Research Article

Green Aid Tax Relief Participation Scheme – A Study about a Creative Environmental Tax Towards Carbon Reduction in the Post – Covid 19 Era

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Abstract: Environmental tax is the climate policy that offers, in theory, the easiest way for carbon reduction. But in practice, implementation has proven complicated despite public demand for policy action on climate change. This research investigates to reframe environmental taxes in ways more personally engaging to create a moral foundation, and massive participation. As people show rising demand, we aimed to design a tool that responds to public expectations and operates directly at source on emission reducers, viz the trees.

Drawing on research from environmental taxes and the evidence of measures taken, we reasoned that an environmental fiscal policy may not intend necessarily to punish the "bads", but rather might reward the positive attitude and direct it to act. Consequently, we focused on tax reliefs and designed Green Aid, that can address people's attitude to take active participation into account by incorporating virtuous behaviours into tax relief. Green Aid Tax relief works embedded in the Green Aid Participation Scheme that bears directly on a source of environmental recovery and organizes the global call to public action in a sustained, structured, and collective participation to forestation.

Green Aid bridges the action of contributing to carbon reduction with immediate, tangible, and direct benefits.

It can be an alternative environmental tax, able to address and operate directly at source on emission reducers and secure effectiveness in carbon reduction and efficiency in terms of public acceptance and viability at a global level.

Keywords: Environmental tax, Environmental policy, Carbon reduction, climate change, tax relief, forestation

1. Introduction

Greenhouse gas emissions (GHG) continue to be a serious threat for humanity especially now that the Covid 19 pandemic has worsened the global environmental crisis and influenced citizens' perception of the climate emergency, focusing attention on public attitudes and expectations on climate actions.

Environmental tax is the climate policy that offers in theory the easiest way to reduce GHG emissions but in practice, implementation has proven complicated. Our paper aims to lay out an alternative instrument of taxation that can overcome the limits encountered by environmental tax policies, and able to work in addition to those already in place or those to be.

The tax instrument we have designed is a tax relief devised to offer resolution broad as the scope; not to affect the economy negatively and not to give rise to distributional concerns, or lack of acceptability or confidence. It would like to be a creative tool able to remove barriers, offer incentives and be supportive at a global level with the certainty of visible effects in the short as in the long term.

An important insight that emerges is that a Participation tax relief can leverage social expectations to fill the gap between government provisions and populations bounded

rationality (1) and bring both actors to fix a common goal and be mutually supportive in the achievement, a real concern in the era of globalisation and pandemics.

The finding of the web survey preliminary conducted in 2020 on people's attitude about the climate crisis and their expectations, revealed a very pronounced trend to actively participate to reverse climate change. This encouraged us to consider if and how far people's attitudes may be leveraged to ensure more effectiveness of environmental fiscal policies.

Based on the sentiment emerging from our survey, on the numerous climate change protests demanding urgent action to tackle global heating, and the recent findings on public commitments, the study proceed to find out and to design a tax tool able to meet these public expectations to actively contribute to the climate crisis, that combined with the social impact can enhance environmental performances and reduce GHG emissions, thus being very effective to encourage compliance with environmental policy.

Because taxes have shown in their history to be a versatile means able to achieve different purposes, we want to consider if they can be used also to direct both taxpayers and government to the uniqueness of views and interests in tackling climate change with minimal barriers and high effects.

In the specific, given that environmental tax policies use taxes or subsidies, we want to find out an alternative tax tool to those designed for punishing the "bads" or pickle the winners. Our attention poses on tax relief and brings us to structure a Green Aid tax relief based on the combined double effect of participation and reward to ensure its effectiveness.

The research continues with the intent of capturing the above considerations into the newly devised Green Aid Tax Relief Participation scheme. It allows us to ponder on a new creative vision of environmental fiscal policies in the global era, devised as a purposive structure, designed starting from public expectations and purposely structured to develop a synergic interaction between government and population to achieve a designated mutual benefit. Where governments recur to fiscal environmental policies not only to raise public money but also to educate the population to responsibly collaborate in the management and the name of the public interest. In so doing, governors can in return achieve successful policy outcomes thank the wide range capillary diffusion of the policies undertaken, which would be hardly achievable acting alone. This approach recalls the concept of a "res publica", in the original Socratic meaning of Plato and Cicero, where the state is upheld by the agreement of its members and an allocation of rewards that is proportionate to the contributions (2).

In summary, **Section 1** provides a perspective of climate policies taxation methods which highlights that despite the effectiveness in the reduction of GHG emissions, the use of taxes and subsidies has some limits in acceptance and implementation.

Section 2 investigates people's expectations and attitudes about the climate crisis. It gives an insight into surveys and more recent sentiments and puts the basis of our research of an alternative tax tool.

Section 3 considers if and how a relief scheme can be used for environmental purposes given the findings. It designs the Green Aid Environmental Participation Scheme based on the mutual cooperation between governors and taxpayers in tackling climate change.

Section 4 structures the Green Aid Participation scheme, gives an economic insight and proposes the tax design.

Section 5 wants to hypothesize to test the Scheme to local instances and briefly discuss the achievable results. We propose two case studies on the London Urban Forest project in the UK and on Parco Regionale Urbano di Aguzzano in Italy.

Conclusions end up our study about the use of environmental tax relief. Evaluating a tax and its environmental impact is not easy. Taxes are often part of a policy package that is hard to disentangle: therefore, the effectiveness of the tax 'per se' cannot always be clearly identified (3) (p.9).

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Nevertheless, our findings theoretically suggest that a so conceived environmental tax relief can be used to directly address the effort of taxpayers to take environmental impacts into account and enhance their commitment to reducing climate impact, inciting consciousness of the environmental problem, willingness to participate and flexibility about how best to contribute to carbon offset. Green Aid Participation Scheme can offer a simple and transparent structure that is easy to understand and can be socially accepted to organize public action in a structured manner to achieve the final common goal of carbon-cutting globally with visible incentives. The scope is commensurate with global damage but flexible and feasible to apply across multiple jurisdictions.

Green Aid Participation Scheme can be able to initiate a coordinated behavioural change of people right now and motivate environmental improvements by letting businesses invest in their own innovation. It can avoid the risk of competitiveness and indeed stimulate green economic sectors growth. Besides, it can educate associate sustainable life choices with the enjoyable visible benefit.

2. Materials and Methods

Section 1

Climate policy's taxation

Environmental taxes and subsidies can be an effective and advantageous tool to reduce and control environmental damage for their effectiveness, economic efficiency, transparency; and for the wide range of issues they can address, including waste disposal, water pollution and air emissions.

Climate policy theory aims to use taxes as a means to address market failures by taking into account environmental impacts, pricing environmentally harmful products or activities so to reduce demand (4).

Carbon pricing is the initiative to capture the external costs of Greenhouse gas (GHG) emissions and tie them to their sources – the emitters, through a price that can take different forms and shapes such as an explicit price on the carbon dioxide (CO_2) emitted (i.e. a price expressed as a value per ton of carbon dioxide equivalent (tCO_2e)), an emissions trading system (ETS) or results-based climate finance (RBCF)

Currently, an increasing number of regions, nations and sub nations employ carbon pricing mechanisms, with plans to further implement them in the future. Altogether, these schemes report covering about half of their emissions; about 13% of annual GHG emissions (5).

Research on the effects of CO_2 taxation is not readily available, does not draw firm conclusions, and is bound to national scope. Some studies found real reductions in those countries that have carbon taxes, other studies only small contributions or limited impacts on household energy consumption. Some estimated the mitigation effects, and another showed significant emission reductions, at least in terms of GHG intensity compared to GDP, occurring before 1990; that is, before the introduction of any carbon tax (6).

Policies to price pollutant or polluting behaviour internalize external costs but may rectify externalities, things which people don't take into account when deciding about what to buy or to produce or to sell because they do not directly affect them; giving them the flexibility to determine the least cost way to reduce the environmental damage. The behavioural change can reduce damage to socially desirable levels, but can also generate inefficiencies, and the behavioural response is hardly calculable.

For governments, carbon pricing is a source of additional tax revenue presumed to increase GDP growth. Money raised is explained to go funding innovation and incentivization of further "Green" production. The population does not see advantages straightforward. Not only is the cost of potentially pollutant activities increased, but the "Green" development result promised by governments is not immediately perceivable, rendering such activities less attractive to consumers and businesses, with a potential effect of distorting tax bases.

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Even if pricing is presumably the easiest way to reduce GHG emissions, peoples' behaviours can become a barrier to environmental tax reforms if they are not directly affected by environmental harm, or if results are not visible and straightforward, if economic suffering ensues as a result of the immediate effects of higher pricing, or if the feeling that ones' sacrifices are not proportionate to the benefits achieved is felt. This already occurred in the mid -1990s in multiple EU countries, where taxpayers did not accept that the money raised was not used for environmental purposes and disputed the augmentation and introduction of environmental taxes; and again, it occurred in France in 2018 in the proposal of a Carbon Tax, where scepticism about the new tax, seen as a guise to generally increase taxes, stopped the implementation and caused the Gilet Jaune protest.

Alternatively. governments can opt for subsidies to relieve environmentally beneficial goods or actions, using tax exemptions or lower favourable tax rates. These are normally restricted to specific instances and do not cover all the alternatives. This may prejudice other good choices, generate higher costs (as subsidies are paid for by other taxpayers), generate "free-riding" phenomena, and people may passively accept tax impositions due to unawareness of the interventions' aims, limiting themselves to simply taking advantage of the benefits without knowing even why.

Both strategies also suffer from a lack of global deployment, being restricted by national jurisdictions and borders. National Governments feel the pressure of environmental challenges but in some cases, the breadth of the scope finds limits not only in the lack of social interest and participation but also and especially in the territoriality of political jurisdictions that legislate. This is the case shown in the protracted negotiations over the Kyoto Treaty (1997), the Copenhagen forum (2009), and the UN Summit in September 2019, and COP26 in November 2021. International coordination is often evoked as the only way to ensure overall efficiency.

The aspect that emerges, in essence, is that, despite the effectiveness in the reduction of GHG emissions, the use of taxes and subsidies has some limits in acceptance and implementation. Thus, it remains unclear how "net-zero" goals will be accomplished, given the global target to reduce CO_2 emissions to zero by 2050 according to the UN, and which effective environmental policy tools can be adopted globally.

