

Table of Contents

Acknowledgements	3
Abstract.....	5
1 Introduction	7
1.1 Background and Context.....	8
1.2 National Health Strategies.....	10
1.3 Healing Environments.....	11
1.4 The NHS and Sustainability.....	11
1.5 NHS Spending.....	12
1.6 Sowing the Seeds.....	13
1.7 Heat Islands.	14
1.8 Summary.....	16
2 Literature Review	17
2.1 Greenhouse Gas Emissions.....	17
2.2 Transport and Health.....	19
2.3 Parks, Green Spaces and Health.....	20
2.4 Can Trees Reduce Recovery Time?.....	23
2.5 Prevention is better than a cure?.....	24
2.6 Effects of Woodland on Health.....	26
2.7 Heat Island Effect.....	27
2.8 Forest Carbon.....	28
2.9 Do Aesthetics Matter?.....	31
3 The Study.....	33
3.1 Space.....	33
3.2 Studies and perceptions	35
3.3 Carbon Sequestration	36
4 Results	37
4.1 Available space	37
4.2 Carbon Sequestration	39
4.3 Perceptions of local people	41
5 Analysis and Discussion.....	43
5.1 Space to create a better healthcare environment	43
5.2 Transport Links.....	46
5.3 Links with other projects and existing green space.....	46
5.4 Aesthetics.....	47
5.5 Carbon Sequestration	48
6 Conclusions	49
6.1 Enhancing the healing environment	49
6.2 Carbon Sequestration	49
6.3 Creating quality green space for patients and local communities	49
6.4 General points	49
7 Recommendations	51
8 References.....	53
APPENDICES.....	65

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Abstract

The conception of the NHS Forest was at a meeting held in December 2008 and had developed from a number of leading NHS professionals, such as Sir Muir Gray and William Bird who felt that many NHS Estates would benefit from greening their sites which would in turn help the health of patients and staff that work there. The initial scope of the project was simply about greening the NHS Estate and putting trees in the ground with a target of 1 tree for every NHS employee, i.e. 1.3 million trees. The *aims* of the NHS Forest are;

- Greening the NHS Estates and planting 1 tree per employee, amounting to 1.3 million trees within 5 years.
- Improving the health of staff, patients and communities through the use of green space.
- Encouraging the NHS to provide environmental benefits through their Estates including an element of reducing the NHS' carbon footprint through carbon offsetting from the 1.3 million trees planted.
- Engaging people in and around healthcare organisations with their immediate environment as a way to increase awareness of the wider environment and sustainability, encouraging greater social cohesion between NHS Estates and the local community. Improving access to green space on or near to NHS land.
- Bringing together a range of highly skilled professionals to produce woodland that includes the use of art, food crops and mapping.

This dissertation examines the notion of the NHS Forest to see how feasible it is and what are the barriers to achieving the successful planting of 1.3 million trees. It will show that without the NHS acquiring land from neighbours and partner organisations, there is not enough space to succeed with the target, and demonstrate that as a vehicle for carbon sequestration the NHS Forest will be relatively insignificant, largely due to the nature and spacing of the trees. There is however much evidence that trees and green space have intrinsic healing qualities, create space for rest and relaxation and help to improve the local air quality. These factors alone have many connotations for the NHS and can only help to cut costs through improved general health of the population.

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1 Introduction

The Earth's climate is changing; this is partly due to the huge amount of anthropogenic Greenhouse Gasses (GHGs) emitted to atmosphere on a daily basis (Karl and Trenberth 2003) (Black, 2006). These gasses are a direct result of our success as a species; our intelligence has led us to develop ways of survival that can no longer be considered part of the natural cycles of nature, by the burning of fossil fuels to keep us warm and entertained. Rather than survival of the fittest, for the Human race, as the title of Jonas Salk's 1973 book suggests, it is more "survival of the wisest".

The NHS Forest is a project that supports the Climate Change Act and provides a visual statement of "Greening the NHS". There is currently a great emphasis on Carbon reduction worldwide, and the NHS, the largest employer in Britain, has a moral duty to lead the way in carbon reduction strategies, because as the full effects of climate change come to fruition the NHS is likely to face an onslaught of people with poor health and disease as a direct result.

The Campaign for Greener Healthcare, a charitable organisation based in Oxford, UK, and proposers for the NHS Forest recognise that a forest of 1.3 million trees will not be sufficient to offset the total carbon emissions from the NHS Estate, but if strategically executed it is estimated will offset approximately 10% of the emissions by 2020. It will also provide assistance to the NHS Estates energy consumption by sheltering buildings from heat of the summer and the cold winds of winter. The presence of trees in the urban environment can help to reduce the abnormally high temperatures caused by the heat island effect (Rosenfeld et al., 1995), by creating shade to cool the pavements and retaining moisture to release into the atmosphere further cooling the air and helping to relieve the stresses and premature deaths associated with heat waves(DOH, 2010a).

Trees also absorb harmful pollutants that cause many cardiovascular and respiratory disorders, acting as lungs for the cities and towns as natural 'air conditioners' (Stewart et al., 2003), (Broadmeadow and Freer-Smith, 1996). Trees and green spaces also help prevent flash floods by slowing down the rate at which rain hits the streets and retaining some of the water in the ground thus reducing surface water runoff (DEFRA, 2007a)

Other benefits to planting the forest are the intrinsic healing properties of trees, not only through absorption of harmful pollutants but trees are said to have a calming effect on people (O'Brien, 2004b), (SDC 2008), and are especially useful for people suffering mental

ill health (Shumaker and Pequegnat 1989) (Pretty et al., 2005) making the basis for the NHS Forest a strong one that should last a lifetime.

1.1 Background and Context

We are constantly being reminded by the media that climate change is a reality and there is a need to act now otherwise we could reach a point of no return, where a global catastrophe is inevitable; *“Climate change is the biggest global health threat of the 21st century”* (*The Lancet* 2009). It is therefore obvious that we owe a duty to the planet and ourselves to act sustainably; healthcare is no exception to this, and many would say that the future of the National Health Service (NHS) in the UK depends on it becoming a leader by acting responsibly and promoting sustainability by developing hospitals fit for the future that fulfil all of the needs of the patients, but also the needs of the planet.

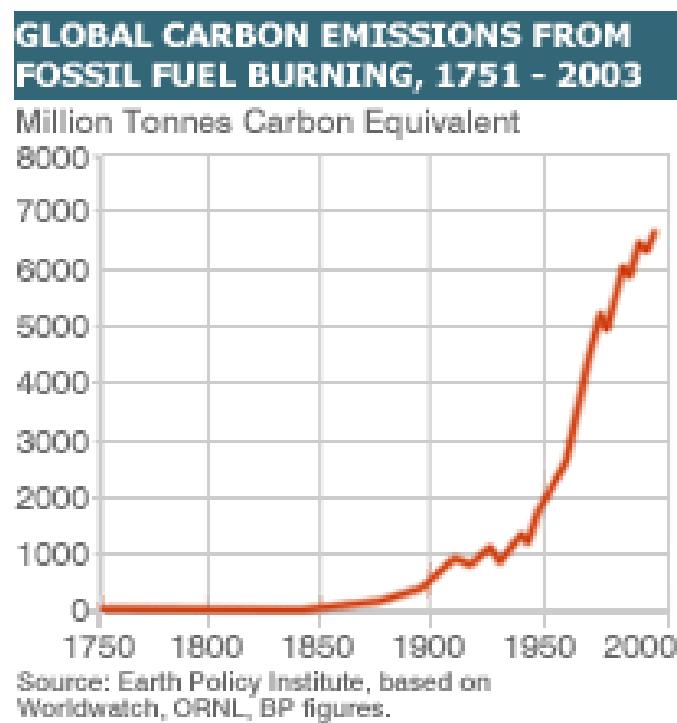


Figure 1; Global Carbon Emissions from Fossil Fuel Burning, 1751 – 2003: BBC 2006

The relationship between human health and the planet is vitally important if we are to believe scientists views on climate change, of which the evidence is overwhelming; as we create an unprecedented scenario with extremely high levels of anthropogenic atmospheric carbon dioxide (CO₂) (Figure 1), the most abundant greenhouse gas (GHG) we can only guess at what will follow in terms of climate change and the effects it will have on the weather and biodiversity of our home, Earth.

The Campaign for Greener Healthcare (CGH) are a group of motivated individuals that exist as part of the registered charity Knowledge into Action, based in Oxford, UK, set up to improve the health and healthcare of the people of the UK. The CGH work independently on the interface between health and sustainability to help forge the link between climate change and better health. It was through this charity that the concept of the NHS Forest came about, primarily as a way of greening NHS Estates. A pilot phase was

launched in 2009 and very early on in the process it became apparent that engagement with local people was going to be the overriding driver to ensure the sustainability of the Forest.

The NHS Forest has the ability to achieve its objectives but the big question is on what scale? This paper will look at what extent the forest can achieve, the barriers to achieving the objective, and the impacts, both direct and indirect, the NHS Forest can have in achieving its primary objectives.

There is a school of thought that animals instinctively know how to behave and what to do without being taught; they sense danger and when it comes to survival the weakest are left to die; that is nature's way, but humans circumvented these natural processes in many ways, found ways to eradicate disease, protect the weak and live longer so that the natural evolutionary cycle and our natural animal instincts have largely been lost. Longer life spans and lower premature death rates lead to increased population, so there will inevitably be concern over how much human life the Earth can sustain? According to the Worldwide Fund for Nature (WWF) if everyone consumed resources in the same quantities that the UK does, we would need three planets to support us (WWF 2010), and as the population continues to grow, we see diseases become more prevalent, more places become inhabited and therefore more urbanised, this leads to a decline in local air quality and the creation of local 'heat islands'; with it comes more pollution causing accelerated climate change. The end result is likely to be more extreme weather events; so the burden on the planet becomes heavier and heavier; not only does the burden on the planet become heavier but also the burden on the NHS becomes heavier, which is one of the main reasons why the NHS should be leading the field and setting the standard for others to follow. The NHS Forest may be a small contribution, but may prove to be socially, and politically, a significant step on the road to combat climate change and, perhaps just as importantly for the NHS, help to reduce the incidences of adverse health associated with climate change. It appears obvious therefore that the quicker we act and the more we do to try and combat the effects of climate change through reducing our GHG emissions, whether by directly reducing energy and fuel consumption, or by methods to absorb some of the pollutants and gasses that directly contribute to climate change and adverse health effects, or a combination of both, the better off we will be.

