	?				
Mermaid Theatre, EC	?				
51 Lime Street, EC	?				

EXTENSIVE					
New Street Square Development, EC1	800				
	EXTENSIVE PLANNED	EXTENSIVE COMPLETED			
TOTAL M^2	16,000	16,671			

INTENSIVE					
SITE		COMPLETED (M^2)			
Westferry Circus		11,311			
Canada Square		6,700			
Derby and Jones		2,000			
Liffe Building / Cannon Street		2,000			
Arundel Great Court, Embankment		3,000			
Merrill Lynch European HQ		1,000			
Jacobs Island, Mill Lane		3,500			
No.1 Poultry, EC1		500			

INTENSIVE					
Royal Artillery & Gunnery Quays, SE10		8,000			
Jubilee Park Gardens, Canary Wharf		11,000			
Odyssey Car Park		3,000			
Kensington Village		3,500			
Reuters Building		1,500			
Millennium Village		3,000			
		INTENSIVE COMPLETED			
TOTAL M²		**60,011**			
EXTENSIVE	**TOTAL**	**32,671**			
INTENSIVE	**TOTAL**	**60,011**			
	COMBINED TOTAL	**92,682 m²**			

*Source LivingRoofs.org

LIST OF ILLUSTRATIONS

Figure 12: Environmental Agency, *Annual Mean Concentration of PM10 in Ambient Air in London During 2006*, Illustration, 2006. London Air Quality Network.

Figure 13: New Yorker passing through security to enter 9/11 Memorial. Getty Images, *NYC Keeps Security Tight Following 9/11 Memorial*, Photograph, September 2011. AM New York (11 September 2011).

Figure 14: Space Hijackers, *No Photography Are You a Terrorist*, n.d., Photograph. 2012. Accessed on 26 April 2012 from Space Hijackers <http://www.spacehijackers.co.uk/html/projects/privatepublic/cityhall.html>.

Figure 15: Woman watering vegetables on the roof of her Anderson Shelter. *Anderson Shelter Allotment*, n.d, Photograph, c. 1940. Accessed on 26 April 2012 from BBC <http://www.bbc.co.uk/schools/primaryhistory/world_war2/air_raids/teachers_resources.shtml>.

Figure 16: Azul Thome on the roof of Thornton's Budgens Grocery Store. Oli Scarf, *London's Garden Squares are Open to the Public,* Photograph, 2011. Accessed on 26 April 2012 from Zimbo http://www.zimbio.com/pictures/FI0aaeV2fDz/London+Garden+Squares+Opened+Public/d44LwuxQAp9/Azul+Thome>.

Figure 17: Roof garden at the Lyric Theatre. *Hammersmith London Roof Garden at the Lyric Theatre*, Photograph, 2010. Accessed on 26 April 2012 from Groundwork London <http://london.groundwork.org.uk/what-we-do/case-studies/2009/hammersmith-london-roof-garden/full-story.aspx>.

Figure 18: Cityscape of Copenhagen. Phillip Proefrock, *Copenhagen Adopts a Mandatory Green Roof Policy,* Photograph, 2010. Accessed on 26 April 2012 from Inhabitat <http://inhabitat.com/copenhagen-adopts-a-mandatory-green-roof-policy/>.

Figure 19: Message to Boris Johnson. Climate Rush, *This is Not a Solution*, Street Graffiti, 2012. Accessed on 26 April 2012 from The Guardian (5 April 2012) <http://www.guardian.co.uk/environment/blog/2012/apr/05/boris-johnson-pollution-london>.

Figure 20: Dalston Roof Park stairwell. Heather Shimmin, *The Grass is Greener*, Photograph, 2012.

Figure 21: Containers on the roof of Thornton's Budgens Grocery Store. The Guardian, *Budgens Rooftop Garden*, Photograph, 2011. Accessed on 27 April 2012 from Inside Urban Green (12 March 2011) <http://www.insideurbangreen.org/2011/03/the-supermarket-growing-food-on-its-roof-environment-the-guardian.html>.

Figure 22: Putting green on Adelaide House, London. *Gentlemen Golfers - Adelaide House, London Bridge 1938*, Photograph, 1938. Accessed on 27 April 2012 from Peter Berthould (5 March 2012) <http://www.peterberthoud.co.uk/2012/03/golf-guns-londons-rooftop- playground-s/>.