2. Section 2

People's expectations

Scaling up GHG emission reductions and lowering the cost of mitigation is crucial to decarbonize economies. People's scepticism about fiscal policies, competitiveness impacts, and lack of cooperation are some of the serious threats to the effectiveness of the results.

We, therefore, wanted to start with investigating people's expectations and attitudes about the climate crisis and step further to find if it is possible to design an ad hoc tax tool able to respond to public concerns, that embodies these instances to drive people's expectations and sensitivity to secure higher effectiveness in Carbon reduction and compliance with environmental policy.

Our research foreplay, which started in 2020, outlined the social interest for climate phenomena and its international recognition through a web survey, precisely to consider if people's attitudes can be leveraged to tackle climate change.

Based on the collected answers, 92% of respondents heard about climate change. 34% were very worried and 58 % were extremely worried. They fell a moral duty to do something about climate change (86%) and expected governments to provide incentives for people to look after the environment, with 86% thinking that we can all do our bit to reduce the effects of climate change.

Our web survey revealed public expectations to active participation in enhancing climate changes, confirming a trend increasingly evident later on. People are becoming sensitive to climate change and environmental pollution problems these days. The Climate Activism and the Fridays for Future Movement demonstrations are examples that put in

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evidence this trend dramatically highlighted during COP26 by public participation and protests.

The findings conducted by the Yale Program on Climate Change Communication (7) report that more than six in ten Americans (64%) say the issue of global warming is either "extremely," "very," or "somewhat" important to them personally.

Finally, CDP, a not-for-profit charity that runs a disclosure system for environmental effects and publishes an annual climate action ranking of groups based on a questionnaire, reported that 9,600 companies took part in it in 2020 (8) with 44% of respondents committed to achieving net-zero emissions before 2050.[1]

Our study moved forward consequently aiming to devise an environmental instrument of taxation that has regard to the purpose of reducing pollution by leveraging public expectations so evidently outlined to broaden so far as possible its scope and effectiveness. Structured to make people actively participate in enhancing environmental performance for Carbon reduction and to reward them, with the final goal of boosting the effectiveness of tax policies and climate mitigation.

Section 3

Tax reliefs

Environmental challenges are increasing the need for tax policies with a scope so broad as the environmental damages, certain environmental outcomes. and a well-structured and clear communication tool for their public acceptance and success.

Tax pricing in its different forms and shapes offers in theory the easiest way to reduce GHG emissions, but policymakers and institutions are not yet able to develop efficient and cost-effective instruments to put a price on the social costs of emissions. Furthermore, studies and experiments on PCC Carbon Prices, as well as on Product Attributes (9) and WTP showed that tax based on the IPCC carbon prices cannot change consumption and seem too weak for efficiently changing the consumption towards sustainable products (10).

Environmental messaging and appropriate guidance in the shaping of people's behaviour showed instead of their efficacy (11), outlining the need for clear and transparent provisions.

Tax measures can incentivise environmentally friendly practices and act as a deterrent to unsustainable activities, if well designed. This is the case for instance in the plastic pollution, of the Latte-levy case in the UK (12). In 2018, given that consumers used and disposed of 2.5bn of non - recyclable coffee cups per year, a regulation was introduced to reduce the use of plastic in disposable coffee cups made with a cardboard outer layer and a plastic lining, materials difficult to separate to recycle. " Coffee cups make up 0.7% of total paper packaging waste in the UK." – it was explained in The House of Commons report- "We believe it is important to look at the packaging producer responsibility system and waste management system as a whole, in order to drive the best environmental outcomes." In the light of it, the government resolution was a 25p charge per disposable coffee cup. "Latte levy" of 25p was intended to discourage the usage of non-recyclable cups and drive people to change their behaviour. A cheaper cost for reusable cups was a reward because "Several industry stakeholders were concerned that a coffee cup charge would add an "unwelcome tax burden on UK consumers."

[1] Question: Has your organisation made a commitment to achieve net zero?

- 44% Yes before 2050
- 28% Yes but not before 2050
- 22% Not yet but we have a plan to make commitment to achieving net zero in future
- 4% No we expect our managers to have a plan in place on our behalf
- 2% No we are not currently planning to commit to achieving net zero

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In the same year in Italy, a law provision set rules to reduce plastic consumption and protect the environment. It stated that starting from 1 January 2018 plastic sachets needed to bag vegetables and fruits at the supermarket must be replaced by biodegradable ones and consumers must pay 2 to 10 euro cents for each biodegradable sachet they use (13). Consumers, hence, started to pay to be green in the use of the just-introduced biodegradable sachets, while plastic ones remained free, banned from supermarkets, their use fined but still no cost, making the provision not understood, unpopular and unwelcome.

Both countries resolved to control and limit plastic production and waste, but they used environmental taxation in a diametrically opposed way.

Italian consumers were not educated to choose the less pollutant behaviour, nor either rewarded for their eco-choice, but rather charged to pay a sort of pollution tax for a non-pollutant behaviour without understanding the reason and having indication of where the money raised was going. Tax policy was not devised with a realistic and proven understanding of citizens' behaviours. Collection and waste remained a still non-solved problem such as collaborative behaviour.

In the UK consumers were driven to pay less if they chose the less pollutant. They felt rewarded for their contribution to the environment eventually, also underlined by famous coffee shop brands initiatives organized to encourage consumers to opt for reusable cups, such as a 50p discount for choosing for them. Waste collection of recyclable cups was activated and increased by private initiatives.

The two examples reported above, although referring to the effect of plastic pollution in a restricted field of use, showed how two different tax designs adopted for environmental problems of the same kind, related to waste disposal in this case, can impact so differently and the role that interplay between enforcement of laws and consumer population can play in achieving goals and effectiveness.

Based on these considerations we focused on verifying whether it is possible to structure an environmental tax instrument that responds to public expectations and doing so can leverage people's attitude to be extremely effective in its environmental outcomes and efficient also in terms of public acceptance and viability at a global level. In short, our approach wanted to be a purposive structure built up starting from considering local instances of public demand and going on with interpreting and embedding them in a tax tool shaped specifically to drive people to contribute to reducing carbon.

The study looked for an alternative to environmental taxes and subsidies conceived to punish the "bads" or pickle the winners whose limits are known, and focused on tax relief, posing the question of whether a tax relief may be able to deal with these instances; and in the affirmative case, be the supportive instrument intended to reduce effectively Carbon emissions with a favourable reception.

Tax relief means to pay less tax to take account of money spent on specific things or to get tax back or get it repaid in another way (14). It "may be a universal tax cut or a targeted program that benefits a specific group of taxpayers or bolsters a particular goal of the government (15). " It grounds on the occurrence of events acting upon one another between governors and taxpayers towards a common goal and we would like to add it should make use of simple open and transparent communication for better results.

Our study concentrated to analyse the case in the specific of the tax relief given for donation to Charities in the UK. Gift Aid Donation is a Scheme available to Charities and Community Amateur Sports Clubs that can claim an extra 25p for every £1 the donor gives. The donor with a tax rate above the basic rate of 20%, can personally claim back 20% tax relief (that is the difference between the higher rate of 40 per cent and the basic rate of 20 per cent) on the grossed-up donation. So, for example, if the taxpayer donates £100, given a basic rate of 20%, Charity receives a totally of £125 and the higher tax rate – the donor can claim back an additional 20% x £125 = £25.

Over time Gift Aid as a tax relief has increased in size and scope to become worth £828 million to UK charities in 2006-07 (16) and has grown to dominate in the last 20 years.

Based on the latest statistics commentary in the annual update of UK Charity Tax Relief Statistics 2018-19, tax reliefs to charities show an upward trend with an increase of

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over £100m since the previous tax year. It was on Individuals' donation £90m in 2018-19; the total amount of relief for individuals raised to £1,530 with an increase of £30 from the previous tax year, and a mean donation peaking in 2017-18 at £2,590 and 2018-19 at £2,620 (17) (see Table A.1, Appendix A).

Overall, the rise in the latest years and the upward trend show that people are inclined to give, and that Gift Aid tax relief has been able to drive people's behaviour to the common goal of supporting charities.

The decision to donate can involve some criteria such as whether to give money to one charity or another or how much to give and for what cause. Among even the 75 million tax returns analysed by NAO - University of Birmingham Tax Centre, the researchers found that many basic-rate taxpayers filled in donation amounts on their self-assessment forms even though they were not entitled to a rebate (18).

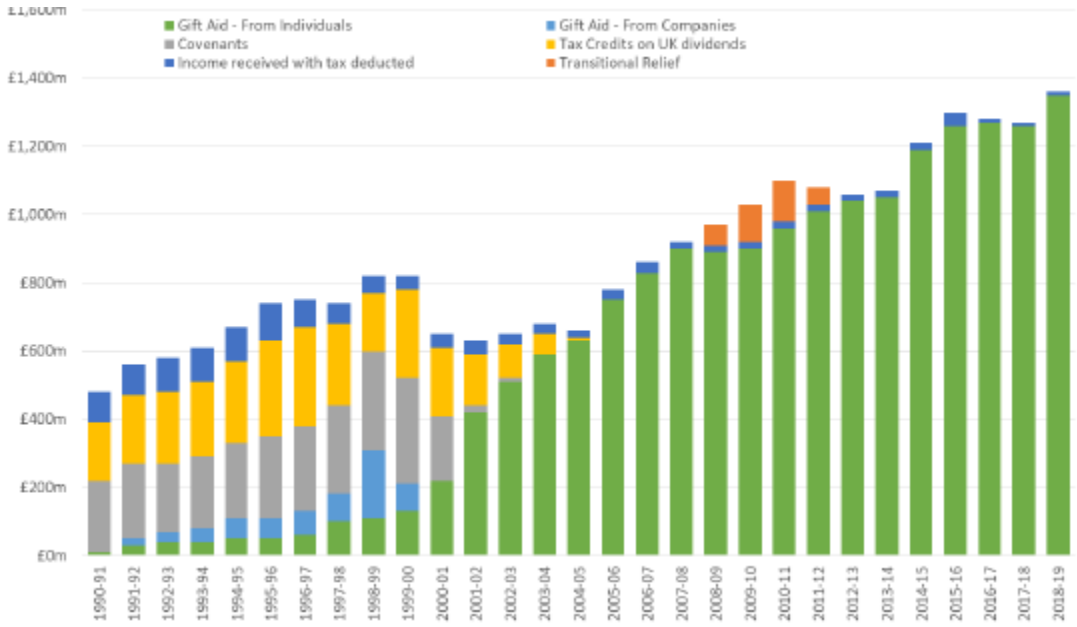

Figure 1 Tax repayments to Charities on Donations – UK Charity Tax relief Statistics1990-91 to 2018-2019 HMRC

In the light of the above considerations, we aimed to examine if a tax relief may be structured for environmental causes with the specific intent of driving people's behaviour to reduce pollution and respond to their expectations.