The introduction of the Climate Change Act (2008), a bold statement to the world that many think unrealistic and unachievable, has set ambitious, legally binding targets for all

organisations to reduce their energy consumption 80% by 2050 from the baseline year set in 1990. To meet these targets is going to be a huge challenge for all organisations, and with public bodies this is potentially even more challenging, especially with the threat of budget cuts and reduced spending; however offsetting carbon is a means that could have potentially significant benefits in helping the NHS to meet these demanding reduction targets; and in planting trees to help offset carbon emissions other benefits relevant to the NHS are inevitable, namely the health of the nation and ultimately the health of the planet. Determining the scope of the potential will require much work and will not be determined fully in the scope of this document.

1.2 National Health Strategies

There are a number of direct policies and background papers that underpin the ethos of the NHS Forest and that are driving the project forward in terms of the NHS such as Climate Change Act 2008, the NHS Sustainable Development Unit strategy for the NHS; Saving Carbon, Improving Health (2009 as updated 2010), but more than this the threat of catastrophic climate change, and the general declining health and sedentary lifestyles of the UK population are major drivers also.

There are several other Department of Health (DOH) strategies that underpin the NHS Forest and its direction such as:

- Healthy lives, healthy people White Paper: Our strategy for public health in England (Nov 2010)
- Change4Life – Eat Well, Move More, Live Longer (2009)
- Choosing Health; Making healthier choices easier. White Paper (Nov 2004)
- Tackling health inequalities: A Programme for Action (July 2003)

There are other drivers that also directly link with these health strategies such as the reformed planning regulations 2009 and designing for the future.

The NHS Forest is only one element of the strategy and alongside the planting of the trees it is hoped that a network of available land is developed where local communities can grow not only woodland to add to the forest but also their own food crops, so helping communities to get fresh local fruit and vegetables.

1.3 Healing Environments

Though certain types of healthcare facility, such as hospices, often do provide outdoor spaces which form part of the overall healing environment, there are many that do not. Like much of the surrounding urban environment, site layouts tend to be dominated by traffic and parking requirements at the expense of the pedestrian. 'Patient care' is something which takes place indoors, not outdoors, and more bed-spaces and parking spaces take priority over an improved outdoor space, even when outdoor space could have major benefits. There are some genuine reasons for this lack of outdoor space, not least the lack of available land on which to develop green spaces, and the NHS Forest is not going to easily overcome this barrier as it will have to if the 1.3million trees are to be planted.

The NHS Forest project is more than just planting trees, it is a project that will focus on engaging with people to use their local environment by jointly creating space that will be used and continually improved by staff, patients and the local community. It is envisaged that the localised projects will, in consultation and negotiation with local volunteer groups, establish and maintain ownership of the NHS Forest and this, it is hoped, will help to ensure its survival. Essentially the ultimate marker for the success of the NHS Forest will be its long-term legacy, as Jonas Salk said "*Our greatest responsibility is to be good ancestors*" (Salk, J. In: Frumkin H et.al., 2008), for those who are involved and who will be involved in the future of the NHS Forest, maybe they will be remembered for being '*good ancestors*' in doing the right thing.

1.4 The NHS and Sustainability.

In 1987 the 1st report of the world commission for environment and development was published, commonly known as the Brundtland Report, *Our Common Future*; this set the standard description for sustainable development and is commonly cited thus;

"development that meets the needs of the present without compromising the ability of future generations to meet their own needs". (Brundtland 1987)

Sustainable development (SD) is a concept that is difficult to both understand fully and quantify in simple terms, and though many attempts to explain what SD actually is, the term is still open to interpretation in many different and diverse ways. A simple explanation of SD is depicted in figure 2, demonstrat-

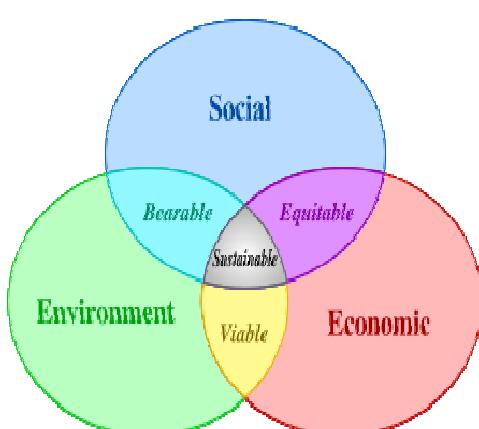


Figure 2 Sustainable Development Model
SCM (2008)

ing how difficult SD is to achieve, getting a balance between the social and environmental aspects and at the same time trying to balance these with the equally delicately balanced scale that is economics.

For something to be truly sustainable it must first satisfy all three elements in the model, but also must not deplete any resource so that it would adversely impact future supply. The NHS Forest if executed properly will easily satisfy 2 of the SD elements in the Environment and Social categories, but many will question the economics; can the NHS in times of financial hardship actually afford to plant a forest? This is a question that requires a certain amount of analysis to answer. For the NHS Forest to have any success of course the answer has to be yes, and the case for action at any trust will have to be backed up by robust figures that satisfy the different agendas to get approval by the Boards. Sustainable Development is of course one of the major drivers in the NHS at the moment and being seen to be doing the right thing has much credence, however as jobs are being cut will spending on the forest actually be perceived as a negative action?

1.5 NHS Spending

The NHS naturally consider improvements in healthcare, more particularly the delivery of quality healthcare over and above other factors when determining budgets and where capital spending is to be allocated, therefore when spending cuts are required it is naturally expected that these cuts won't affect the levels of care given to patients, so health professionals tend to look to estates and support services to make a lot of these cuts on their behalf. However cuts in spending on the NHS Estate are likely to have a detrimental effect on the delivery of healthcare, and much thought should be given to delivering good quality low carbon and sustainable buildings with whole life costing featuring in the design brief. Too often budgets are restrained by the bottom line and compromises in the design are often reflective of this. This approach does however ensure that building projects are delivered on time and on budget, but with the whole life costs, including associated costs with future healthcare provision, not taken into account, these buildings will in the long term be more expensive to run both financially, ecologically and environmentally than if they had been designed with sustainability and the future of healthcare in mind. The NHS Sustainable Development Unit (NHS SDU), have produced a Carbon Reduction Strategy for the NHS; 'Saving Carbon, Improving Health' (NHS SDU, 2009), which requires all NHS Bodies to have a Board approved Carbon Management Plan in place by 2010/11. This is now driving Trusts to think about low cost, low carbon ways of improving healthcare provision. The NHS Forest has the potential to partially fulfil some of those needs.

The same can be said for the design and layout of hospital campuses. To take us into the future of healthcare all aspects of care need be considered and outdoor space should be no exception. Sadly in the past the inclusion of outdoor space has been considered a necessary addition that will use “what money is left in the budgets” (Spaven, 2010) when all else is covered. Recently however, with the help of charitable organisations like the Kings Fund, there have been moves towards outdoor space being included as a vital part of the healing environment, (EHE 2010) and more funding is now being allocated to providing good quality usable outdoor space. Local authorities also now have the power to insist on a certain amount of green space being allocated (CABE, 2010?) and can if desired specify a number of trees to be planted based on the size of the proposed build, however it is still often seen as a luxury not easily afforded in many cases.

1.6 Sowing the Seeds

By creating a healthier environment, lowering localised air pollution and, with it, reducing the effect of local heat stress often experienced in large cities and towns; by the creation of ‘health parks’ (parks and green space designed specifically with health in mind, i.e. for exercise and therapy in hospital grounds), or simply creating accessible green spaces for exercise could be a much better and healthier exercise option than, for example, using a regular gym. Although spending public money on creation of parks and green space may to the uninformed seem like spending public money intended for health care indiscriminately, there is much evidence that access to green space is beneficial to health, (Shumaker and Pequegnat 1989) (Pretty et al., 2005) (SDC 2004) (Taylor, Kuo and Sullivan, 2001) and this could directly reduce NHS spending. Justification can therefore be sought for the creation of accessible quality green space through projects such as the NHS Forest. One could also put forward an argument for the NHS to purchase additional land on which to plant the NHS Forest, or at least enter into partnership agreements with local landowners to plant and manage the forest for them. As long as the forest remains accessible to all and can demonstrate a benefit to the local community it serves it will satisfy the objectives of the NHS Forest.

In Todmorden, a project known as Incredible Edible has begun, (Incredible Edible Todmorden 2011) where on almost every street corner and garden capable of raising something, food crops, in some cases chickens and pigs, have and are being grown and tended to, by local people, for use by local people. The NHS Forest although different in that it is for amenity value rather than food, serves essentially the same purpose; moreover the NHS Forest could also develop into a similar scheme with glades and smaller areas being

planted with food crops such as apples, pears nuts and other woodland fruits for use in our hospitals.

Green space not only has a positive effect on preventive healthcare, there are convincing studies that demonstrate patients in hospital beds tend to recover more quickly when they have views of trees and green space rather than concrete and buildings (see Ulrich 1984) and (Kaplan, 1995). Hospitalised patients in the middle of the last century used to be wheeled outside to get fresh air after operations, and this it seemed helped them to recover more quickly see (Ulrich 1984 & 1986). While at this time doctors believed this to be as a result of patients breathing in fresh air, it would seem that more likely the reason was psychological rather than physiological. We can trace this idea back to Florence Nightingale who believed that simply giving hospitalised patients access to fresh air would speed up their recovery further supporting the theories of Robert Ulrich and Steven Kaplan , it follows then that sustainability and, more importantly, access to green space should always be considered a vital part of the process in the design of the NHS Estate.

1.7 Heat Islands.

Urban areas consist of large expanses of concrete and tarmac which absorb heat at a greater rate than arable green space (US Environmental Protection Agency (EPA) 2010), this absorbed heat is stored within the concrete and released slowly as the air temperature falls at night therefore the temperatures in urban areas, especially in the summer, can be considerably higher (up to 22°C higher (US EPA 2010)) than the surrounding countryside, this is known as the heat island effect. There are other factors that influence the heat island effect such as long wave and short wave radiation that effectively restrict the flow of heat from urban landscapes at night further compounding the problem. In a study into urban areas in the Northern Hemisphere (Haider, 1997) they found on average urban areas have 12% less solar radiation, 8% more clouds, 14% more rainfall, 10% more snowfall and 15% more thunderstorms than their rural counterparts, this is compounded by the human interference causing atmospheric pollution to be 10 times higher than in rural areas, and temperature being an average 2°C higher.