Figure 23: Extensive Mexican roof garden. David Matzdorf, *The Green Roof in Autumn, Looking Uphill*, Photograph, 2007. Accessed on 27 April 2012 from Growing on the Edge (29 October 2007) <http://growingontheedge.net/viewtopic.php?p=21554>.

Figure 24: Heather Shimmin, *PV Panels, Dalston Roof Park*, Photograph, 2012.

Figure 25: Heather Shimmin, *Wigwam atop the Queen of Hoxton, Shoreditch*, Photograph, 2012.

Figure 26: Heather Shimmin, *The English Garden, Derry and Toms, South Kensington, London,* Photograph, 2012.

Figure 27: Groundwork UK, *Surreal Estates Gardens,* Photograph, n.d. Accessed on 27 April 2012 from Elle Decor <http://www.elledecor.com/entertaining-travel/articles/surreal_ estate_gardens>.

BIBLIOGRAPHY

Adams, W Bridges. "How to Convert London into a Garden." Once a Week. 17 December 1859: 519-522. Print.

"A Farm in a Shop." F*arm:shop*. 2011. Farm London. 8 April 2012. Web <http://farmlondon.weebly.com/farmshop.html>.

"Allotment Tales." *Meridian Tonight*. iTV. iTV Meridian, Dover, England. 18 August 2007. Television.

Beatley, Tim. "Green Cities: Urbanism and Advancing Sustainability." *School of Architecture: Podcast Series*. 15 April 2010. University of Virginia. 28 April 2012. <http://deimos3.apple.com/WebObjects/Core.woa/Feed/virginia-public-dz.51548 40338.0515 4840340>.

Beehives in Adelaide House. Prod. WPA. WPA News, 1937. Newsreel Archive.

"Benefits of Green Roofs," *Apex Green Roofs*. n.d. Apex Green Roofs. 18 March 2012. Web. <http://www.apexgreenroofs.com/green-roof-benefits.html>.

Bethph. "London's Great Green Space Sell-Off" The Londonist. 7 March 2012. Web. 20 March 2012. <http://londonist.com/2012/03/londons-great-green-space-sell-off.php>.

Berthold, Peter. "Golf & Guns – London's Rooftop Playground in the 1930′s." *Discovering London*. 5 March 2012. Web. 31 March 2012 <http://www.peterberthoud.co.uk/ 2012/03/ golf-guns-londons-rooftop-playground-s/>.

Björk, Docent Folke. International Green Roof Institute. Division of Building Technology, Department of Civil and Architectural Engineering. *Green Roofs Effect on Durability of Roof Membranes*. Malmö: EU-Life, 2008. Web.

Campbell, Margaret and Ian Campbell. "A Survey of Allotment Waiting Lists in England." *National Society of Allotments and Leisure Gardens,* June 2009. Web. 20 March 2012 <http://www.nsalg.org.uk/uploads/article564/ttwk_nsalg_survey_09.pdf>.

Cantor, Steven L. Green Roofs in Sustainable Landscape Design. New York: W W Norton & Company, 2008. Print.

Clayton, Peter A. and Martin Price. The Seven Wonders of the Ancient World. London: Routledge, 1988. Print.

Coles, Ben. "Hammersmith London Roof Garden at the Lyric Theatre" *Groundwork London*. 2010. Groundwork London. 8 April 2012. Web <http://london.groundwork.org.uk/ what-we-do/case-studies/2009/hammersmith-london-roof-garden/full-story.aspx>.

"Copenhagen's Green Roof Ambitions." *Living Roofs*. n.d. Living Roofs.org. Web. 31 March 2012 <http://livingroofs.org/20100522222/world-green-roof-policies/copenhagen-green-roofs.html>.

"Dalston Roof Park." *Bootstrap Co.* 27 February 2012. Bootstrap Company. Web. 1 April 2012 <http://www.bootstrapcompany.co.uk/13_dalston_roof_park>.

"Dig For Victory." Prod. Ministry of Information and the Ministry of Agriculture Production, 1942. Film.

Dunnet, Nigel and Nöel Kingsbury. Planting Green Roofs and Living Walls. London: Timber Press, 2008. Print.

Duterloo-Morgan, Fridy. "Kensington's Babylon: Derry & Toms Roof Garden." London Gardener. Vol. 4, 1998/1999, p. 39-45. Print.

"England's Garden's 'Under Threat.'" *BBC*. 18 July 2007. Web. 20 March 2012. <http://news.bbc.co.uk/2/hi/uk_news/england/6904260.stm>.