In our structure we took into consideration that the Gift Aid Scheme in the UK experienced a simple and clear communication and that UK Government believes that creating social norms around giving, including the use of peer effects can move people to do more (19); that furthermore recent research shows that public support for taxation is significantly higher for schemes with hypothecation than for those without it (20).

3. Results

Section 4

Green Aid™ Participation Scheme

Given that people are sensitive to environmental problems and call for an urgent solution to climate change, an environmental tax may have regards to this to elevate its

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effectiveness and directly address people's attitude to take active participation into account by incorporating their behaviours into tax relief.

In light of this, an environmental fiscal policy may not intend to punish the "bads", but rather reward the positive attitude, such as by relieving taxes of participants to decarbonization, a direct reward.

Green Aid Tax Relief should bridge the action of contributing to Carbon offsetting with tax relief. Where governments policy is to engage committed citizens to a sustained collective action through a Green Aid Participation scheme, once the common goal of lowering pollution and the instructions on how to achieve it has been set out clearly and unambiguously.

Our next step was therefore to set out a Green Aid Tax Relief able to combine the benefit of carbon-cutting with the double reward of both the tax relief itself and the visible environmental outcome achievable by individual contribution.

3.1. Why participate? - An economic insight

"Green Aid **Tax Relief** should be the tool able to meet public expectations of active participation in enhancing environmental performances in the name of the common well-being and survivorship.

It can be drawn up as a Green Aid Tax Relief Participation Scheme able to steer individuals' actions to an organized collective contribution to Carbon offsetting with expectations of direct and immediate rewards; based on the interplay between government and population both engaged in fight climate change with visible and effective results and for contributors in the achievement of the additional benefit of tax relief.

Governments may recur to the Scheme to vehiculate their global call to reduce global warming giving the positive message of a reward for virtuous behaviours, and with the final aim to raise environmental policy effectiveness thanks to people's active participation through which achieve massive and capillary effects that otherwise they could not reach on their own.

The common action shares the goal of Carbon offsetting in our case, but a Participation Scheme may give the start to actions on intermediate cases limited to a relatively small area, like water pollution, black tar, waste or plastic collection, road maintenance and cleanliness, welfare services, promotion of development policies etc…all cases where intervention by the government may request widespread enforcement measures easier to achieve if enhanced by the responsible local participation of committed citizens shaped and targeted efficiently to maximise impacts.

The environmental tax relief can leverage people's commitment to participate for reasons that may vary from purely rational such as to be out of their own self-interest, or after having referred to some criteria to try to make the best decisions, or acting purely randomly, or driven by social norms.

"Green Aid Participation Scheme "comprises three elements in the decision-making process. The first element is the common goal between contributors and government to participate to reduce pollution. The intention to participate lies in the initial contribution that people make to start. For every unit currency initially given to participate **d**, government match and participate to adding their contribution m so that the total result of the Participation will be made up of:

$$d + dm,$$

The second element is the cost of participating. In this case, it is how much is given d and the rebate **r** returned by the government relieving taxable income due:

$$d- dr,$$

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The third element is the commitment b to the final benefit of impacting Carbon reduction, in our case.

In the standard economic model of giving, donors are assumed to care about their total contribution and how much it will cost to donate (21). In Green Aid participants care about the total participation and the cost as well. The initial contribution matched by the government and the final tax relief that brings a cost reduction commensurate to the participation make both appealing the act of participating. The third element is an independent motivation, a personal and collective goal, that in itself can drive people to act.

The Environmental Participation (pe) is made of**:**

$$pe = d+dm + b,$$

and the cost to donate **c** will be:

$$c= d - dr,$$

The price of participating:

$$P = \frac{c}{pe}$$

When participants decide rationally how much to initially give, they consider that the much they give (**d)** will be increased in the total by any addition given by government (**m**) and it will cost them only the original amount (**d)** donated together with any additional rebate rate (r) from governments. But the final decision will depend also on another achievable benefit (**b**), not monetizable, and on how much is deemed worthy, in this case, the benefit of Carbon offsetting whose reduction varies according to the amount donated, is measurable, predictable, achieved personally and visible.

Hence the final decision to participate is driven by two components: a tax incentive and an overall benefit, that are independent of each other and on whose prevalence the final result depends on but leads to anyway.

$$\frac{c}{pe} = \frac{d-dr}{d+dm+b} = \frac{1-r}{1+m} + \frac{1}{b}.$$

Environmental Participation (pe) can broaden the environmental tax policy efficacy by utilizing the tax relief to motivate and organize people in a wide social contest, involving them to responsibly participate in common welfare and environmental sustainability.

3.2. What is the "Green Aid Participation Scheme"

Greenhouse gas emissions are environmental harm affecting the climate on a global basis. They should be addressed by a global fiscal policy across multiple jurisdictions and require both international overview and public acceptance.

Green Aid tax relief wants to reduce environmental damages from carbon emissions and promote the conscious involvement of citizens as a global action.

It is designed to have a broad impactful action rather than to create a broad tax base; be credible and be an effective aid measure in the reduction of global warming.

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It follows the three main key objectives indicated for EU members in the EU Environment Action Programme to 2020 (22) that are:

- to protect, conserve and enhance the natural capital,
- to help developing, Green, and low-carbon economies,
- to safeguard the population from environment-related pressures and risks to health and wellbeing.

Embedded in an Environmental Participation Scheme, it can spread its effectiveness by connecting committed people to sustained global action, leveraging people's attitude to active participation in acting for climate change. It stands at the core of the action in the fight against climate change, being devised to bear directly on a source of environmental recovery without boundaries, important in the global fight for decarbonisation.

We refer to forest and green areas. New research, published in Nature Climate Change found that the world's forests sequestered about twice as much carbon dioxide as they emitted between 2001 and 2019. In other words, forests provide a "carbon sink" that absorbs a net 7.6 billion metric tonnes of CO_2 per year, 1.5 times more carbon than the United States emits annually (23).

Green Aid Participation Scheme offers a tax incentive for individuals and businesses to make an Environmental Donation to the local government to plant the right trees in the right "Green Aid Point" through which participate in the establishment or maintenance of "Green Aid Points".

Green Aid Points can be forest, young regrowing forest, native woodland, urban green infrastructure, vegetation shrubs or a stand of trees but dedicated public state-run areas or controlled by government or again connected to State forestry programs anyway. Public lands, state parks, public forests, urban forests, forest lands are specifically identified by local governments for their protection, conservation, or regeneration and come within the broader global scope of establishing "Green Aid Points" across the world to create carbon sinks globally. The Green Aid Points with their right trees species to plant for their carbon absorption and sequestration capacity in each Point should be presented in a "Green Aid Guidance", the public manual that should be disseminated in the local jurisdictions to share the common environmental policy and motivate public participation.

The free initial donation (d) of money made to the government by participants gives the start to a Green Aid Environmental Participation realized by purchasing and planting the desired number of native trees chosen from among the species indicated according to the criteria of reforestation or ecosystem capacities explained for each Green Aid Point in the preferred Green Aid Point. Where the initial price paid (d) is conveniently matched by the government (m) to complete the trees plantation process.

The match (m) varies upon local government intendment. It can be the additional cost needed to plant the trees, or VAT exemption on the original purchase cost, etc.., but the amount is given anyway by the total spent, from purchase to plant trees or shrubs on the "Green Aid Point".

Each unit tree counts for its price (PUC) and its measurable impact on Carbon reduction, its Participation capacity (PAC).

Participation capacity (PAC) is the unitary environmental benefit in terms of estimated Carbon reduction achievable by planting one unit of that tree species. Hence unit trees species are listed for their unit price and their unitary carbon reduction capacity in each "Green Aid Point" location in the public guidance. Once the unit values have been consulted, participants may fix the price according to the number of unit trees calculated worthy to benefit from the tax relief they want (dr) or to the environmental contribution (b) to be benefited. The total price paid (d) generates an environmental contribution(b) and a tax relief (dr) that is calculated at the rate (r) on the price originally paid. They are direct and visible rewards and depend both on the number of unit trees purchased and planted.

Donation is free and can be made yearly. Participants are free to decide the sum to donate – theoretically, there is no upper or lower limit in the amount to give, but it can be

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capped according to local jurisdictions intendments or differentiated for individuals and companies. The Scheme gives the flexibility to determine if to participate and how best to reduce carbon emissions or rather relieve taxes, based on the number of trees you decide to plant anyway.

Participants can be individuals and businesses. Tax relief reduces the taxable income participants are due to pay.

Individual participants can deduct or exempt donations from their personal taxable income.[2]

Businesses choose to participate to redirect their tax relieved directly in investments for their Green Innovation or R&D. Government loans funded directly by the government or made by private and backed by the government can help businesses to increase funding needed.

Explanation and calculation are available in the public guidance before any decision is taken to ease an informed choice.

3.3. How to design Green Aid™ Participation Scheme

3.3.1. The scope of the environmental tax relief

- The scope of Green Aid tax relief should be as broad as the scope of the environmental damage being addressed.

Green Aid tax relief refers to Greenhouse gas emissions that from one location contribute to atmospheric changes affecting the climate on a global basis. Therefore, it wants to address natural surroundings to be ideally able to act globally without boundaries and spread social commitment through the public call to reduce pollution to broaden its resolution.

The fiscal instrument operates directly at source on emissions reducers, on the cause of environmental benefit and engages citizens who demand action, rewarding them for both their participation in the public action of planting trees for pulling carbon dioxide out of the atmosphere (24) and their awareness of a sustainable life (25).

The choice to turn to trees considers that they are present all over the world similarly to the Carbon emissions they can fight.