Heat stress is a major cause for concern to the NHS, especially with obesity levels, cardiovascular disease, respiratory diseases and the elderly population all on the increase. It is not only the heat that causes problems. With the heat there are pollutants from traffic, industry and power generation that compound the problems and lead to premature deaths. In one hot spell in August 2003 in England, deaths in those aged 75 and over rose

by 60%, with approximately 2000 total extra deaths than would normally be expected for the time of year. (DOH, 2010). In an effort to mitigate some of the effects of heat stress the DOH have produced a heatwave plan; one of the medium term objectives within the plan is to increase green space within hospitals:

“Review external hospital and health care land for ways to aid cooling – for example, consider constructing underground car parks and maximise green space and trees surrounding buildings.” (DOH 2010 a.)

The effect of planting trees in cities has a threefold effect on the people:

- They feel better from just seeing trees (O'Brien, 2004a & 2004b),
- They have cleaner air to breathe because trees absorb a lot of the harmful green-house gasses and particulate matter that cause many respiratory illnesses, and
- Trees absorb heat so reduce urban heat stress during the summer (SDC, 2008).

As the Heatwave Plan for England (DOH, 2010) also states, from the studies into the effects of trees in cities, effective tree planting schemes can reduce the need for air conditioning by up to 30% simply by cooling the air outside. They do this by absorbing and retaining moisture which is released slowly through the day, also by shading the ground they reduce heat absorption in the concrete and tarmac and also reduce the rate of water evaporation. Thus trees in the urban landscape have an effect of reducing the Heat Island effect and help to improve the local air quality for everyone.

1.8 Summary

All of these effects have a direct effect on the NHS, and these reasons were some of the main drivers for the Campaign for Greener Healthcare proposing to plant the NHS Forest.

This paper will examine the idea of planting an NHS Forest to determine whether in the literal sense, ‘Greening the NHS, can play a significant role in the policies and strategies that underpin the ethos of the NHS and whether the forest can also play a significant role in changing the future for the NHS. It has the possibility for doing this in three distinct ways;

1. Creating visual stimuli for hospitalised patients to help them recover more quickly. ***(Healing Environment)***
2. Creating a healthier environment; cleaning the air, reducing heat stress in urban areas and having a positive effect on climate change. ***(Carbon Sink and Air Conditioner)***
3. Creating safe accessible green space for rest, relaxation and exercise, thus having a direct effect on more healthy lifestyles. ***(Preventive Healthcare)***

The difficulties lie in the execution of the task, availability of suitable land, the perception of the public and also perception of many staff working within the NHS.

2 Literature Review

2.1 Greenhouse Gas Emissions

To get an understanding of the importance of controlling GHG emissions it is helpful to see how our relatively small contribution in terms of output of GHGs has contributed to the earth's warming over the last 100 years or so.

Table 1: Estimated major stores of carbon on the Earth.	
Sink	Amount in Billions of Metric Tons
Atmosphere	578 (as of 1700) - 766 (as of 1999)
Soil Organic Matter	1500 to 1600
Ocean	38,000 to 40,000
Marine Sediments and Sedimentary Rocks	66,000,000 to 100,000,000
Terrestrial Plants	540 to 610
Fossil Fuel Deposits	4000

Source; Pidwinney, (2010)

In today's fast moving world it is easy to engulf ourselves in our own daily business and lose sight of the global challenge, although it this not necessarily important in everyday life as long as in our own small way we consciously decide to reduce energy, if only for selfish reasons such as to save money, the global challenge will be suitably addressed.

The media remind us of how much the Earth is warming up as a direct result of anthropogenic greenhouse gas emissions, and what it might mean to us in the future see (Hari, 2010) and (McCarthy, 2010), and now many of the most sceptical of scientists have admitted that they believe anthropogenic carbon emissions are to blame, see (Moore, 2010).

The mean global temperature during the mini ice age that lasted between the 14th and 17th centuries was only 1° Celsius lower than at present (Mintzer, 1993), and in the last century the earth's mean global temperature has risen by 0.6° Celsius; the greater part of which has

happened since the 1970s (NASA 2006). This temperature rise is already starting to spark some uncommon weather events, hurricanes are becoming more prevalent and stronger as are worldwide flooding events and droughts (Glicksman, 2006); scientists predict the temperature rise will potentially cause some catastrophic and irreversible events not so far into the future (Gregory, Huybrechts and Raper, 2004) and (Alley et al., 2005).

Perhaps the largest and most significant of these events is the melting of the polar ice caps; the Antarctic and Greenland Ice Sheets are the most important of these since they are situated over land. As floating ice melts it doesn't raise the water level, much like ice melting in a glass, but ice sheets on land masses will melt into and significantly raise sea levels '*Scientists warn that temperature rise of between 2C and 7C would cause ice to melt, resulting in a 23ft rise in sea level*' (Goldenberg 2010), although this may be seen to be a case of extremism even a rise of half this magnitude will lead to widespread flooding of many coastal regions and inland areas along the main estuaries of the Humber, The Wash, Thames Estuary and Bristol Channel in this country and many other low lying cities worldwide such as New Orleans in the USA, much of the Netherlands, Austria and Western Germany. (Tingle 2007). The raising of the sea level will potentially have a fourfold effect on the planet and the all living things that call Earth their home;

- Flooding
- Loss of Land
- Mass Migration
- Disease and poor health

Flooding will inevitably lead to mass migration, loss of valuable agricultural land, loss of habitat, food shortage and large scale economic damage. Furthermore flooding of urban areas particularly leads to heavy pollution, compounding problems with more widespread disease.

Warmer temperatures will mean that the malaria carrying mosquitoes will be able to migrate further away from the equator and to higher altitudes causing more widespread disease. See (Dupont and Pearman 2006). Although if all the predicted combined effects of global warming happen, then the UK could be spared Malaria by the potential reduction of the warming effect from ocean currents, see (WHOI, 2010).

All of these effects will have some effect on the NHS, some lesser and some greater, some direct some indirect; we know that extreme weather events i.e. storms, floods, heat waves and prolonged cold periods cause a higher prevalence of premature deaths (DOH 2004). putting a strain on the Health Service, and the knock on effects of people suffering from stress, anxiety and grief after such events puts yet further strain on the service.

2.2 Transport and Health

One of the major contributing factors to poorer public health is linked with direct emissions from transport. Transport infrastructures are directly related to pedestrian and motor vehicle fatalities and injuries, the design of better infrastructure particularly for pedestrians and cyclists could significantly reduce transport related fatalities by encouraging walking and cycling above the car. Through initiatives like the NHS Forest we can potentially contribute to the availability of suitable foot and cycle paths by linking parts of towns and cities through NHS Sites, and encourage people to leave their cars and walk or cycle more.

In 2008 there were a total of 230,905 reported road casualties in the UK; this represents a 7% reduction from 2007. 2,538 people were killed, 26,034 were seriously injured and 202,333 were slightly injured (DfT 2009). In France over the last 10 years road fatalities have fallen by a staggering 48%, (TISPOL, 2010) this can be partly attributed to the vast increase in cycling across France particularly in the big cities, where a public cycle hire scheme, the *Vélo à la Carte* service, was originally introduced in Rennes. People pay a one off fee of 23 Euros to register, and then cycle hire is free for up to two hours. In 2004 a total of 63,000 journeys were recorded by cycle across Rennes (Bührmann 2005). Similar schemes are now available in Paris (Vélib 2010) and across the majority of major cities in France. Similar schemes are slowly emerging now in the UK such as the Barclay's cycle hire scheme in central London.

A second benefit to promoting cycling and walking is that motor transport is directly linked to climate change. While climate change affects weather patterns, which alters local air quality, so transport affects local air quality directly and promotes climate change by emitting GHGs. The resulting localised air pollution has a direct impact on the health of the people, and therefore a knock on effect on the NHS.

Exposure to air pollutants on a daily basis is directly linked to many different illnesses (DOH, 2005) requiring some sort of treatment or hospitalisation such as; cardiovascular disease, chronic obstructive pulmonary disease, acute asthma, risk of lung cancer, birth

defects, impaired breathing, fatigue, headaches, eye irritations and respiratory infections; most of these illnesses and infections are more prevalent in groups of lower social economic status, (Younger, et al., 2008) and it is children that are particularly at risk (DOH 2005). In the UK, particularly those of lower social economic status, the vast majority of these will seek help through the NHS system, increasing the financial burden yet further.

A third benefit to promoting cycling and walking is of course the fact that it contributes to people's fitness. Exercise is a major contributory factor to benefit human health, and one of the major targets of the NHS is to promote 'exercise for health' (DOH 2005a). If we get more people walking, cycling and using public transport, this further reduces the road traffic, reducing road accidents, pollution and subsequently many of the associated illnesses related to pollution as mentioned earlier, as well as targeting obesity. However there is an argument that cycling and walking along major traffic routes have inherent dangers, notably the risk of being killed in a road traffic incident, and the effects of breathing in roadside pollutants from the masses of vehicles, further supporting the argument for planting trees along streets, particularly busy routes.

2.3 Parks, Green Spaces and Health

Much research into the health benefits of green space has been carried out and two major themes come through from this research; firstly the theory put forth by Roger Ulrich, that aesthetics and access to natural environments reduce stress and promote faster recovery, with less dependence on drugs after surgery; secondly the theory put forth by Stephen Kaplan that natural environments reduce fatigue and help with peoples day to day activities and make them think more clearly.

Green spaces can be defined as vegetated areas in or surrounding urban locations, which include parks and gardens; whereas natural spaces are areas subjected to less human influence, with the exception of farmland, in the countryside or on the urban fringe.

In a statistical document 'Measuring Progress' produced by the Department for the Environment, Food and Rural Affairs (DEFRA) each year in 2010 one statistic states that:

Over 95 per cent of people thought that it was very or fairly important to have green spaces near to where they live. (Anon., 2010)

Parks and green spaces provide a valuable asset for the NHS in creating space for exercise and relaxation, 30 minutes of gentle exercise a day on at least 5 days a week greatly re-

duces our risk of getting heart disease and strokes (Department of Health 2005a), and the current trend towards obesity, particularly in children, needs to be halted; so providing these parks and green spaces can play a vital role in the overall health of the nation and therefore lessen the burden on the NHS.

A key target for the government, and particularly the NHS, is to promote more healthy lifestyles in an endeavour to try to prevent or manage over 20 conditions and diseases, including coronary heart disease, cardiovascular and respiratory disorders and cancer among others, which account for almost 60% of the premature deaths in England (Department of Health, 2005). This target links easily with the climate change targets set by the government.