Environment News Service. "Irreversible Climate Change Looms Within Five Years," 9 November 2011. *Common Dreams*. Web. 22 April 2012 <http://www.commondreams.org/headline/20 11/11/09-0>.

EPA. "Particulate Matter (PM): Basic Information." United States Environmental Protection Agency. 23 March 2012. Web. 25 March 2012 <http://www.epa.gov/pm/basic.html>.

"Facebook Statistics, Stats and Facts for 2011." *Digital Buzz Blog*. 18 January 2011. Digital Buzz Blog. Web. 25 March 2012 <http://www.digitalbuzzblog.com/facebook-statistic s-stats-facts-2011/>.

Fast, Kate. Iraq the Land. New York: Crabtree Publishing, 2005. Print

"Food From the Sky." *Food from the Sky,* 2012. Web. 1 April 2012 <http://foodfromthesky.org.uk/>.

"Flooding." *Climate Change Adaptation Strategy*.. n.d. Greater London Authority. 15 March 2012. Web. <http://www.london.gov.uk/climatechange/content/flooding>.

Gedge, Dusty. "Living Roofs and Walls." 12 January 2012. PowerPoint Presentation.

Gedge, Dusty, John Newton, Carl Cradick, and Phil Cooper. "Living Roofs and Walls, Technical Report:Supporting London Plan Policy" Greater London Authority: London, 2008. Web. <http://static.london.gov.uk/mayor/strategies/sds/docs/living-roofs.pdf>.

Global Footprint Network. "Do We Fit on the Planet?" 7 February 2011. Web. 20 March 2012 <http://www.footprintnetwork.org/en/index.php/GFN/page/world_footprint/>.

"Green Roof Audit of London." *Living Roofs.org*. 2012. Livingroofs.org Ltd. Web. 18 April 2012 <http://livingroofs.org/20100309100/latest/resauditlondon.html>.

"Green Roof Benefits." *Green Roofs for Healthy Cities.* 26 January 2012. The Green Roof Infrastructure Association. 16 March 2012. Web. <http://www.greenroofs.org/index.php/about-green-roofs/2577-aboutgrnroofs>.

"Green Roof Course." Interview Dusty Gedge and John Little. *Living Roofs.org.* 2010. YouTube.com. 15 April 2012.

"Gosforth Park Nature Reserve," *Natural History Society of Northumbria.* n.d. NHSN. Web. 22 March 2012 <http://www.nhsn.ncl.ac.uk/resources-gosforth-nature-reserve.php>.

Grimes, Siobhan and Alice Haworth-Booth. "Boris Johnson, Gluing Pollution to the Ground is No Way to Clean up London." The Guardian, 5 April 2012. Guardian News and Media Limited. Web. 15 April 2012. <http://www.guardian.co.uk/environment/ blog/2012/apr/05/boris-johnson-pollution-london?INTCMP=SRCH>.

"Guerrilla Gardening in New York: An Eco Tipping Point." *GGTV*. Guerrilla Gardening.org. 5 April 2012. YouTube.

Harrison, John. "Allotment History: A Brief History of Allotments in the UK." *Allotment Vegetable Growing*. n.d. Alltoment.org.uk. 20 March 2012. Web <http://www.allotment.org.uk/articles/Allotment-History.php>.

Hawkins, David. "Farm:Shop East London's Radical Experiment in Food Growing and Community Building" The Ecologist. 14 February 2011. Web. 8 April 2012 <http://www.theecologist.org/how_to_make_a_difference/food_and_gardening/724652/farm_shop_east_londons_radical_experiment_in_food_growing_and_community_building.html>.

Hill, David. "London Olympics: Politics, Pollution and Plague." The Guardian, 17 January 2012. The Guardian News and Media Limited. Web. 15 April 2012 <http://www.guardian.co.uk/environment/london-2012-olympics-blog/2012/jan/17/london-olympics-air-pollution-boris-johnson?INTCMP=SRCH>.

Hoscik, Martin. "WEZ Abolition Increases Traffic Levels, Slows Speeds," *Mayor Watch*. 3 June 2011. Mayorwatch Publications Limited. Web. 15 April 2012 <http://www.mayorwatch.co.uk /wez-abolition-increases-traffic-levels-slows-speeds/201115257>.

How, Jeffrey. Insurgent Public Space: Guerrilla Urbanism and the Remaking of Contemporary Cities. Routledge: New York, 2008. Print.