New research finds that low-cost reforestation programs, coupled with programs to end deforestation, can increase the amount of carbon dioxide absorbed between 2020 – 2050 by 5.7 gigatonnes, or 5.6 per cent, with a carbon price of just $20 per ton, or by 15.1 gigatonnes (14.8 per cent) for $50 per ton (26).

Paris Agreement recognizes the importance of stable forests, but they have received comparatively little attention through existing forest protection mechanisms and finance. Instead, emphasis has been placed on targeting locations where deforestation and forest degradation are happening actively (27), and World leaders promise to end deforestation by 2030 in COP26. Yet stopping deforestation and forest degradation does not guarantee durable success, especially outside the geographic scope of targeted efforts. Furthermore, there are concerns about REDD+ projects environmental integrity, including the ability to control leakage (when deforestation activities simply move to another area) and risks for overestimation of credits due to baseline uncertainty (28) (29). As a result, today's stable forests may be at risk without additional efforts to secure their long-term conservation (30). Let's think about Germany's forests, able to absorb 62 million tonnes of CO_2 every year (31), they have been greatly damaged by extreme weather events in 2020 but no action has been taken yet to help restore them to health.

Green Aid Participation Scheme could leave to exploit the nature-based solution at a global level, but adaptable to local circumstances, being politically feasible conforming to national jurisdictions how Green Aid Participation Scheme can be adopted, whilst

[2] Some of Tax deduction schemes in place offer tax credit.

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maintaining the uniqueness of its environmental goal, an issue we will deal with below in the discussion on Competitiveness.

The second element that can broaden the scope of Green Aid tax relief is the collective contribution. Green Aid tax relief is designed to organize individual action in a structured manner to reach the final common goal of carbon-cutting. Participants take the tax relief into account when they decide to give their Green Aid contribution to the government to plant a set of trees in a dedicated area and express doing so their commitment to Carbon abatement. The Participation Scheme funnels governors and people to take part in a common action where participating is a social incentive itself, but the further immediate visible reward comes from the tangible and direct outcomes of both taxes relieved and a measurable Carbon reduction.

Communication to this end is critical.

3.3.2. Clear global communication and public acceptance – "Green Aid one name one action"

- Green Aid tax relief approach should be a standard simple scheme with a well-defined unambiguous structure to be flexible and feasible to apply across multiple jurisdictions, making climate action simple for businesses and individuals.

- Clear communication is crucial to the effectiveness of the measures**.** Green Aid Environmental Scheme should clearly explain eligible environmental participation with a simple, open, and transparent communication that includes a simple user-friendly route for participants to ensure that their tax relief goes directly to tackle climate change.

The Scheme in the specific bears directly on a source of environmental recovery and bridges the action of contributing to Carbon offsetting with the tax relief, giving contributors a simple route to re-direct their initial donation to active participation to protect the environment and consequent benefits. Giving an action perspective (32) such communication can motivate people to change their behaviour and become greener but also educate and form the new generation and its awareness. This is crucial in defeating scepticism and encouraging taxpayers to choose to use the Green Aid as a personal commitment to the well-being and biodiversity preservation, considering that past environmental tax policies have found among their limits in the scepticism of the population about the utilization of the funds for environmental purposes and in poor visibility of the proposed results.

Here participants are double rewarded. Being taxpayers, the tax relief is a fully realized incentive by contributors and fixes the base for reciprocal cooperation between governors and citizens to benefit from the common goal of decarbonisation. As citizens, they take action directly to restore or maintain trees and woodlands in public land, paying from their pocket and governments match the action taken; and praise and reward the effort, through granting a tax relief.

For the effectiveness of government intervention, it is fundamental how to structure communication.

Behavioural insights and the three principles of human decision-making (33), (34) are recognised to be a powerful tool to enhance the effectiveness of the policy design itself, once individuated and used the right model that can work in the specific case (35).

Following recommendations of the Behavioural Insights Applied to Policy (BIAP) Report 2016 and the four key conclusions, when designing and implementing policies (33) the guidance should be structured to inform throughout the policy cycle - including in anticipating implementation and enforcement issues - to generate useful evidence in the most effective way (33).

The manual " Green Aid™ Participation Scheme Guidance" hence should be structured to assist contributors to make informed choices from the beginning, explaining the tax relief and the Carbon absorption capacity and highlighting the progress they can reach planting trees in each dedicated Green Aid Point. This way improves, BIAP Report explains, the effectiveness of behavioural policy initiatives, shedding light on their long-

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term impact and increasing transparency, through more effective communication and evidence sharing with citizens (33).

Thus, for clear and transparent communication, the Guidance should show per unit tree of the cultivar peculiar of each Green Aid Point:

- Unit price, and
- Carbon absorption capacity.

Participants can orientate their choice by pre-calculating tax relief and carbon sequestration in total and decide consequently, how many unit trees want to donate with their purchase according to the goal they deem prevail: tax relief for the total of units purchased or the carbon sequestration predictable for the selected number of unit trees.

Finally, part of the communication process can be also to educate environmental behaviour to foster people's capacity in an educative way to make their own choices. To this end, interventions can foster people's skills and knowledge and expand the available set of decisions tools (36) providing for instance to welcome participants to follow the all-plantation process of their purchase going in person to the **"Green Aid Point"** once donated or suggesting to visit the point and enjoy nature or for recreational activities.

Visible effects and immediate rewards will give contributors a sense of control that can be an important motivator, given that environmental participation is a free choice that gives contributors consciousness of the environmental problem, willingness to participate and flexibility about how best to contribute and can also make them enjoy the benefits from participation concretely.

3.3.3. Motivate environmental improvements. Incentives to innovate

- Green Aid can promote innovation and the development of cleaner technologies for the future. It provides that businesses must directly invest tax relieved in their innovation. The scheme fosters businesses to participate to redirect the amount relieved in investments for their green innovation and R&D.

The environmental tax relief is targeted at individuals and businesses because they all suffer from pollution and can cooperate in their manner.

Individuals benefit from the benefits themselves paying less direct taxes to take account of money spent on environmental participation.

Businesses choose to participate to put a value to the Carbon reduction their contribution gives. They become incentivized to redirect their strategies in investing tax relieved to stimulate their technological advance through research and development. All types of businesses can contribute in their manner.

There are no sectors or pollution sources favoured over others and being a free contribution, it provides a continuous incentive to abate. In addition, lowering taxable profit and redirecting tax relieved to invest in environmental innovation may bring firms to seek new and cleaner solutions and makes it attractive for the third party to invest in innovation and R&D to develop new technologies and products less pollutant. Thus, local politics should make provisions of government loans funded directly by the government or made by private and backed by the government to help businesses to increase the funding needed.

This means that companies pivoting their business models and starting to decarbonise can increase the investment sector.

3.3.4. Competitiveness

- Green Aid can recycle the environmental tax relieved to participant firms themselves.

Firms take potential future tax rate changes into account when making their location choice today and high rates of environmental taxation can encourage them to relocate to lower-taxed jurisdictions or may result in "unfair" competition with foreign firms, risking causing carbon leakage anyway. To date, environmentally related taxes have not been identified as causing significant reductions in the competitiveness of any sector. However,

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this is partly because countries applying environmentally related taxes have provided for total or partial exemptions for energy-intensive industries.

A major obstacle to the implementation of environmentally related taxes is often the fear of reduced international competitiveness in the most polluting, often energy-intensive sectors of the economy (4). Besides, globally many countries have backtracked on environmental regulations and taxes to fight economic downturns due to Covid 19 crisis.

A tax relief designed to contribute to establishing forest or green growth together with the opportunity to reinvest the untaxed income in their own innovation with possible additional funding can be extremely effective in directing businesses to operate in areas where a contribution is more needed, Least Developed Countries included, or conditions are more favourable. The jurisdiction to which businesses relocate will presumably set the conditions for a win-win solution, such as fixing the tax relief cap or the funding provisions, to avoid economic detriment and minimal environmental gain or to attract businesses or intentioned investors.

There is also to consider, on the other hand, that state-run forestation activity should produce additional revenue and lead to the emergence of new economic sectors with an additional workforce as a result.

The risk of relocation can be avoided if businesses can contribute to reducing carbon emission with a Green Aid Tax Relief that makes them save money from taxes and reuse that money directly in their innovation technologies internally.

3.3.5. Green Aid Points

- Green Aid Points are biodiversity key site areas chosen by local governments to preserve and protect establish green in a new area, or recover endangered and declining woodland in their country, with a programme of hand-planted seedlings for species with specific carbon sequestration capacities for forest restoration, afforestation, or urban forest.

"Green Aid Points" should be state-run dedicated areas or connected to State forestry programs. Structured and organised appropriately by local governments in the way they think fit. Local jurisdictions identify Green Aid Points according to their agro system and socio-economic conditions, but also to climate zones.

Therefore, the reasons that may lead to deciding to preserve, create or reconstitute an area may be different, such as example revegetating the landscape with native trees and shrubs to encourage wildlife to return or remain in the urban environment, while at the same time removing carbon from the atmosphere; or creating a sustainable value-chain through planting species for future timber production and protecting the remaining patches of native vegetation; or again finally creating additional conservation areas to offer a natural habitat for native animals and plants, protect and enrich the soil, save and filter water, or diversifying for a more resilient tree population, but always with the final global goal of contributing to the mitigation of the greenhouse effect.

Whatever the reasons, it is advisable to share them publicly in a National "Green Aid Guidance, where people can find the areas appropriately pinpointed and the native tree carbon focused species to plant listed for unit price and their environmental impact per unit tree. Communication of this kind gives participants a sense of control and immediately visible reward as they can estimate and decide the impact of their donation in advance, receiving a positive message from their decision to contribute to the environment (37).

For a functioning Green Aid Point there need to be trees of all shapes and sizes and in the right proportions to ensure that benefits can be delivered. A preventive study should be at the base of the settlement process to find out in each adhering country which trees and shrubs are the best suited to the specific purposes for their physical and physiological characteristics and drive to plant the native trees.