Recent studies by the Department of Health (DOH) England show that a lack of physical exercise and poor diet is contributing to rising obesity levels in children. In 2003 studies conducted by the DOH showed that 16.6% of boys and 16.7% of girls are obese (Department of Health, 2005). This had risen to almost 30% for both boys and girls in 2009, with boys being slightly higher than girls (Anon., 2009b). It is therefore vitally important to encourage youngsters outside into more physical activity, but to do this safe areas for exercise have to be created, and the exercise has to be enjoyable. There is a fear of what might happen to children 'playing out' today that didn't exist 30 years ago, ranging from risks associated with dramatically increased traffic on the roads, to violent and abusive offenses against children that are today more widely published in the media.

A department for transport survey that took place between 1999 and 2001 found that, according to the Chief Medical Officer's minimum recommendations for physical activity in adults, only 37% of men and 24% of women are active enough to gain any significant health benefit; in children 30% of boys and 40% of girls aged between 2 and 15 are not meeting the current recommended levels of physical activity required to maintain a healthy lifestyle. This trend in the reduction of physical activity has been a major contributor to rising obesity levels; in 2003 a Department of Health survey found 23% of women and 22% of men in England were obese. (Anon, 2004a).

Prescribing exercise, particularly outdoor exercise, instead of drugs for certain conditions such as stress and obesity is a way forward for the NHS. This was promoted heavily in the late 1990's and early 2000's, but with little uptake from general practitioners (GPs). Reasons cited were lack of guidance, and fear of alienating patients. An obese person suffering with depression is likely to get more depressed if sent to a regular gym to work out

with many ‘fit’ people. Cardiff and Bangor Universities, Wales in conjunction with the NHS ran an exercise programme to help people reduce the risk of developing some chronic health conditions and found it to be a ‘cost effective’ exercise (Welsh Government 2010) demonstrating that prescribing exercise for health was not only a good option for the patient but also had major financial benefits.

So by providing parks and woodland around hospitals, if planned and executed correctly and effectively we can provide good safe places for this exercise to take place in a supported environment. The services of the British Trust for Conservation Volunteers (BTCV) Green Gym programme could be utilised to assist and create opportunities for managed exercise in a controlled environment.

In order to run a Green Gym, the key activities are to:

- *Run a programme of practical conservation or gardening sessions that are held at least once a week throughout the year.*
- *Provide active and stimulating gardening or conservation activities, which are pulse raising and keep peoples interest.*
- *Establish links with local health services, for example a local health centre, which could endorse your Green Gym and recommend people to take part.*
- *Publicise the Green Gym activities, and recruit new members.*
- *Follow health and safety procedures, including warm-up and cool-down exercises at the beginning and end of each session.*
(BTCV, 2010)

With the additional help of the Woodland Trust and the Forestry Commission, any prescribed exercise could help to promote and enhance the NHS Forest, as well as provide a means to achieve the goal of planting 1.3 million trees with minimal costs.

Exercise is not the whole answer, but it is recognised as being a great benefit and people that take regular exercise on the whole live longer and healthier lives.

2.4 Can Trees Reduce Recovery Time?

Another aspect of Green space is the recovery of patients, and the long term benefits particularly for mental health problems. Behavioural research suggests that poor hospital design can negatively affect both patients and staff health by creating stressful environments (Shumaker and Pequegnat 1989). Research into people in stressful situations, such as those recovering from operations in hospitals, revealed that they appear to recover more quickly when they have views of natural environments (Ulrich 1984) rather than urban landscapes and the ugly building facades commonly seen from many of the older institutional type hospitals.

Through the 80's and 90's research showed that psychiatric patients responded better to hospital settings that integrate well with the natural environment, see (Ulrich, 1984,1986 and 1991), (Kaplan, 1987) and (Purcell & Lamb 1984). Indeed at Rotherham, Doncaster and South Humber Mental Health NHS Foundation Trust (RDASH) when the acute mental health ward moved from the third floor of the Doncaster Royal Infirmary, an old Victorian building that overlooks a very built up area, and particularly the back of the main hospital, with pipes, air conditioning units, and chimneys as the view, to the more open and beautifully landscaped almost semi rural St Catherine's Hospital, with natural woodland and open green space in abundance, it was commented by both patients and staff that the behaviour of patients significantly improved, and although there has been no formal study into the turnaround time from patients admitted to the psychiatric intensive care unit (PICU) to them being moved on, according to senior staff on the unit two distinct patterns emerged after the move:

1. Patients sectioned under the mental health act, and who were in effect 'detained' calmed down and recovered more quickly and moved on after a shorter stay on the unit than prior to the ward move. (Jones, 2010)
2. Patients suffering with anxiety and depression and who were admitted under their own free will, were reluctant to leave saying that they were more relaxed and felt happier and safer on the unit, this was a unique situation to the staff never experienced before the ward move. (Jones, 2010)

The basis of this evidence builds upon other studies that place and surroundings certainly assist with the treatment of acute mental health problems.

In a study conducted at a psychiatric hospital in 1998 on both staff and patients to try and determine preferred behaviours in preferred settings, using both computer based and location based tests with different activities, it was found that in almost all situations the preferred setting was a natural and open setting, with a second preference for enclosed natural surrounds; there was almost no distinguishable difference, approximately 50% from each group, in the preferences of staff and patients, concluding that the most favoured setting for social activity is the open natural environment.(Barnhart, et al., 1998).

There are also many studies that relate to the health and wellbeing of people in towns and cities, and the effect that green spaces and street trees have upon them. Neilson and Hansen (2006) concluded that access to gardens and local green spaces are associated with lower levels of stress and obesity. In 2007 to 2008 stress related illness in the UK resulted in 13.5 million days lost at work (Kerr, McHugh and McCrory, 2009). The financial burden on the UK from these lost days is considerable, and a large proportion will have sought medical help through the NHS further increasing the financial burden on the NHS.

2.5 Prevention is better than a cure?

The notion that 'prevention is better than a cure' is a well known and familiar phrase, and there is much evidence to support it. People that keep themselves fit and active tend to suffer less illness and are therefore likely to be less of a burden on the health service (DOH, 2005). The term itself can be applied to many situations of which climate change is one, although there are some that would say we have passed the point of preventing climate change see (McCarthy, 2006) (Weitzman 2009), all we can do now is prevent it getting any worse.

Health professionals and governors within the NHS also need to start to look more favourably at preventive healthcare as a priority, rather than just the treatment of illnesses; there are many drivers that are doing just that, such as the good work that has been done through the Kings Fund Charity in conjunction with the Department of Health, with the 'Enhancing the Healing Environment' projects developing both indoor and outdoor spaces that are more conducive to medical intervention and promoting sustainability within, see (EHE, 2010)

General Practitioners (GPs) have the capability through prescribing physical activity before resorting to drugs, though to do this the support mechanisms need to be in place to facilitate the actions. Prescribing exercise for health in the 1990s was a way forward that

GPs were encouraged to take, though uptake has been generally poor for a number of reasons; health ministers , while floating the idea in parliament for the past decade or two have not really pushed the issue as much as possible(Iliffe et al., 1994), also most people who don't do enough regular exercise, i.e. those for whom the exercise would be prescribed, would generally feel uncomfortable and self conscious in a gym, the preferred referral within the UK . (Iliffe et al., 1994) and (Dobson, 2009), with regular users that are generally fit which could have more of a psychological impact on the patient and be less beneficial to their long term health. The British Trust for Conservation Volunteers (BTCV) Green Gym (anon 2010a) idea is one such support mechanism that is greatly underutilised and as a result has not developed quite as it perhaps should have, this is perhaps through GPs not wanting to upset their patients by being perceived to be offering cheap alternatives to 'real' medicine (Iliffe et al., 1994)

Research into diseases and illness, whilst important perhaps now needs to take more of a back seat and the direction and focus be more centred towards researching what are the primary causes of most illnesses and targeting the cause rather than the illness itself. This is likely to be one of the most cost effective ways of making essential savings required by the NHS. This would in effect be taking a step backwards to move forward as this is by no means a new or revolutionary idea.

Dr. Jonas Salk, founder of the Salk Institute in the US and inventor of the Polio Vaccine was a great believer in preventive medicine, scientists of the time, Salk included, were researching ways of destroying viruses, but Salk was also looking at ways to prevent illness rather than find cures, and this is something that is required of the politicians, Health professionals and scientists of today to steer us in the right direction. Salk was also a person who believed in the ways and laws of nature, with an understanding that man was a part of nature; in his 1973 book "The Survival of the Wisest" he wrote of man:

"His concerns, thus far, have been more with details than with the overall picture. He has been occupied with disease and death, and with the amenities of life appropriate to each age and epoch. He has not yet seen the importance of understanding life's "purpose," and therefore, his purpose individually and collectively, and of understanding where he fits into the evolutionary scheme of things. When he does, he will then better comprehend his own nature and develop ways and means of dealing with the problems of life as part of the process of life itself, not as questions to be avoided or obliterated." (Salk, J. 1973)

He goes on to explain how man should consider his own "*chosen purposes*" to pursue not to come into conflict with the "*purposes of nature*" and how it is the process of evolution that

has caused us to develop intelligent ways of overcoming the problems we encounter through life. This has reduced the restrictions imposed upon us through nature and presented us with almost unrestricted choices with little regard for nature at all.

Salk's way of thinking is an example of what we need to adopt today if we want to make a real difference to enable the necessary changes. It's not about giving up luxuries that we are accustomed to, or about becoming eco warriors living off the land, but more about changing our attitudes and developing innovative ways of living and entertainment that doesn't emit tonnes of harmful GHGs, but perhaps most importantly understanding our place in, and respecting nature for what it is and finding a prevention rather than a cure. This is essentially the ethos of the NHS Forest, looking at a prevention to some of the major illnesses and diseases already talked about through the combined perceived benefits the NHS Forest can bring.

2.6 Effects of Woodland on Health

Woodland in the United Kingdom is defined as land with a minimum area of 0.1 ha under stands of trees, with the potential to achieve tree crown cover of more than 20 %. (Forestry Commission, 2010). The terms 'woodland' and 'forest' are used almost interchangeably, though imply different meanings. Generally forests are perceived as vast expanses of trees generally coniferous in nature and usually managed for timber production, whereas woodland is generally perceived as containing native broadleaved trees, more natural and implied to be less 'managed' than forests

It is said that trees have the ability to make us actually feel better, see (Obrien, 2004), (Ulrich, 1986) and (Kaplan, 1995), strolling through a woodland has the capacity to release us from the stresses and strains of everyday life, soaking up the natural beauty around us and relaxing us. But it's not only psychological effects that have a positive benefit on our lives, as trees also 'clean' the air we breathe, and help to improve the quality of life;

“Each increase in tree density of 343 trees per square kilometre [in urban landscapes] is associated with a significant 29% lower prevalence of early childhood asthma” (Lorvasi et al., 2008)

This statement speaks volumes about the physical effects trees can have on urban landscapes. It's not only respiratory infections that benefit from the trees' physical cleansing of the air. In 1995 and 1996 air pollution was considered to have contributed to 24,000 pre-

mature deaths in vulnerable people in the UK (COMEAP, 1998) and the Department for Environment, Food and Rural Affairs (DEFRA) (2007) estimated the cost of air pollution on the British economy to be in the region of £20.2 billion per annum.