Ibrahim, Magda. "Public Roof Garden Open in West London." *Horticulture Week*. 19 June 2009. Haymarket Business Media. 8 April 2012. Web <http://www.hortweek.com/news/913519/Public-roof-garden-opens-west-London/>.

"Introduction to Living Roofs Benefits." *Living Roofs.* n.d. Living Roofs. 12 March 2012. Web. <http://livingroofs.org/2010030565/green-roof-benefits/greenroof-benefits.html>.

Jacobs, Jane. The Death and Life of Great American Cities. New York: Vintage Books, 1991. Print.

Jaffe, Eric. "This Side of Paradise: Discovering Why the Human Mind Needs Nature." *Personal Sustainability Psychology & Support for Your Sustainable Lifestyle*, 15 May 2010. Web. 20 March 2012 <http://personalsustainability.com/tag/roger-ulrich/>.

Kadas, Gyongyver. "Rare Invertebrates Colonizing Green Roofs in London," Urban Habitats Volume 4. Issue 1 (2008): 66. Print.

Kazmierczak, A. and Carter, J. Adaptation to Climate Change Using Green and Blue Infrastructure: A Database of Case Studies. Grabs EU. Basel: Naturdach, 2010. PDF.

Kelly, Jon, "What Would Britain Look Like Without a Green Belt?" BBC News Magazine. 15 September 2011. Web. <http://www.bbc.co.uk/news/magazine-14916238>.

Konen, Leah and Tory Marlin. "Ten of the World's Most Unusual and Enchanting Public Gardens" *Elle Décor*. n.d. Hearst Digital Media. 8 April 2012. Web <http://www.elledecor.com/entertaining-travel/articles/ten_worlds_most_unusual_and_enchanting_public_gardens>.

"LBC Interview: Clean Earth's Clean Air for London Campaign." *Clean Air For London*. London's Biggest Conversation, LBC, London, England. 29 July 2009. Television.

Le Lievere, Audrey. "Gardens Among the Chimneypots" Country Life. 16 March 1989: 120-121. Print.

Liu, K., and B. Baskaran. "Thermal Performance of Green Roofs Through Field Evaluation." *National Research Council of Canada*. May 2003. Web. 15 March 2012 <http://www.nrc-cnrc.gc.ca/obj/irc/doc/pubs/nrcc46412/nrcc46412.pdf>.

London Climate Change Partnership "A Summary of Climate Change Risks for London" ClimateUK. 2012, Web. 15 March 2012 <http://www.london.gov.uk/lccp/docs/London_summary.pdf>.

London Climate Change Partnership. "High Temperatures and the Urban Heat Island." *London.gov.uk*. n.d. Web. 4 March 2012 <http://www.london.gov.uk/lccp/ourclimate/overheating.jsp>.

"London Congestion Charge." *Wikipedia, the Free Encyclopedia*. Wikimedia Foundation, Inc.. 19 March 2012. Web. 25 March 2012 <http://en.wikipedia.org/wiki/London_congestion_charge>.

"London Low Emission Zone." *Wikipedia, the Free Encyclopedia*. Wikimedia Foundation, Inc.. 24 March 2012. Web. 25 March 2012 <http://en.wikipedia.org/wiki/ London_low_emission_zone>.

"London Squares." *Garden Visit*. Nightingale Garden Company Limited. n.d. Web. 24 April 2012 <http://www.gardenvisit.com/landscape_architecture/london_landscape_architecture/visitors_guide/london_squares>.

"Making Green Roofs Happen: A Discussion Paper Presented to Toronto's Roundtable on the Environment." *Toronto City Planning*. November 2005. PDF.

Matzdorf, David. "A Mexican Hillside in London." *Living Roofs*. 30 August 2008. Living Roofs.org. Web. 1 April 2012 <http://livingroofs.org/20100319205/single-articles-on-green-roofs/mexican-hillside-green-roof-london.html>.

Matzdorf, David. "The Green Roof in Autumn." *Growing on the Edge*. 27 October 2007. Growing on the Edge. Web. 1 April 2012 <http://growingontheed ge.net/viewtopic.php?p=21554>.

Meek, Will. "Gardening as Mental Health Treatment" World of Psychology, 2006. Psych Central. Web 20 March 2012 <http://psychcentral.com/blog/archives/2006/07/ 19/gardening-as-mental-health-treatment/>.

Miller, Brian G. Greater London Authority. Consulting Report on London Air. Quality. Report on Estimation of Mortality Impacts of Particulate Air Pollution in London. IOM: Edinburgh, 2010.