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There is to consider that trees can help mitigate climate change by carbon sequestration and carbon storage. Carbon storage relates to the carbon currently held in trees tissue (roots, stem, and branches), whereas carbon sequestration is the estimated amount of carbon removed annually by trees. Carbon storage and sequestration depend not only on the number of trees present but also on their characteristics. In this case, the mass of a tree is important, as larger trees store more carbon in their tissues. As trees grow, they store more carbon by holding it in their tissue. As trees die and decompose, they release this carbon back into the atmosphere. Net carbon sequestration is negative in this case, as the emission of carbon from decomposition (dead trees) is greater than the amount sequestered. Therefore, the carbon storage of trees and woodland is an indication of the amount of carbon that could be released if all the trees died.

At a very basic level a tree population ideally needs enough large and mature trees, to deliver the widest possible range of environmental benefits in urban areas; and of enough trees in some younger age classes to replace these mature trees as they eventually die.

Green Aid Participation Scheme will be conveniently structured in the National Green Aid Scheme to follow the planting programs tailored by each country to cover their specific needs, but with the final univocal aim of maintaining a healthy tree population to ensure that more carbon is stored than released, either locally or globally for the effect of the international implementation of the Scheme.

Green Aid Points can help to make a green economic growth.

3.3.6. Green economic growth

- The links between the economy and the environment are manifold: the environment provides resources to the economy and acts as a sink for emissions and waste (38). Green Aid Participation Scheme gives help to abatement but can also generate revenue and additional income.

Green Aid Participation Scheme gives help to abatement and encourages innovation but can also generate revenue and additional income at the central and local level in the Agriculture and Forestry sector. It can create side commercial partnering and collateral local businesses experiencing woodlands, nature conservation and other activities, such as timber and forestry industry, contracting businesses, sawmills but also cafes, shops, recreational, woodland and estate management; activities all in support of local economies, employment, and investment anyway.

The stocking of forest and green areas can combine Carbon reduction with multiple ecological and socio-economic benefits for local communities and the environment in developing countries as well, engaging local communities to provide long-term co-benefits in the areas such as energy, water supply, health, education, and social affairs contributing to the United Nation's Sustainable Development Goals (SDGs).

Sustainability can be achieved by creating an ecosystem whose bio-capacity serves the diversity and stability of ecological and social life, supporting sustainable rural livelihoods of local communities and promoting biodiversity conservation. Through forest and green growth, it can be strengthened cooperative structures and involved local stakeholders by working with them in all stages from the establishment of nurseries and the growth of native tree species to the supervision and management of forest with long-term benefits that enhance natural and social resources.

Developing countries can also encourage businesses to invest under the Participation Scheme.

Reforestation combined with tax relief in a Green Aid Participation Scheme may represent an exciting opportunity for the capital markets and private individuals in the coming years. The resulting partnership between investors, local jurisdictions, and local people can give a maximum impact in improving ecological resilience and diversity, and improving the lives of local communities, employment and income for local people ensuring that the Green Aid Participation Scheme's commitment goes far beyond the goals of strictly carbon offset provision. On the other hand, very little revenue is generated from

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environmental taxes. In 2019, total environmental tax revenue in the EU amounted to €330.6 billion, representing 2.4% of EU GDP and 5.9% of total EU government revenue from taxes and social contributions (39). In OECD countries environmentally related taxes account for on average approximately 5% of total tax revenues (40).

3.3.7. Political feasibility

- The scope of the Green Aid Participation Scheme is commensurate with global damage but adaptable to local circumstances.

Green Aid Tax Relief does not provide abatement incentives on pollution by pricing the environmental harm, but rather by relieving remediation costs at the local level for global warming.

Each Country may be able to transpose the Green Aid Scheme into national law and adapt it to local instances. Adhering countries can design the scheme to their fiscal policies, configuring how to match and rebate, but can also set their environmental parameters such as afforestation needs, level of pollution to control, kind of green to plant, and also designate the Green Aid Points according to their needs. Hence each country shall release a planting program structured with the different species composition, in the respect of tree health and of the territoriality of the political jurisdiction but also in line with global environmental tax policies deployment. The scope of the Green Aid Participation Scheme can be commensurate with global damage but adaptable to local circumstances.

4. Discussion

4.1. CASE STUDY- London Urban Forest

London has been classified as the world's first National Park City in July 2019. The green infrastructure with a canopy cover of 21% and 8,421,000 trees distributed in parks, gardens woodlands and open spaces can be classified as a forest by FAO definition. An urban forest, grown and matured over many years in conditions very different from the cityscape of today, with legacies of planting by city planners in the early 1800s, and a growing environmental awareness more recently, that has led to a blossoming of urban orchards and community woodlands planted and cared for by local groups from all of London's diverse communities (41) (p. 4).

London's Urban Forest is a natural capital containing all of the trees, plants, and associated animals in the urban environment, both in and around the city, providing to citizens valuable resources that are not only clean air, food, and recreation, but also ecosystem services such as climate mitigation Carbon storage and sequestration, biodiversity, pollution mitigation to mention only a few.

Recently the urgent need to plant more trees to help tackle the climate emergency and the role of trees and woodlands in supporting Londoners' health and wellbeing during the Covid-19 pandemic has considerably increased the importance of maintaining and increasing the canopy cover over time and has resulted in initiatives designed to demonstrate the value of London's green areas and actioned to plant more trees. The Mayor Street tree programme leans towards more trees to be planted by developers and the London Urban Forest Plan published in November 2020, to name a few, proposes a combination of better protection and management; encouraging new planting and natural regeneration to increase the capital's tree canopy cover by 10% which would provide approximately 3,300 hectares of the additional canopy.

Such ambitions urged the need of quantifying the benefits of the urban forest in meaningful terms, valuing trees as the asset they are now.

Collating data about London's urban forest is challenging due to the number of landowners and managers involved, as well as the limited resources available. Nationally, there is a lack of common data standards and reporting for tree data.

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Forest Research has recently consulted on a set of standards for tree data as part of their Communitree project (42).

The tree inventories of London boroughs tracked part of London's street tree population and are currently partial as cover 25 boroughs only (43).

Greater London Authority updated in March 2021 a dataset including the locations and species information for over 880,000 of London's trees (44).

The i-Tree report "Valuing London's Urban Forest" period 2014, estimated that there are over eight million trees in London, which includes trees in woodlands, parks, streets, private gardens and more. The data includes 26 of London's 33 boroughs, the City of London, and Transport for London (45).

The latter is the study that has reported a valuable survey of the structure and the composition and distribution of London's urban forest, most of all showing how to determine its benefits by measuring the structure of the urban forest (the physical attributes such as tree density, tree health, leaf area and biomass) to assess the environmental impact by species and age, to obtain a baseline from which to set goals and to monitor progress and be able to calculate the value of the benefits in monetary terms.

We wanted to test Green Aid Tax Relief in a natural real-life context to see how Green Aid Participation Scheme can be applied to local instances and adapted to local jurisdiction. We resolved to combine the scientific methodology applied to local data and our tax scheme to see if they can work together and with what presumable effects.

In this case, it was about combining the valuation system of the local environmental impact assessment by i-Tree Eco Data "Valuing London's Urban Forest" and the Green Aid tax relief adapted to a progressive tax system to see how they can drive public demand and government to act together against climate change by supporting woodland creation and regeneration projects.

The Urban Forest of London is reported as woodlands, which are mostly broadleaved, cover 13,300 hectares, (8% of London's land area), with 20% of these defined as ancient woodland (46) London's trees and woodlands support a wide range of important wildlife including ten bat species, birds, insects, and fungi. The most common tree species are Birch, Lime, Apple in Inner London, Sycamore, Oak, Hawthorn in Outer London. Although London's urban forest is quite species diverse, there are areas where diversity of both species and age profile is low, increasing vulnerability to the impact of pests and diseases. Over two fifths, (43%) of the urban forest is under public ownership and management – the majority under the control of London's 32 boroughs and the City of London. A fifth of London's urban forest stands within private gardens (45).

The London Urban Forest Plan identifies a set of goals including creating new woodlands in the Green Belt, tree planting "right tree right place", increasing the number of trees on the capital's streets; planting in parks and other green spaces, and planting by Londoners in their gardens; biosecurity in the procurement, favouring locally, or at least UK grown trees.

We supposed the above to be the goals explained and shared with participants to Green Aid Participation Scheme as well, where the Green Aid Participation Manual should deliver all the information together with the maps of the Green Aid Points, the public areas specifically identified by the government to regenerate or to create among which there would be therefore London Urban Forest too.

In the specific, individuals accessing the Manual could direct their search to know:

- Where the Green Aid Points are located;
- Which tree species are needed in each Point;
- Unit costs per tree species, hence Green Aid Participation Unit Price PUC;
- Participation capacity per unit tree species PAC, none other than carbon absorption capacity per single unit of tree species in our case.

Participants can assess therefore the direct benefits achievable from their individual participation to reduce Carbon emissions by calculating for each total number of trees they would think to donate what follows:

- The total cost of their participation ;

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- Green Aid Tax Relief they can be eligible for;
- Participation Capacity, that is their ability to reduce Carbon emission by purchasing and planting the desired set of trees;
- Achievable direct benefits from the much they were able to contribute in person in Carbon reduction.

This means that the Manual, besides explaining why to participate in simple and clear terms, should report also in an easy-to-understand way how to obtain both a reduction in carbon emissions and a tax relief driving people to calculate them in an intuitive mode.

For this purpose, we referred to the data reported in the i-Tree Eco Project for London that provides estimates for trees in London by land, use and species. We assumed that the Green Aid Points pinpointed in the Manual were Inner London and Outer London, as in the Project and prepared two tables, Green Aid Point - Inner London and Green Aid Point - Outer London listing the same trees species reported in i-Tree Data.

The London i- Tree Eco Data records the size of the trees and shrubs, including height, canopy spread and diameter of trunk to construct the i-Tree Model to calculate the ecosystem services. The total number of inventoried trees is then reported per species ranked per Dominance, Carbon Storage and Carbon Sequestration, Leaf Area and Biomass (Appendix A Table A.2 and Table A.3 - Carbon by Species). The importance of the trees can be based in fact on the dominance that indicates the abundance of the trees combined with the gross leaf surface area of that species. The most leaf area provides the delivery of the most associated benefits or ecosystem services. So, tree species take relevance for the leaf area rather than just the population.