Trees provide a physical presence that filter out much of the pollution found in the air such as CO₂, Nitrous Oxide (NO₂), Particulate Matter (PM), particularly PM10 (particles with an aerodynamic diameter less than 10 µm), Sulphur Dioxide (SO₂) and volatile Organic Compounds (VOCs) see (Stewart et.al. 2003) and (Broadmeadow and Freer-Smith, 1996).

Trees in urban parks are also vital in providing many ecological benefits; besides being visual stimuli for local people they increase the biodiversity of the urban area and a wider variety of trees bring a wider variety of biodiversity. Increase the tree cover to areas where no formal maintenance takes place beneath the trees and the biodiversity increases even more. Increased biodiversity means more visual stimuli for people and so increases the desirability of the woodland for visitors (Kaplan, 1995). A study in Canada within a psychiatric hospital showed that both patients and staff selected natural settings as the most desirable place to be for passive behaviour such as relaxation, with a preference for enclosed ‘natural’ settings for more active behaviours (Barnhart, Perkins & Fitzsimonds, 1998).

Woodlands are places that can be used for all manner of exercise, from a gentle walk to horse riding, cycling and even den building and rarely seem overcrowded even when busy because trees have the ability to absorb noise and create a physical barrier that in effect hide the mass of people in them.

Woodlands in particular are landscapes that can be sought generally without the need to travel great distances for the majority of people, unlike coastal and mountainous landscapes that require great effort for the majority. Woodlands are also inexpensive places to visit: an important factor when considering health inequalities and social inclusion.

2.7 Heat Island Effect

Large urban parks that contain trees have been found to be 1 to 3 degrees Celsius lower than the surrounding built environment (McPherson, 1994), this is because trees store and release moisture into the air and provide shade; soft landscape also absorbs and stores less heat than the surrounding concrete, and allows moisture to remain in the soil. It is estimated that surface run off in urban parks is approximately 10-20% whereas the runoff

from the hard surfaces is 60-70% (TDAG, 2008) so parks also help reduce the risk of flash floods, something that is likely to be of greater importance if the earth warms up and more extreme weather events take place. Furthermore the rain that falls on parks is filtered through the soil and bedrock removing pollutants and helps to replenish much needed underground reservoirs, whereas the rain that remains on hard landscaped areas evaporates quickly into the air. Tree cover is especially important as the rain reaching the ground is slowed by the canopy which can also help to reduce the incidences of flash floods (TDAG, 2008)

The benefits associated with the above topics are all relevant factors in determining whether the NHS Forest is a feasible project, though not necessarily completely relevant in the same way, however by leading the way forward other organisations may get involved and the NHS Forest could lead to the creation of parks and green space beyond initial expectations.

2.8 Forest Carbon

The basis for planting forests and the feasibility was studied in some depth after the acceptance for carbon trading through sequestration in forests was adopted by the Kyoto Protocol in 1997(UNFCCC, 1998). A study by the Intergovernmental Panel on Climate Change (IPCC) in 1996 estimated the amount of potential carbon to be sequestered worldwide between 1995 and 2050 would be roughly equivalent to a 12 – 15 per cent cut in the ‘business as usual’ fossil fuel emissions over the same period (Cannell, M.G.R., 1999). It did however make some broad assumptions in the business as usual scenario. The 12 – 15 per cent is however considered not sufficient to stabilise the atmospheric CO₂ at less than 600 parts per million, a figure that some regard as the point at which it becomes dangerously high.(Weitzman, 2009)(Cannell, 1999)

On a global scale the UK is relatively insignificant in terms of fossil fuel emissions, the burning of fossil fuels in the UK contribute only about 2% of the total global emissions (Cannell, M.G.R., 1999). However to adequately absorb the equivalent amount of carbon from a forest stand of mixed broad leaved forest would require a plantation of approximately 12.6 million hectares (equivalent to approximately 51% of the UK land coverage) (Cannell, 1995). In 1995 the total forested area in the UK amounted to 2.5 million hectares (10% coverage), this had risen to approximately 2.8 million hectares (12% coverage) by 2009 (Forestry Commission 2010), far short of the required amount to offset the UK’s emissions

As we have already seen however, different types of plantation will yield different levels of carbon. Any plantation that remains in situ permanently such as an amenity woodland, will store the greatest amount of carbon over a given period of time (Woodland Trust 2010), however the store is potentially vulnerable as a long term carbon sink since the carbon stored is not completely stable, and is vulnerable to decay and fire, both of which are carbon sources which directly release carbon back into the atmosphere (Bateman and Lovett 2000)

Soil types it would seem are often more critical than the tree types. A rich fertile soil that supports rapid tree growth will produce a higher yield of carbon than a poor soil type; this is largely due to the rapid growth rate of the tree. However over a long period of time, the litter from the trees is estimated to deposit many tonnes of carbon on the forest floor resulting in a net increase of stored carbon on poor soil types. Pine forests on the other hand tend to be planted on very rich peaty soils that already contain high levels of carbon and the decomposition of forest litter in this situation is thought to cancel out the carbon deposited in the soil resulting in no determinable change in the soil carbon. (Dewar and Cannell 1992). Bateman and Lovett (2000) concluded from research in the forests of Wales that planting on very peaty soils can actually result in a net carbon emissions being greater than the carbon stored in the timber. In the case of the NHS Forest however it is unlikely that any trees will be planted on peaty soils, since these tend to be exclusive to either mountainous or boggy regions which are remote and not suitable for building land.

It is common knowledge that forests and woodland are the largest and most effective carbon sinks on land. Different types of woodland absorb atmospheric carbon at different rates, and this also varies dependant on the age of the stand, the location, soil type and the overall size.

According to the Woodland Trust Approximately 4 million tonnes of carbon dioxide are removed from the atmosphere each year by trees in the UK. A study commissioned by the Woodland Trust estimated that the amount of atmospheric CO₂ locked up in 1 hectare of native mixed broadleaved forest is 400tonnes, equivalent to 108 tonnes of carbon. This figure though is conservative as the estimate for carbon locked up in deposits on forest floors and soil carbon, is far greater than that locked up in the trees themselves (Anon., 2010b).

Forests absorb carbon dioxide from the atmosphere at different rates depending on types of tree, age, soil type and density of planting; it is estimated that a native broadleaved tree

in the UK will absorb approximately 1 tonne of CO₂ in its lifetime (Anon., 2010c). Assuming 1 acre of woodland contains approximately 440 trees with an average spacing of about 10feet, and that a tree lives approximately 100 years then 1 acre of woodland absorbs CO₂ at a rate of 4.4 tonnes per year, which converts to 1.2 tonnes carbon per year. (Anon., 2010c). Of course as the woodland matures, so the struggle for space becomes greater between the trees and it is inevitable that some will die, however the natural cycle of regeneration will ensure that a similar number exists for the life of the woodland, it is therefore important, from a carbon management point of view, to ensure woodland and forest coverage remains constant or increases rather than look at individual numbers of trees planted; the number of trees over time becomes largely insignificant as long as the coverage remains.

Forest carbon uptake is also greater in younger forests than old mature forests; ancient forests can in fact become too old to be useful as carbon sinks (Liu and Han 2009), and instead the decay of the forest means that it becomes a carbon source; however if an ancient forest is carefully managed, and mature trees are removed to make way for new growth, the forest will stabilise and remain a carbon sink, deducing that managed forests with a certain amount of careful harvesting store more carbon than unmanaged forests, particularly if the timber is harvested and used rather than left to decay naturally in the forest (Helms, 2007)

The carbon absorbed from the atmosphere is not only captured, but is stored in the biomass of the forest for a century or more, some of the biomass will decay and release carbon back into the atmosphere, through the natural cycle of leaf fall and dead wood falling to the forest floors. However much of the biomass that falls is stored as carbon in the soil of the forest floors, how long for and in what quantity is not known exactly and the science used to calculate this carbon store is complicated by several variables, with different types of vegetation, atmospheric conditions and biodiversity.

The carbon locked up in the timber will remain in storage as long as the tree is alive, and when the tree is felled, assuming the wood is used in the production of timber products will remain for the life of the product. Naturally due to the processing of the timber a certain amount of carbon will be released generally by decomposition.

A number of studies into soil carbon have and are still taking place (Wullschleger et.al. 2004)(Lehmann 2007)(Guo & Gifford 2008), and the results look like they could be of significance, but none at this stage have proved conclusive enough to present an accurate

picture of the total amount of carbon stored in the soils. One study by Johannes Lehman (2007) at Cornell University, New York, USA, into the creation of biochar to be used as a soil improver suggests that this is a logical step forward. The Kyoto Protocol accepted methods of sequestering carbon through afforestation as tradable ‘carbon offsets’; however Lehmann argues that this can be taken a step further by heating the plant biomass through a process known as low temperature pyrolysis, a low temperature burning without oxygen present. Pyrolysis converts plant material into biochar which has twice the carbon content of normal biomass such as wood, and the biochar also locks up the rapidly decomposing carbon in plant biomass into a much more stable and durable form (Lehmann, J., 2007). One of the big advantages of biochar other than the locking up of carbon in a stable form, is the heating process that could be used as an alternative ‘carbon neutral’ heat source, and if the gasses emitted from the biochar pyrolysis are captured and used as fuel further sequestration is possible. The resulting biochar can also be used as a substitute for the thousands of tonnes of fertilisers used on agricultural crops throughout the world year after year, so reducing the pollution of ground waters. This is however a relatively new concept that is not fully tested so all the figures quoted by Lehmann need rigorous and thorough testing, however if biochar is accepted by the IPPC as a good source for emissions trading it will be easy to monitor without any additional cost or effort as both the conversion from biomass to biochar and the application to soil will be closely measured.

Rachel Carson, in her groundbreaking book *Silent Spring*, highlighted the problems we could be facing if we continued to use pesticides and fertilisers indiscriminately, though the legislation that followed has made things invariably safer, clearly demonstrating that natural fertilisers and pesticides should always be favoured over manmade chemicals, so the production of Biochar could have significant advantages and benefits if it is proven to be as good as Lehmann suggests.