Mulholland, Hélène . "London Low Emission Plan Stalled." The Guardian, 2 February 2009. Guardian News and Media Limited. Web. 15 April 2012 <http://www.guardian.co.uk/politics/2009/feb/03/boris-carbon-emissions-zone-charges?INTCMP=SRCH>.

Moss, Richard. "Protests Grow as Planning Changes 'Threaten' Green Belt." *BBC News England*. 10 February 2012. BBC.com. Web. 10 March 2012 <http://www.bbc.co.uk /news/uk-england-16987389>.

Oldfield, Leslie. "150 Protest Over Gosforth Nature Reserve Plans." The Journal. 31 October 2011. NCJMedia. Web. 30 March 2012 <http://www.journallive.co.uk/north-east-news/todays-news/2011/10/31/150-protest-over-gosforth-park-nature-reserve-plans-61634-29691436/>.

Prynn, Jonathan. "Drought to Send Food Prices Soaring." The Evening Standard. 12 March 2012. Web. 15 March 2012 <http://www.thisislondon.co.uk/news/london/drought-to-send-food-prices-soaring-7562420.html>.

Reynolds, Richard. On Guerrilla Gardening: A Handbook for Gardening Without Boundaries. London: Bloomsbury, 2008. Print.

Ross, David. "English Gardens." *English History*. n.d. British Express. Web. 20 March 2012 <http://www.britainexpress.com/History/english-gardens.htm>.

"South East Latest Part of England Officially in Drought." BBC, 20 February 2012. BBC News UK. Web. 20 March 2012 <http://www.bbc.co.uk/news/uk-england-17102615>.

"The Big Tree Plant on Target as it Celebrates its First Anniversary." *The Big Tree Plant.* December 2011. DEFRA. Web. 10 April 2012 <http://www.defra.gov.uk/bigtreeplant/whats- going-on/>.

"The Hanging Gardens of Babylon." *The Hanging Gardens of Babylon.org.* n.d. The Hanging Gardens of Babylon. Web. 10 March 2012 <http://hanginggardensofbabylon.org/>.

"The Impact of the 2003 Heat Wave on Daily Mortality in England and Wales and the Use of Rapid Weekly Mortality Estimates." Eurosurveillance. 10. 7 (2005). Web. 10 March 2012 <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=558>.

Odgeno, Carmen. "The Ideal City; Pienza, Pope Pius II and Urban Planning." *A Non Traditional Student in Italy.* 20 October 2011. Web. 11 March 2012 <http://anontraditionals tudentinitaly.wordpress.com/2011/10/20/the-ideal-c ity-pienza-pope-pius-ii-and-urban-planning/>.

Osmundson, Theodore. Roof Gardens: History, Design, and Construction. New York: W. W. Norton & Company, 1999. Print

University of Southampton. "How trees clean the air in London." ScienceDaily, 5 Oct. 2011. Web. 10 Apr. 2012 <http://www.sciencedaily.com/releases/2011/10/111005110800.htm>.

Urbinato, David. "London's Historic Pea-Soupers." *EPA.* 1994. United States Environmental Protection Agency. Web. 18 March 2012 <http://www.epa.gov/aboutepa/history /topics/perspect/london.html>.

Van du Zee, Paul. "New York Roof Gardens." Godey's Magazine July-December 1894: 201-210. Print.

Vaughan, Adam. "London Air Pollution at Record High." The Guardian. 15 March 2012. Web. 20 March 2012 <http://www.guardian.co.uk/environment/2012/mar/15/london-air-pollution-record-high>.

"Victorian Parks, Cemeteries, and other Green Spaces." *The Victorian Web.* 25 May 2011. The Victorian Web. Web. 30 March 2012 <http://www.victorianweb.org/art/parks/index. html>.

"When are Public Spaces not Public?" *The Politics Show.* BBC, London. 24 January 2012. Television.

Williams, Sam. "Cool(er) Roofs." Gotham Gazette. March 2005. Citizens Union Foundation. Web. 7 April 2012 <http://www.gothamgazette.com/article/environment/20051028 /7/ 1635>.

Woodward, Christopher. "The Age of Flower Towers." *FT.com.* 7 October 2011. The Financial Times, LTD. Web. 10 March 2012 <http://www.ft.com/cms/s/2/03b0f876-ea8 3-11e0-b0f5-00144feab49a.html#axzz1a947nXSb>.