Carbon Storage relates to the carbon currently held in trees tissue (roots, stem, and branches) and can influence global climate change. Carbon stored in trees tissue grows as trees grow, but as trees die and decompose, they release carbon with the risk that net carbon sequestration can be negative if the emission of carbon from decomposition is greater than the amount stored by healthy trees.

Finally, Carbon Sequestration is the estimated amount of carbon removed annually by trees. Carbon Storage and Sequestration depend not only on the number of trees present but also on their characteristics. In this case, the mass of a tree is important, as larger trees store more carbon in their tissues. London Plane trees make up just 1.4% of the tree population but store 6% of the total carbon, for example, apple trees, on the other hand, store only 0.8% of carbon but make up 4% of the tree population. Maintaining a healthy tree population with a balanced number of new and ancient trees will ensure that more carbon is stored and sequestered than released.

In our study, given the Carbon Storage and Carbon Sequestration per trees species indicated by i-Tree Data, we calculated the unitary Participation Capacity per tree species PAC, that is Carbon storage per unit tree species and again the Carbon sequestration per unit tree species. We reported these unitary values in the two dedicated tables of Green Aid Point - Inner London and Green Aid Point - Outer London where the trees species are ranked per Dominance as indicated by London i- Tree Eco Data. (Table 1 and Table 2 below for the first eleven species ranked by importance).

We reported in the two Tables also the Participation Cost per Unit (PUC) per tree species, that is the cost to participate by purchasing one unit of the ranked trees or shrubs. We referred to the standard market value from the price list of nurseries per single item with a DBH between 7 - 15.2cm, given that trees with a diameter at breast height 7 – 15cm constitute more than 35% per cent of the population (47) but lower prices are offered for large orders in bulks. Nurseries 'offer was for Sycamore trees (Acer pseudoplatanus) 20 - 40cm at £0.94 per unit for 1,000+ units purchase; and the same offer could be found also for Silver Birch trees (Betula pendula) 20-40cm, Golden Curls Weeping Willow Trees (Salix Erythroflexuosa Golden Curls/Twisted Willow) of 90-220cm, and Mature Wild Cherry Trees Prunus Avium Plena. This means that government can think to make supplies at a lower purchase price, when setting up Green Aid Points, to lower the participation unit price or to mark it up to generate revenue alternatively. On the other hand, the initial

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purchase from the nurseries would be repaid by participants, so it would only cost the state the amount of the tax relief claimed and would be anyway much less than the replacement cost[3] that does not constitute an advantage provided by trees, because of its high amount.

Participants accessing the Green Aid Manual can find therefore the information at their fingertips in a coloured table that shows which are the right trees in the right place for each Green Aid Point, and what the benefits their participation can bring to themselves and the environment if they will participate. The Green Aid Participation Table, in fact, ranking trees and shrubs per Dominance, indicates the capacity to store and sequester carbon of one tree for each species and the unit cost of participation which is nothing but the Green Aid tax relief claimable per purchased unit tree.

Green Aid Participation Inner London									
Series: City	Time Period: 2014	tonnes	tonnes		~ Units you wish to purchase	~ Your Green Aid Participation ~		**Green Aid Calculator**	
		Carbon stored (¹mt) per unit tree	Gross Sequestration (¹mt/yr) per unit	Green Aid Participation **£/unit**			Carbon you store (¹mt)	Carbon you sequester (¹mt/yr)	Green Aid tax Relief you may be eligible
Inner London	Acer pseudoplatanus	0.5136	0.0153	59.5					
Inner London	Quercus robur	1.2891	0.0253	49.5					
Inner London	Betula pendula	0.1231	0.0086	59.4					
Inner London	Crataegus monogyna	0.0557	0.0042	0.94		£0.00	0.00	0.00	£0.00
Inner London	Malus	0.0226	0.0040	54					
Inner London	Cupressus	0.1804	0.0073	1.62		£0.00	0.00	0.00	£0.00
Inner London	Fraxinus	0.1691	0.0069	45					
Inner London	Salix	0.9273	0.0235	59.4		£0.00	0.00	0.00	£0.00
Inner London	Prunus	0.1764	0.0092	51.6					
Inner London	Prunus avium	0.0951	0.0079	51.6		£0.00	0.00	0.00	£0.00
Inner London	Quercus	0.6031	0.0125	8.95					

Table 1: GREEN AID PARTICIPATION - Inner London

[3] The formula is: Tree Value = Base Value x Cross-sectional Area x Species Class x Condition Class x Location

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Green Aid Participation Outer London									
Series: City	Time Period: 2014	tonnes	tonnes		~ Units you wish to purchase	~ Your Green Aid Participation	Green Aid Calculator		
		Carbon stored (¹mt) per unit tree	Gross Sequestration (¹mt/yr) per unit tree	Green Aid Participation £/unit			Carbon you store (¹mt)	Carbon you sequester (¹mt/yr)	Green Aid tax Relief you may be eligible
Outer London	Acer pseudoplatanus	0.3049	0.0110	59.5					
Outer London	Quercus robur	0.7415	0.0180	49.5		0	0	0	
Outer London	Betula pendula	0.1230	0.0075	59.4					
Outer London	Crataegus monogyna	0.0844	0.0047	0.94		0	0	0	0
Outer London	Fraxinus excelsior	0.4362	0.0102	45					
Outer London	Malus	0.0727	0.0065	54		0	0	0	0
Outer London	Cupressus	0.0809	0.0047	1.62					
Outer London	Fraxinus	0.1619	0.0075	45		0	0	0	0
Outer London	Salix	0.5141	0.0079	59.4					
Outer London	Prunus	0.1420	0.0092	51.6		0	0	0	0
Outer London	Prunus avium	0.1212	0.0083	51.6					
Outer London	Quercus	0.6671	0.0137	8.95		0	0	0	0

Table 2: GREEN AID PARTICIPATION - Outer London

In this way, the public can orientate their choice by species, or by area or by aim in an easy, social attractive and timely manner.

Participants can easily put into action their commitment by simply watching PAC and PUC (Unit Participation Capacity and Unit Purchasing Cost per tree species). Once they have chosen the tree species they are willing to buy, they multiply unitary values of that species by the number of units to know what tax relief they might be eligible to claim and the environmental benefit they can expect from their action. An informed choice, prompted hence when people are likely to be the most receptive, made by considering the immediate cost and benefits, personalised to their preference for tax relief or rather for Carbon cutting.

You can choose, for example, the indication of purchasing Oak trees – *Quercus robur*, because you can see on the Green Aid Participation Table a high unit cost of participation that may bring you a higher tax relief or because the table shows that one unit stores the greatest amount of carbon in both Inner and Outer London, although oak trees rank second in number. Alternatively, you can choose London Plane trees or Sycamore trees in Inner London; or Sycamore trees and Silver birch trees in Outer London if you consider the importance in terms of carbon sequestration. You can opt alternatively for a less costly common species like the Hawthorn shrubs- Crataegus priced £0,94 per unit[4].

Let's say that your choice is orientated to participate in planting one English Oak tree with a girth 20cm in Inner London. Table 1 shows that it will cost you the unit price of £49.5 an active participation to reduce pollution, effectively benefitting of:

- Carbon Storage 1.29 mt tonnes,
- Carbon Sequestration 0.03 mt tonnes/y.
- Claimable tax relief for £49.5 you spent.

Where:

- average household emissions in the UK from heating their home is 2.7 tonnes of CO_2 /y (48),

- the average new car emits 120g/km of CO_2 in 2020 (49) that is 0.01 mt tonnes/y of Carbon.

[4] List price from nurseries as of May 2021

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- Taxes shifted away from Income taxes for £49.5 you spent.

If you change your mind opting to plant a set of three Oak trees rather than just one, nothing else to do but simulate how much your participation can cost and benefit you. Referring to Oaktree data reported in Table 1, there is to multiply both Unit Participation Cost and Unit Participation Capacity – Storage and Sequestration, in this case, by three units. Your participation will make you eligible for a Tax relief of £ £49.5 x 3 = £148.5, store Carbon for 3 x 1.29 = 3.87 mt tonnes and sequester Carbon for 3 x 0.025 = 0.08 03 mt tonnes/y and so forth depending on the number of units you choose.

Green Aid Participation Inner London									
Series: City	Time Period: 2014	tonnes	tonnes		~ Units you wish to purchase	~ Your Green Aid Participation ~		**Green Aid Calculator**	
		Carbon stored (¹mt) per unit tree	Gross Sequestration (¹mt/yr) per unit	Green Aid Participation **£/unit**			Carbon you store (¹mt)	Carbon you sequester (¹mt/yr)	Green Aid tax Relief you may be eligible
Inner London	Acer pseudoplatanus	0.5136	0.0153	59.5					
Inner London	Quercus robur	1.2891	0.0253	49.5	3	£148.50	3.87	0.08	£148.50

Table 3: GREEN AID PARTICIPATION - Quercus robur Inner London

4.1.1. Green Aid Tax Relief – Tax incentive for Individuals

Let's focus on individual giving and suppose participation to purchase and plant Apple trees in the Green Aid Point - Inner London.

Table 1 explains that one Malus tree in that land can store 0.0226 metric tonnes, sequester 0.0040 metric tonnes per year and give tax relief for its purchase price of £54.

If we theoretically suppose that an individual's willingness to participate is almost the same as for donation to Charities, we can then consider that one person is likely to participate with an amount approaching the mean donation per individual in 2018-19 of £2,620 (it was £4,940 for London). If it is so, a person could participate for that amount and purchase 48 units of Maple trees at £2,592 participation cost. Green Aid Participation is treated as being made of the total amount spent of £2,592, supposing that government match is included and consists of an all-inclusive cost up to planting trees.

Green Aid Participation Inner London									
Series: City	Time Period: 2014	tonnes	tonnes		~ Units you wish to purchase	~ Your Green Aid Participation ~		**Green Aid Calculator**	
		Carbon stored (¹mt) per unit tree	Gross Sequestration (¹mt/yr) per unit	Green Aid Participation **£/unit**			Carbon you store (¹mt)	Carbon you sequester (¹mt/yr)	Green Aid tax Relief you may be eligible
Inner London	Malus	0.0226	0.0040	54	48	£2,592.00	1.08	0.19	£2,592.00

Table 4 GREEN AID PARTICIPATION - Malus Inner London

The Green Point – Inner London will release a Green Aid Donation certificate concerning the donation, which should include name, home address; detail of the tree's species and planting location; the number of units bought, the total amount paid, once participation has been paid.