2.9 Do Aesthetics Matter?

A number of studies have taken place to determine people’s perceptions of trees and open spaces to try and determine a preference. A Canadian study in a psychiatric hospital focused on preference of place for relaxation and exercise, which found the preferred setting for sedentary activity to be natural open space, whereas the preferred setting for physical activity was enclosed natural space, such as a park (Barnhart, et.al., 1998). This doesn’t however tell us anything about the aesthetics of the setting; a natural open space could be

woodland, mountains, coast or open fields, and a park could be strewn with trees, have a lake or simply be a large grassed sports field.

Virginia I. Lohr, a professor in the Department of Horticulture and Landscape Architecture at Washington State University USA began studying the effects of plants on people in the late 1970s. In 2004 Lohr conducted a survey on people in the US looking at the benefits and problems associated with trees in cities. The results of the survey showed that the public ranked shade from trees in the summer as the most important feature, second was the potential of the trees to make people feel better; of the problems, the highest ranked was the problem with allergies, although in this group of people they still ranked shade from trees as being the biggest benefit. People in the lower social economic category and people aged 18-21 ranked the importance of trees lower than other groups but all agreed that trees had benefits that outweighed any problems. (Lohr, et al., 2004). In 2006 Lohr produced another paper that discussed the shape of trees and how people responded to the various shapes to test a theory known as the savannah hypothesis (from research that shows people give a high aesthetic rating to trees with large spreading canopies as found on the African savannah. (See Orians 1980)). The results were as expected with spreading canopies being the preferred tree shape. People that took part in the study also preferred scenes with trees in them over scenes that had the trees substituted for inanimate objects; the participants also commented they felt more positive emotions when viewing scenes with trees, particularly trees with spreading canopies which also made them happier.

3 The Study

In order to evaluate the evidence gathered throughout this study, there are limitations that must be acknowledged. The study areas are so vast that many works relevant to the topic, that may support or otherwise contradict the evidence found here, have not been consulted. The representative sample however draws on academic works from past to present, government and department of health publications, the media and personal interpretations of the literature.

The method used for determining the likely potential of the NHS Forest fulfilling all criteria namely improved green space, improved health and reduced carbon emissions could be done in many different ways.

To be able to determine the exact scope of the potential there are certain criteria that must be examined:

- Availability of land – both NHS Land and partners land that can be used for the creation of parkland and woodland.
- Willingness to participate in the scheme – Trust's are not compelled to take part in the scheme therefore responsibility rests with the Trust Boards and Estates managers to engage with the programme.
- Acceptance of the concept, particularly by hospital administrators and boards of directors, but also by the general public.

3.1 Space

To try and establish what extent the NHS can achieve in planting the forest using only NHS land I looked at the NHS Estates Returns Information Collection system (ERIC) (Appendix 2). ERIC collects data about many differing criteria including area of land on each site. The data sets used for assessing areas and space contain:

- Gross internal site floor area, m^2
- NHS estate Occupied floor area, %
- Site footprint, m^2 (excludes any leased or licensed out areas)
- Site land area, m^2

I have therefore chosen to look at a representative sample of NHS Trusts across the country and evaluate the problems and the benefits associated with the planting of trees for each Trust. This work has been done mainly by using aerial photographs taken from Google Maps to determine the scope of the potential for tree planting and data for the site land area taken from the ERIC system. To determine a representative sample I looked at two sites at opposite ends of the spectrum i.e. one with virtually no green space and one with more green space than built environment. I then looked at Estates Data to determine the average sized site and selected 3 as representative. As an employee of the Rotherham, Doncaster and South Humber NHS Foundation Trust (RDASH) I have firsthand knowledge of the planting and the further potential for planting at the Trust HQ site in Doncaster, St Catherine's and at the Trusts outlying sites that will be used for future planting of the NHS Forest.

Using the ERIC data I looked at the total land area available on all trust sites, and the total footprint of the buildings. To determine the land available for tree planting from the remaining land estimations have had to be made based on the site type:

- Primary Care Trust
- Mental Health Trust
- Acute Trust – ambulance trusts were included in this section since most are located within acute trust sites.

I looked at the site areas and footprints of these three sections individually and averaged them by taking the total building footprints and land area and dividing by the number of Trusts to get an understanding of the different site types. From this data a representative sample of sites was chosen to study that were close to or matched the averages in percentage terms, i.e. an Acute Trust with a footprint equal to approximately 25% of the total land area etc.

As no reliable area data is given for car parks, roads and other paved areas within the Eric data an estimation of this has been done for the whole and for the three site types using aerial photographs for reference at the chosen representative sites.

3.2 Studies and perceptions

A questionnaire devised by the Campaign for Greener Healthcare as part of a public consultation exercise backing a bid for Lottery monies to support the planting of the NHS Forest and associated schemes to encourage the general public to use hospital grounds for exercise and relaxation has been used to gather local residents' thoughts about accessing the green space within the Rotherham, Doncaster and South Humber Mental Health NHS Foundation Trust site at St. Catherine's see (Appendix 1).

The survey was carried out on 2 separate days in good weather conditions, and at 4 separate locations in the local community. 3 of the locations were in a "New Deal for Communities" (NDC) area, considered to be an area of deprivation and lower socioeconomic status, the fourth location was at the opposite side of the hospital on a relatively new housing estate. All four locations were within 1km of the hospital. The same questionnaire was used to survey residents at University Hospitals Coventry and Warwickshire NHS Trust in Coventry for a similar scheme with similar results to St Catherine's. This study is included to give an idea of people's perceptions and interest in accessing the green space but was on such a small scale it cannot be considered reliable, and is therefore here to support the studies within the literature review.

Literature has been chosen from past to present and studies have been included as part of the literature review to demonstrate this type of research in many different situations has also taken place.

The literature review also provides necessary data supporting the benefits of planting trees in urban environments. This has not been sampled further as part of this study since the evidence is overwhelmingly positive and demonstrate the obvious benefits far outweigh the negative impacts.

3.3 Carbon Sequestration

The rates of carbon sequestration have been taken from the Forestry Commission figures as quoted in the Literature review (section 2.8), and other suitable academic works, rates have been averaged based on mixed broadleaved woodlands, as this will likely form the main basis of the NHS Forest. Other stands have been analysed and compared to the mixed broadleaved average to determine certain factors such as what is the most effective plantation in terms of Carbon Sequestration.

The potential for planting trees as food and fuel crops has also been considered. The need to meet significant carbon reduction targets could mean that using the NHS Forest as a fuel crop to supply wood fuel boilers that could be used as a replacement for gas boilers in many of the smaller NHS buildings could be explored further as a potentially viable option, however the NHS is not in the business of Forest Management and so the use of woodland as a managed fuel crop would only be considered in partnership with a body such as the Forestry Commission and/or local farmers to make this a viable option. Further the use of wood fuel would actually constitute a carbon source, and therefore the net positive benefit to the NHS from the Forest as a carbon sink would be lessened. This is an area for further research not covered fully here.

4 Results

4.1 Available space

The NHS has a large amount of land across the whole of the country on all of its estates equating to nearly 7,500Ha in total (NHS Hospitals Estates and Facilities Statistics 2010), (Appendix 2). And the footprint of all the buildings amounts to approximately 1,500Ha, leaving an area of approximately 6,000Ha, but the way data is collected, as mentioned earlier, makes analysis difficult.

As previously mentioned NHS Trusts can be generally divided into three main categories;

- Acute Trusts
- Mental Health Trusts
- Primary Care Trusts

Analysis of the ERIC data sets (appendix 2) show that there are;

- 644 Primary Care Trusts,
- 468 Acute Trusts.
- 438 Mental Health Trusts and

The average building footprint for a Primary Care Trust is 18,777m², and the average land area is 21,662m², covering approximately 87% of the available land with buildings. Of the 438 Mental Health Trusts, building footprints average 12% of the total land at 6,152m², of 50,080m². Acute Trusts building footprints occupy an average 25% of the land at 19,066m², of 77,588m². (see appendices 2 and 6).

Using the ERIC Data as a start point the total land area owned by the NHS is 7,461ha.

The occupied space on the land by buildings (building footprint) is 1,464ha.

There are a total number of reported parking spaces of 480,481 of which 23,219 are disabled spaces. These equate to an area of 567ha based on an average car parking space being 2.4m x 4.8m, and disabled bays being 3.6m x 4.8m. It is not reported whether these parking spaces are surface, underground or above ground spaces, such as in multi storey car parks. From my experience of visiting numerous hospitals and talking with estates managers I believe the majority of these to be surface spaces but an assumption that approximately 10% are either above or below ground has been used to reduce the overall



figure to 510ha. It is fair to assume that the area of a car park not used for parking spaces, i.e. the aisles and footpaths, is roughly equivalent to the actual car parking space as is evident from the picture (left) of a typical hospital surface car park. The aisles of the car park must be a minimum of 6m to allow enough room to

exit a car parking space though they are generally greater than this. I have therefore assumed the land area allocated to car parks to be double the reported spaces at 1,020ha.

Access roads, turning circles, footpaths, patio areas and loading bays also occupy a large area of the land. There are no reported figures to base this area on so again assumptions and estimated figures have been used. Using the case studies of Alder Hey (Appendix 3) a typical Acute Trust and Guys Hospital (Appendix 4), although an Acute Trust is used as a representative PCT, the area of land on these existing 2 hospital sites taken up by concrete and tarmac I would estimate to be 80% to 90% of the remaining land (after deducting the building footprints). By contrast the aerial photograph in the case study of St Catherine's (Appendix 5) a typical mental health trust, this shows a complete reverse, where approximately 70% to 80% of the land is green space. However as previously mentioned the majority of NHS sites fall into the first 2 categories, 1,152 to 438, with little of the land occupied by green space. I have therefore used an estimated figure of 80% of the remaining land being unavailable as suitable for planting trees. This equates as follows.

- Total Land Area: **7,461ha**
- Building Footprints: **1,464ha**
- Car Parks: **1,020ha**
- Other Hard Landscape (80%): **3,981ha**
- Available Green Space: **996ha**

Basing calculations on the above figures, rounding up the available green space to 1,000ha and using the Forestry Commissions recommendations for planting mixed broadleaf woodland at 1,100trees per hectare the NHS roughly has the capacity to plant 1.1million trees.

However, aesthetics and usability have to be considered; the green space cannot be utilised solely for the planting of a forest because of certain practicalities and security issues. Therefore to make the figures meaningful, other assumptions have to be made:

- To allow for usable green space, approximately 30% - 50% of the available land could feasibly be used.
- Every NHS Trust, Primary Care Trust (PCT), GP Surgery etc must decide to plant 30% - 50% of their available green space with trees.

If these two criteria are fulfilled and the funding is allocated then the NHS Forest on NHS land could see approximately 550,000 trees planted, or 42% of its targeted 1.3 million at the top estimate. Meaning a further 58% would be required to be planted on neighbouring land or as in the case of Alder Hey, in partnership with a local borough council or other landowner.

4.2 Carbon Sequestration

According to the NHS Sustainable Development Unit in 2007 the total carbon emissions from the NHS Estate account for almost 3% of the UK emissions, this does however take into account approximately 60% from procurement i.e. scope 3, or non direct, emissions (NHS SDU, 2007). Based on this figure 1.2% of the NHS emissions are direct emissions i.e. 40% of 3%, therefore to offset the NHS emissions as measured in 2007 we would need to plant 1.2% of 12.6 million hectares, a total of 151,200 hectares. The recommended spacing for the creation of new amenity woodland as given by the UK Forestry Commission is 1,100 trees per hectare (British Trust for Conservation Volunteers (BTCV), 2010). So to adequately offset the NHS Carbon emissions by 10% as suggested by the Campaign for Greener Healthcare at today's levels using the above assumptions and calculations would require the planting of 16.6 million trees, and not 1.3 million as proposed.

To plant a forest purely to sequester carbon quickly the best approach would be to plant fast growing species. Timber production is measured in terms of Yield Class (YC) which is defined by the Forestry Commission as the average amount of timber produced by a tree type per hectare (ha^{-1}) per year (a^{-1}) and is measured in cubic meters(m^3) (Brown, N., 2002); therefore a tree with a YC 12 produces timber at $12m^3 ha^{-1} a^{-1}$.

Carbon sequestration is directly related to YC; however certain species sequester larger amounts of Carbon depending on altitude and soil types. Poplars at YC12 accumulate

about 7.3 tC ha⁻¹ a⁻¹ over a rotation of 26 years (Rotation = number of years from planting to harvesting), Sitka Spruce, a typical conifer used for commercial timber production, YC16, produce about 3.6 tC ha⁻¹ a⁻¹ over 55 years rotation and Beech, generally used to typify a mixed broadleaved woodland, YC6 produce about 2.4tC ha⁻¹ a⁻¹ over 92 years rotation (Dewar and Cannell 1992).

If the NHS forest has a long term aim to sequester carbon over a period of 100 to 200 years, according to a study carried out in 1992 looking at the carbon sink provided by UK forests, it doesn't really matter what types of trees are grown (Dewar and Cannell, 1992), in studies on Poplar, Sitka Spruce and Beech the time averaged amount of carbon in the stand, soil and litter remained fairly constant at about 200 tonnes Carbon per Hectare assuming a 92 year rotation (Cannell, MGR 1999).

4.3 Perceptions of local people

Analysing the results of the Campaign for Greener Healthcare's Questionnaire showed that respondents at location four, an area of higher socioeconomic status, were less inclined to look at the questionnaires than at the other three locations in the NDC areas; of those that did, all said they accessed the green space at St. Catherine's once or twice a week to either walk the dog or use as a thoroughfare.

The respondents at the first three locations (NDC areas) were more ready to respond but most commented that they were not aware that the green space was readily accessible, with approximately half commenting on the fear factor with the mental health connections, i.e. stigma.

Most of the respondents were female aged between 20 and 40 and had children with them:

- 8 per cent of respondents said they wouldn't visit the site,
- 24% said they would like to use the woodland for relaxation if they knew they were welcome and there was sufficient seating in place;
- 56% said they would visit if there were things to do; some of the suggestions were activities for children, refreshments available at weekend's better access including better footpaths, better signage to help them get around etc.
- 12% said they would go if the green space was accessible and
- 32% said they would take the children to play if they knew it was safe.
- In total 92% of respondents said they would use the site for relaxation or activity if it was readily available.

The same questionnaire was used in Coventry for the University Hospitals Coventry and Warwickshire NHS Trust and the results were very similar, however 100% of respondents in Coventry said they would use the space in some capacity if it was made aware that it was accessible.

5 Analysis and Discussion

To date during the pilot phase a total of 13 trusts in England and 1 Trust in Scotland have taken part in the scheme, ranging from the planting of a single tree at Featherstone Health Centre to approximately 1.2 acres of woodland with a total of 864 Trees being planted at St Catherine's in Doncaster.

The essence of this study is to look at the three factors cited as the drivers for the NHS Forest:

- Creating a better healthcare environment
- Offsetting Carbon and mitigating the effects of Climate Change
- Creating good quality available green space for patients and local communities

The NHS Forest is a public statement of active promotion of Greener Healthcare, literally “Greening the NHS”. Rotherham, Doncaster and South Humber NHS Foundation Trust is one of the hospitals chosen as a pilot site and planting has taken place at St Catherine's with the Woodland Trust coordinating the planting with local people, staff and particularly local school children.

5.1 Space to create a better healthcare environment

Planting trees and woodland to create the NHS Forest is a practical way of enhancing the healing environment at hospital sites, encouraging better local biodiversity, and helping to clean the air in the immediate area. So it would seem to be a win, win, win situation! However, there is a more to it than just planting a few trees.

The NHS owns a great deal of land, and aside from the ‘green’ benefits, planting trees on that land to create “Health Parks”, while theoretically would have significant positive health benefits, with the potential to help the NHS meet some of its targets such as, reducing obesity, health inequalities, cardiovascular disease and many respiratory diseases, which if successfully implemented will result in significant financial savings, could potentially also have a lasting detrimental effect in tying up land that could otherwise be used to build new hospitals.

Thus there is a struggle between the strategic planning of the NHS Estate and the need for green space that needs to be resolved for the benefit of all, and as is evident from the literature review, Estates Officers and Planners responsible for the development of the sites need to be mindful of the therapeutic benefits of access to green space, and the con-

tribution trees can have in the urban environment that can have a direct benefit on the buildings themselves.

Furthermore public and staff perception of the NHS spending money on planting trees may be seen as diverting money away from direct healthcare, which at a time when the NHS is expected to reduce its “*burden of bureaucracy*” by releasing over £20 million in administrative efficiency savings by 2014, a saving in management costs of 45% (Department of Health, 2010b) needs to be overcome, so the need to demonstrate and actively promote the positive health benefits of the project is essential, which must be clearly backed up with studies demonstrating the benefits.

From the small scale study carried out asking local residents about access to hospital green space (appendix 1), there seems to be a general consensus that it is a good idea and would be used by local residents, but that the facilities would have to be adequate, such as benches, litter bins and signage to get people around, to encourage better use.

Provision of natural green space, within the broader umbrella of green infrastructure, is now a matter of increasing importance to policy makers and decision takers in land-use planning. In the government paper, Policy Planning Guidance 17: planning for open space, sport and recreation (PPG17, 2006), the opening paragraph states; “*Open spaces, sport and recreation all underpin people's quality of life*” it goes on to say “*Well designed and implemented planning policies for open space, sport and recreation are therefore fundamental to delivering broader Government objectives*”. Such policy on planning reflects the NHS policies for tackling health related issues; see for example (Department of Health, 2004 & 2005a) and also the climate change policy, which are all inextricably linked.

Green space, for NHS estates planners, has in the past been very much seen as a luxury that cannot always be afforded. Set budgets have determined the scope of the building, its facilities and functions and building footprints often occupy the majority of the available space, therefore green space is often seen as a luxury ill afforded. Local planning authorities through planning legislation and guidance are now placing more emphasis on the inclusion of green space and trees designed into the available space, and controls in this area are getting tighter. However the NHS should be proactively incorporating green space as a part of the therapeutic environment because of its intrinsic healing qualities.

Recently with the help and drive of organisations such as the Kings Fund, a charitable organisation set up to better understand and improve the health system in the UK, over the

past decade have been running a very successful programme entitled 'Enhancing the Healing Environment', see (EHE, 2011), much of which has focussed on enhancing internal space and the need to have harmony and continuity within hospitals where art has featured strongly. However a large part of the enhancing the healing environment programme has been dedicated to enhancing outdoor space, particularly the areas often found in hospitals that are poorly utilised such as courtyards, this has been met with much success and very positive feedback from all user groups, staff, patients and visitors.

A study to investigate the strength of the relation between the amount of green space in people's living environment and their perceived general health in the Netherlands in 2006 found the relation between amount of green space (in a 3 km radius) and people's opinions of their own health (percentage stating their health is less than good), found that the distance they lived from green space had a direct correlation with their perceived health (Maas, et al., 2006) see figure 4 below. The correlation was more prevalent in the elderly, housewives and groups of lower social economic status.

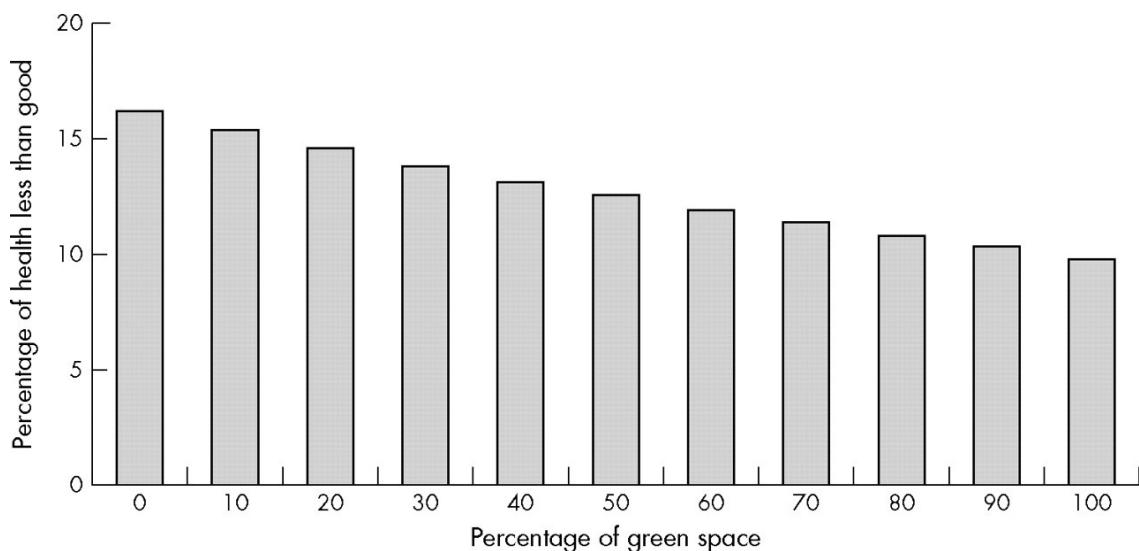


Figure 4. Relation between amount of green space (in a 3 km radius) and self perceived health.
(Maas et.al., 2006)

Woodlands and trees can stimulate the senses making green environments especially effective as places that restore people from mental fatigue (Kaplan, 1995). Other studies suggest that contact with nature may help to reduce anger, aggression and commuter stress (Sullivan and Kuo, 1996) and research with Alzheimer's patients showed a marked reduction in violent behaviour among residents that walked in an outdoor garden (Mooney and Nicell, 1992)

Green space can also be used to help treat children with attention deficit disorders (ADD); research has shown that regular “green” activity in children with ADD results in them having less severe symptoms (Taylor, Kuo and Sullivan 2001).