Given that each unit tree counts for its price and its impact on Carbon reduction, the total benefits achieved will be:

- carbon storage 1.08 metric tonnes,

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- carbon gross sequestration 0.19 metric tonnes/yr,
- Tree cover percentage 0.05 (SE 0,006) (50) (given N total number of sampled points = 1,000)[5]
- Claimable Tax relief £2,590

The purchase will qualify for Green Aid Tax Relief if it is a payment of £2,592 by an individual who's paid or will pay UK tax. It will be calculated on an individual's tax rate.

Green Aid tax Relief will increase the participant's basic rate by the total amount of the participation, so giving relief to the taxpayer. If they are taxed at a higher rate, a higher rate (and upper rates if income is higher) is increased also by the total amount given.

If an individual pays tax above the basic rate of 20%, the claim is the difference between the rate they pay 40% and the basic rate on participation £2,592 x (40%-20%) = £518 because the amount of £2,592 of taxable income moves from higher rate (40%) to basic rate (20%). If the rate they pay is the Additional rate (45%), the claim is the difference between the rate paid and the basic rate on the contribution. This moves £2,592 from the Additional rate to the Basic rate band and saves tax for £2,592 x 25% = £648.

England/Wales/Northern Ireland Income tax band 2021/22	Taxable income	Income tax rate *
Personal allowance	Up to £12,570	0%
Basic rate	£12,571–£50,270	20%
Higher rate	£50,271–£150,000	40%
Additional rate	£150,001+	45%

**UK Income tax for individuals is based on marginal tax rates*

Table 5: UK Income tax for individuals 2021/22

Considering that Green Aid tax relief's final goal is to reduce pollution by enhancing people's active participation, the Scheme should also include participants who only pays a small amount of Income-tax.

A possible solution can be to think that if participants are taxed at the basic rate (20%), but tax liability is less than claimable relief £518 (20% tax rate of £2,592), they can postpone the claim once eligible rather than pay further income tax for the total amount of £518.

If participants are taxed at the basic rate (20%) with a tax liability of more than £518, but within the basic rate band (20% tax rate applicable to the donation of £2,592), they might claim tax relief of R – (100 / (100 – R) where R is the basic tax rate 20 – (100/80) = 18.75. Total tax relief for the participant can be therefore £518 / 18.75 = £27.64 in our example.

[5] **To calculate the percent tree cover and SE:**

N = total number of sampled points (i.e, 1,000)

n = total number of points classified as tree (i.e., 330), and

p = n/N (i.e., 330/1,000 = 0.33)

q = 1 – p (i.e., 1 - 0.33 = 0.67)

SE = √ (pq/N) (i.e., √ (0.33 x 0.67 / 1,000) = 0.0149)

Thus in this example, tree cover in the city is estimated at 33% with a SE of 1.5%. Based on the SE formula, SE is greatest when p=0.5 and least when p is very small or very large.

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4.1.2. Green Aid Tax Relief for Companies Green Aid innovation Regime Scheme

When it comes to corporate participation it is the company that will benefit from the tax incentive by deducting the amount paid in that period to purchase and plant the set of trees from the Total Taxable profit. In Green Aid Participation Scheme, CT relieved will qualify to be directly reinvested in the company's R&D starting from the following tax year or we might propose an Innovation Scheme for the non-qualifying companies as an alternative. Both Schemes should be eligible for government finance and support for business or government-backed loans.

More in-depth, R&D puts some limitations at the moment to eligibility, such as operating only within science and technology and other criteria. If this is the case, the final goal being the reduction of pollution through greater active public participation, it might be advisable to think of an alternative scheme for non-eligible companies such as a conceivable Green Aid Innovation Regime Scheme. The Scheme should provide for businesses benefiting from paying a lower rate of Corporation tax on the amount of trading income that is derived from exploiting the innovation.

Let's suppose that an SME company, eligible for R&D tax relief, participates by purchasing 48 units of Maple trees to plant in Inner London, and qualifies for the £2,592 Green Aid Participation Scheme. That is an allowable expenditure deducted from the total taxable profit lowering it by £2.592 and giving a tax saving of £2,592 x r, where (r) is the Corporation Tax rate set at 19%, Green Aid tax relief will be £ 492.

Green Aid Participation Scheme can leverage relieved tax to promote innovation and development of cleaner technologies for that company by redirecting the amount relieved directly in investments for their business green innovation and R&D.

R&D will give a 130% deduction of qualifying costs from yearly profit, as well as the normal 100% deduction, to make a total 230% deduction. This means that the business will be able to deduct tax relieved £492 x 130% = £640 from the taxable profit and reinvest that amount directly in their environmental innovation.

A Green Aid Innovation Regime Scheme should be offered to companies non-eligible for R&D, as an alternative. It might provide for deducting tax relieved £492 invested in innovation from the Total Taxable Income and from benefitting from paying a lower rate of Corporation tax. If the Corporation Tax rate is 19%, the lower rate of Corporation tax could be 15.4%, that it is like deducting from TTP the residual amount of the donation itself (£2,592 x15.4%= £399 and (£2,592-£492) *19% =-£399).

4.1.3. Conclusions

Green Aid Participation Scheme can address both public commitments to climate mitigation and the great love of British people for forestry to a structured global action to the net-zero policy taken together with the government, by directly rewarding participants who can benefit from the carbon reduction and the tax relief achieved with the participation in planting trees.

This simple to use and transparent tax relief is structured in a user-friendly route to ensure that public participation goes directly to tackle climate change and is being directly rewarded. It triggers the common action of the public and institutions towards the shared environmental goal, where participants purchase trees and the government match it with an extra to finalize trees plantation.

The Scheme can contribute in this case to extend and protect the London Urban Forest by combining the nature-based resource with the Green Aid Tax Relief and can reduce pollution in the least cost way, just driving people's behaviour to their expectations.

Green Aid Tax Relief can be adapted and customised to local provisions and might exploit the propensity to donate revealed by HMRC statistics, besides public demand to step up climate action.

If participation in Carbon cutting could meet the same success achieved by donating to charities, we could expect it to be equal to the number of donors that stood at 249,000 in London have been in 2019, with a mean donation per donor of £2,620 in 2018-19. If so, a mean donation for £2620 could mean planting for instance 48 Apple trees at the cost of

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participation of £2,590, to report the example above, which can lead to carbon storage of 1.08 metric tons[6] and carbon gross sequestration of 0.19 metric tons/yr; or a set of 44 Sycamore trees (Acer Pseudoplatanus) for £2,618, securing Carbon storage of 22.60 tonnes/mt and Carbon sequestration of 0.67 tonnes mt/yr, or again to participate planting 1,617 Cupressus conifers in Outer London purchased for £2,619 with a Carbon storage capacity of 130.81 tonnes mt and sequestration of 7.68 tonnes mt/yr, where London's per capita emissions in 2018 (51) were 3.6 $MtCO_2e$ equals to 0.98 metric tonnes of Carbon.

On the other hand, considering that the government has an ambitious target treble planting 30,000 hectares of trees a year by 2025, overall, a sharp acceleration might be needed to meet this target (52).and Green Aid Participation Scheme could help to make up a lot of ground.

For businesses, it is possible to think that the competitiveness risk of relocation can be avoided if businesses can contribute to reducing carbon emission with a Green Aid Tax relief that shifts taxes away from Corporation tax and makes them reuse money saved internally in their innovation technologies directly.

4.2. CASE STUDY- Parco Regionale Urbano di Aguzzano

We would like to apply Green Aid Participation Scheme to another local context to see impact and feasibility across multiple jurisdictions.

We looked for a previous study that had located already a forest area of national interest and measured the structure of the area (the physical attributes such as tree density, tree health, leaf area and biomass) to assess the environmental impact by species and age and obtain a baseline to refer to.

We found Parco di Aguzzano in Italy, a small Italian park that extends for about 60 hectares in the north-eastern outskirts of Rome along the low valley of the Aniene river. Until the end of the sixties of the last century, agricultural activities and extensive grazing were still widely practised in this part of the city, giving life to an original interpenetration between strips of the Roman countryside and surrounding villages. Then, in the space of a few years, there was drastic urbanization of the territory and the almost total replacement of agricultural areas with areas for residential use.

Detection and sampling were carried out by Casale Podere Rosa in 2017 with the same i-Tree Eco System methodology already described in the previous case study (53), but this particular did not constrain our choice. Within the sampling areas, 556 trees belonging to 33 species and 18 families were recorded by i-Tree Data. Overall, the sampling areas covered 6.3% of the park's territory and tree cover was 26.6%.

The objectives of the "Valutazione dei Servizi ecosistemici nel Parco Regionale Urbano di Aguzzano 2017" Report were two in particular: the hydrological reconversion of the basin of San Basilio ditch and the increase of the tree cover through the reconstruction of native forest strips to protect the park and conserve ecosystem services such as Carbon store and sequestration capacity. The report itself detailed a set of subgoals that include pollution reduction and also a) recovery and redevelopment of a pre-existing reforestation area, b) creation of two mixed oak forest formations, and c) protection of a small area of spontaneous expansion of riparian vegetation.

The study explained that the greatest contribution is given by a population tree shorter than 5 m (30.58%) or between 5 and 10 m high (24.28%). Among the numerous factors that contribute to the young age of trees, it can be assumed that there is the abandonment of agricultural practices and recurrent forest fires. It is therefore an area to defend because it can be part of an ecological network with other areas of naturalistic value and provide a certain biological continuity between the Roman countryside of Marcigliana to the north, the river Aniene Valley Nature Reserve to the southwest, Tiber

[6] The atomic weight of carbon is 12 atomic mass units, while the weight of carbon dioxide is 44, because it includes two oxygen atoms that each weigh 16. So, to switch from one to the other, use the formula: One ton of carbon equals 44/12 = 11/3 = 3.67 tons of carbon dioxide.

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River and the city of Rome with the two parks of Villa Ada and Villa Borghese. For this reason, Aguzzano was ranked as Urban Regional Park in 1989.

Aguzzano Park can be considered a modest size Green Aid Point located in a heavy sectors congested city, assuming to be already in a Green Aid Participation Scheme. Participants accessing the Green Aid Participation Manual should theoretically find an Aguzzano Green Aid Point reported there with the above description and goals. They should be able to choose which species to plant among the "right tree in the right place" list and how many unit trees according to the benefits they wish to achieve.