Programmes like the Green Gym, run by the British Trust for Conservation Volunteers (BTCV) not only give an aerobic workout to those participating in physical activity, but they also get the benefit of being in the outdoors getting positive mental stimulation. Working in partnership with external organisations is actively promoted by the NHS and the recent white paper ‘Equity and Excellence; Liberating the NHS (2010) also talks about integrating with external organisations.

5.2 Transport Links

If transport infrastructures are altered, to increase the footpaths and cycle ways, with trees planted along all major routes, and restrictions to traffic in the busiest parts of towns and cities, perhaps the UK could see marked reduction in road fatalities similar to that of France. The NHS Forest could be an opportunity to work with local authorities and private landowners to develop tree lined paths and cycle-ways away from the major roads that will encourage more cycle and pedestrian use. A project such as this has been started at Alder Hey Hospital in Liverpool, where a major redevelopment of the hospital, incorporating a local authority park, will link two parts of the city through the hospital grounds. Where the walk around now takes up to 20 minutes, the new development will allow people to walk through in less than 10 minutes and amongst beautiful parkland, so people will be less likely to use their cars to go around.

5.3 Links with other projects and existing green space.

The University Hospital Coventry and Warwick NHS Trust has also invested in a footbridge over a stream linking the hospital site with a local beauty spot – the Sowe Valley footpath. The British Trust for Conservation Volunteers (BTCV) will set up a community group at the site to build community cohesion and offer a new focus for local community engagement in a neighbourhood lacking in amenities but keen to tap into local resources. The bridge linking with the public open space is being developed as part of the Outer Space Project, a sister project to the NHS Forest see (Outer Space, 2011)

The NHS Forest could be seen as a step further in Enhancing the Healing Environment, the Kings Fund led programme, which focuses on smaller projects than the NHS Forest, (EHE2011) but the principles are the same; as already demonstrated trees and green space have many positive benefits to health and well being;

- Physical health
- Psychological health
- Social health and wellbeing

Such factors cannot be ignored and in planning for the future, the NHS Estate must reflect and build on these factors to provide a health service “fit for the future”.

Simply using the data in the way it is set out within the ERIC database will not give a true reflection of available land for planting trees, since as demonstrated most of the land not occupied by buildings is taken up by footpaths, roads and car parks in the majority of cases.

Some sites such as the Rotherham, Doncaster and South Humber NHS Foundation Trust (RDaSH) St Catherine’s site are by contrast an exception to this rule. St Catherine’s although it fits the percentage average of 12% building coverage, is a slightly larger than average mental health trust that is already covered with approximately 7 Hectares (Ha) of mainly ancient broadleaved woodland. 1 acre of new woodland was planted in phase one of the NHS Forest project at the site and there is scope to plant plenty more. Sites like this tend to be the older institutions and asylums, but many have been and are being further developed.

Many NHS sites already have a large number of trees growing on them. These trees are not included in the NHS Forest, as the forest plan is to actually plant 1.3 million trees; in essence if the NHS Forest is successful in achieving its target, there will be a great many more trees than 1.3 million that make up the NHS Forest.

5.4 Aesthetics

If a forest is designed to become a therapeutic place, would simply planting trees to represent a natural setting be sufficient? Or do other factors need to be considered such as how, what and why when designing the forest for the intended purpose?

Any design, whether it be a forest or a chair, needs to be ‘fit for purpose’. But in the terms of planting a forest, what denotes being ‘fit for purpose’? Afforesting an area to sequester carbon is arguably fit for purpose as long as there is a net gain to the carbon pool, yet there are many different types of tree and many different types of land, and as already discussed trees sequester carbon at different rates depending on tree type, soil type and atmospheric conditions (altitude, rainfall, temperature etc.), and to maximise the carbon

pool the best option is to plant fast growing species, such as Poplar on fertile but non peaty soils. However a forest of fast growing poplar at optimal spacing would not generally be considered aesthetically pleasing, and wouldn't necessarily be accepted as suitable therapeutic landscape. Aesthetics therefore, it would seem, do matter.

5.5 Carbon Sequestration

In general terms within the overall context of the NHS Forest, although the Campaign for Greener Healthcare have cited it as one of the objectives, carbon sequestration is likely to be more a by product of the forest than a primary concern. Clearly to plant a forest primarily to sequester carbon we would have to discount aesthetics and usability, and this would not fulfil the primary objective of the NHS Forest in providing an enhanced healing environment, nor would it be an acceptable use of public money from a healthcare perspective. Since the NHS is a healthcare provider the main focus for the forest must always have the therapeutic value as a clear objective. If we consider the ability of trees to sequester carbon as a primary objective in tree selection, then the forest will not have the variety and types of trees perceived to be most aesthetically pleasing and therefore of most therapeutic value.

In global terms forestry is considered only a partial solution to the reduction of GHG emissions, this is obviously the same with the NHS, and as the Campaign for Greener Healthcare (CGH) has predicted, the NHS forest is expected to account for 10% of the NHS Carbon emissions in 20 years.(NHS 2007) What this figure doesn't take account of is the amount of tree coverage already in existence on NHS land, so if the CGHs calculations are correct, and we include existing trees and woodland found on many older NHS Sites within the NHS Forest, then it follows that the NHS can expect higher than 10% offset as a result. The 10% is also an aspirational target as the NHS is also expected to reduce its total emissions output by at least 34% in the same period. However if the NHS Forest is to be included in the calculations for carbon reduction, this could be seen as an alternative to a reduction in total emissions output by some Trusts and consequently have a detrimental effect on the overall effectiveness of the project; since the 10% calculation is determined by the predicted reduction by Trusts then the 10% would be reduced as a result.

6 Conclusions

6.1 Enhancing the healing environment

By creating more natural and aesthetically pleasing surroundings within hospital settings will bring positive benefits to the patients and staff, and financial savings for the NHS by helping to reduce recovery times, provide shelter from sun and wind and helping to clean the air for an improved general health of the population.

6.2 Carbon Sequestration

The amount of carbon the forest is able to sequester will be decided by the type and nature of the planting, however to maximise the benefit in terms of carbon sequestration must not be to the detriment of the healing environment and amenity value.

Owing to the nature and size of the majority of potential planting sites, the NHS Forest, which was always envisaged to be widespread, will most likely be developed in terms of its aesthetics rather than for a practical purpose of sequestering carbon, however there is scope and evidence to support the development of larger areas of forest or woodland in conjunction with local landowners and public or charitable bodies such as the Woodland Trust and the Forestry Commission. Further research and opportunities need to be developed to pursue this course of action.

The positive aspects of the project must outweigh the negative and entering into partnerships with other organisations may be the only way forward to realise the 10% offsetting of carbon predicted within 10 years.

6.3 Creating quality green space for patients and local communities

The creation of the forest itself could also be the start of a programme of promoting healthier lifestyles for communities, by engaging organisations such as The British Trust for Conservation Volunteers (BTCV) with projects like the 'Green Gym' to encourage people to engage in outdoor work that involves physical exercise and recreation for the benefit of their health.

6.4 General points

The NHS Forest will be mainly planted in urban areas on small pockets of land consisting of either poor soil, especially in relatively new built hospitals, or a mixture of fertile and less fertile non peaty soils. The mix of trees for the NHS Forest, due in part to the small areas or pockets of land that will accommodate it, and perhaps more importantly the aes-

thetic properties and amenity value, will be native mixed broadleaf trees, YC6, which sequester carbon at a rate of approximately $2.4\text{tC ha}^{-1}\text{a}^{-1}$. Assuming the forest of 1.3 million trees was completed within 10 years, in ten years time the net annual carbon sequestered would be less than 0.4tC per year, approximately 10% of the total emissions from NHS Transport and travel alone (SDU 2009).

The Heatwave Plan for England (Department of Health 2010a) reports that effective tree planting regimes across England could reduce air conditioning need by up to 30%. The NHS Forest obviously supports this strategy and to date a total of 16 Trusts have signed up to the project, with numbers of trees being planted ranging from a single tree, to up to 1,000 trees, making a total to date of 4,275 trees planted. Subsequent planting seasons should hopefully see more sites developed and the NHS Forest expanded. With evidence based reports such as this feeding into NHS planning and NHS Estates Strategies, highlighting the positive aspects of better healing environments and the physical benefits to the Estate, the NHS Forest could be statistically important for helping to reduce everyday running costs, and help drive the NHS carbon footprint down to the target levels.

7 Recommendations

This study has only broken the surface of what could be a hugely beneficial project for the NHS and the people of the UK. From the evidence and research already in existence, the development of the NHS Forest should be a non negotiable and inevitable project to pursue which hopefully will succeed its target of 1.3 million trees and beyond.

Further research needs to be done in relation to acquiring non NHS Land and working in partnership with other organisations to see how feasible, practical and manageable the development of a wider NHS Forest can be. The Alder Hey project is a good example of this type of partnership in action and one where lessons can be learned.

The use of trees as food crops to supply local NHS facilities is a possibility not covered by this study, road miles is one of the major contributors to the NHS carbon footprint, from staff and fleet travel directly, but also from deliveries to sites from procurement. Growing locally sourced food on NHS land is not likely to have a huge impact on this; however it would be a good public relations exercise to openly say we are serious about climate change, and recognise the importance of locally sourced produce.

The author would recommend that further research on the benefits to health green space has, to try and determine a method for assessing the cost benefits in terms of reduced spending for the NHS to support monetary bids for the creation of parks and woodlands.

Research into the feasibility of planting fast growing short rotation coppice for use as a woodfuel for NHS buildings should also be done. This could provide an important contribution to the NHS targets for carbon reduction at relatively low cost. The uncertainty of future fuel costs could potentially make this a viable option for the NHS which could result in significant cost savings on energy expenditure.

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APPENDICES