Aguzzano Park Report explained that Platanus x acerifolia, Ailanthus altissima, Robinia pseudoacacia and Pinus pinea are the species at present potentially providing the greatest contribution to the abatement of atmospheric pollutants. Deciduous broad-leaved trees are 92% of the trees, evergreen broad-leaved trees are 5% and conifers 3%. Table A.5 in Appendix A represents plants distribution among Zone 1 and Zone 2. The i-Tree estimates the presence of 8,932 (± 1,049) trees in the park, 5,800 (± 788) in Zone 1 and 3,132 (± 692) in Zone 2, more extensive but mainly occupied by secondary grasslands.

Zone 1 with an extension of 22.12 ha (37% of the total area) includes strictly trees. The prevalent native species are Robinia pseudoacacia and Prunus. The presence of invasive alien species Robinia pseudoacacia and Ailanthus altissima is widespread, testifying to the profound alterations of the vegetational physiognomy that occurred over time due to human activities, which prevented the achievement of greater forest structural complexity (Appendix Table 6. A).

Zone 2 has an extension of 37.44 ha (63% of the total surface) and mostly includes vegetation shrubs. Salix alba and Populus alba are associated with compact formations of shrubs with Rubus ulmifolius, Arundo plinii, Phragmites australis and Arundo donax (Appendix Table 6. A).

The i-Tree Eco Project estimated Aguzzano's forest structure and its ecosystem based on the collected samples of 8,932 trees as a whole and not subdivided by zones, ranking trees, and shrubs of the same diametric class by Value of Importance (VI) which is the potential contribution given to the abatement of atmospheric pollutants per trees species at that time (Table A.4 in Appendix A).

At this point, we prepared the Green Aid Participation Table for Aguzzano Park (Table 6 below), which participants should find for reference in the hypothetical Italian Green Aid Manual of which Aguzzano Park is one of the Green Aid Points presented. We referred to Table A.4 for ranking trees and shrubs per VI in our table. We then calculated Participation Cost per Unit PUC and Participation Capacity per unit PAC per each of the species ranked and reported the data in the Green Aid Participation Table – Aguzzano Park (Table 6) that shows the estimates of the unit value of Carbon Storage and Carbon Sequestration Capacity per tree and shrubs species detected. These values are calculated on the total absorption capacity per tree species assessed by i-Tree Data (54) based on the tree measurements and field data collected in Aguzzano on total samples (Carbon Storage and Carbon Sequestration Capacity per species, Table A.7- Appendix A, by courtesy of Mr Petrella Associazione Casale Podere Rosa), even if it would have been preferable that absorption capacity had been calculated separately for each of the two zones, given the structural differences.

The Green Aid Participation Table also indicates the Participation Cost per unit PUC. The latter refers to the standard market value from the price list of local nurseries for trees and shrubs with the same specificities as those used for elaborating data, given that over 90% of the Aguzzano tree population consists of individuals belonging to two diametric classes (<10 cm and 10-40 cm). Specifically, the Report assesses trees with a diameter measured at 1.3 m above the ground (DBH - diameter at breast height) ≥ 2.5cm.

The Green Aid Participation Table - Aguzzano Park makes it easy for each participant to simulate the purchase of the desired set of plants and moves straightforward upon a clear unambiguous indication of the costs but also of both monetary and environmentalist personal direct rewards.

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Furthermore, it can help to make an informed choice. It shows that choosing Zone 1 you might prefer an area in which trees prevail and trees species such as Ailanthus altissima, Platanus x acerifolia, Populus x canadensis and Pinus pinea have a high Carbon absorption capacity. Your choice eventually can orientate on invasive alien species that are prevalent such as Ailanthus trees that, if on the one hand, it can alter the vegetational physiognomy, on the other facilitates resilience through population diversity; or it can go to species with higher Carbon Storage capacity per unit otherwise, as Pinus pinea - Carbon storage 0.561 C tonne equals to 2.056 CO_2eq tonnes and a participation cost per unit of 150€.

In Zone 2, the current species do not have a high absorption capacity except Platanus x acerifolia and Quercus ilex, but the choice could be for example to buy shrubs for their lower PUC and in so doing, in addition to fiscal and environmental benefits, it would endorse also the subgoal of restoring riparian vegetation; alternatively purchasing one Oaktree, it would increase the Quercus Ilex trees population reducing carbon emissions consequently as well as achieving intermediate local objectives too.

It is therefore not excluded that Green Aid Participation Scheme in Aguzzano Park may entice and drive also to help in achieving other local objectives explained in the Report's project, but in our case, we must stay to our goal that is Carbon reduction.

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Green Aid Participation Parco di Aguzzano									
	Time Period: 2017	tonnes	tonnes					Green Aid Calculator	
		Carbon stored (¹mt) per unit tree	Gross Sequestration (¹mt/yr) per unit tree	Green Aid Participation €/unit	~ Units you wish to purchase	~ Your Green Aid Participation ~	Carbon you store (¹mt)	Carbon you sequester (¹mt/yr)	Green Aid tax Relief you may be eligible
1	Platanus x acerifolia	0.632	0.026	178 €					
2	Ailanthus altissima	0.018	0.003	25 €					
3	Robinia pseudoacacia	0.021	0.003	69 €					
4	Pinus pinea	0.561	0.023	150 €					
5	Prunus cerasifera	0.034	0.003	179 €					
6	Populus x canadensis	0.329	0.021	119 €					
7	Ulmus minor	0.048	0.003	239 €					
8	Quercus ilex	0.234	0.018	168 €					
9	Tilia platyphyllos	0.030	0.004	329 €					
10	Populus alba	0.014	0.003	119 €					
11	Juglans regia	0.032	0.004	179 €					
12	Celtis australis	0.050	0.006	158 €					
13	Acer negundo	0.049	0.004	138 €					
14	Prunus spinosa	0.037	0.004	12 €					
15	Salix alba	0.063	0.009	120 €					
16	Crataegus monogyna	0.010	0.002	30 €					
17	Ficus carica	0.094	0.013	129 €					
18	Pyrus communis	0.003	0.002	38 €					
19	Fraxinus ornus	0.002	0.001	188 €					
20	Corylus avellana	0.024	0.005	37 €					
21	Laurus nobilis	0.085	0.007	148 €					
22	Punica granatum	0.010	0.002	25 €					
23	Maclura pomifera	0.400	0.028	45 €					
24	Quercus robur	0.017	0.005	399 €					
25	Malus sylvestris	0.015	0.002	50 €					
26	Thuja occidentalis	0.010	0.002	21 €					
27	Prunus persica	0.250	0.029	48 €					
28	Acer campestre	0.019	0.003	298 €					
29	Gleditsia triacanthos	0.025	0.008	55 €					
30	Pinus pinaster	0.394	0.016	75 €					
31	Pyracantha coccinea	0.006	0.001	39 €					
32	Ligustrum lucidum	0.031	0.003	58 €					
34	Olea europaea	0.006	0.001	60 €					

Table 6: GREEN AID PARTICIPATION - Aguzzano Park

In 2017, the tree cover detected for Aguzzano urban forest retained 1,191.60 tonnes of carbon (4,369.50 t of CO_2 equivalent)[7]; and it is estimated that sequestered a gross quantity of carbon of 69.97 t / (256.59 t / year of CO_2 equivalent). The net quantity of sequestered carbon, which takes into account the amount of carbon reintroduced into the atmosphere with the respiration and decomposition of deadwood, is estimated at 61.16 t / year equivalent to 224.28 t / year of CO_2. Platanus x acerifolia is the tree species that contributed most to carbon sequestration (35.3%) and carbon storage (51.3%) (53).

[7] This data however it could prove to be overestimated due to recurring forest fires which, albeit modest, re-emit carbon into the atmosphere.

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Returning to our data in Table 6, it should cost 168€ to participate in the Green Aid Scheme by purchasing one oak tree, and this would give rise to be able to claim tax relief for the same amount of the participation cost.

So, referring to Table 6, if you choose to participate by purchasing one Oak tree – of the same DBH of the sampled trees, one tree would cost you 168€ and it would entail you the following benefits:

- carbon storage 0.234 metric tonnes,
- carbon gross sequestration 0.018 metric tonnes/yr,
- Tax relief claimable €168.

The apport to carbon reduction may vary significantly if you opt to plant it in Zone 1 rather than in zone 2, where the presence of trees is less and also carbon absorption consequently. You might orientate your choice to pay less alternatively, purchasing hawthorn shrubs- Crataegus Monogyna in zone 2, for example. It will apport the following benefits besides restoring riparian vegetation:

- carbon storage 0.010 metric tonnes,
- carbon gross sequestration 0.002 metric tonnes/yr,
- Tax relief claimable 111€

Where:

- CO_2 emissions per capita in Italy were 5.38 metric tonnes in 2018 (55),
- the average new car emits 110g/km of CO_2 in 2020 (49).

Whatever your choice, you will be still eligible for a Green Aid Tax Relief for the Participation Cost you spend.

Italy offers tax incentives to promote philanthropy as the large majority of nations in Europe. According to the tax deduction schemes in place, Italian taxpayers can currently deduct donations in favour of the so-called Third Sector Entities which includes charitable organisations qualifying as ONLUS (Organizzazioni Non Lucrative di Utilità Sociale) - not for profit organizations, Community Amateur Sports Club, foundations, associations, political parties, religious organizations and recently entities engaged in the pandemic emergency.

The benefits vary depending on who donates, the type of the recipient and the cause. They can be calculated as a percentage of the total income on which tax is due or as a fixed amount or a percentage of the Income Tax due. Deductions are limited either through a cap or fixed percentage scheme, however, the level at which the cap comes in varies.

To be able to deduct the expenditure incurred, it is necessary that the donation takes place through bank transfer, ATM or credit card, bank checks and circulars or postal bulletin and that receipt of the payment is kept.

We want to check if Green Aid Tax Relief could be one of the nationally offered tax breaks on charitable giving reshaped in the light of the environmental incentives and adapted to the Green Aid Participation Scheme.

4.2.1. Green Aid Tax Relief – Tax incentives for Individuals

Typically, Italian individual donors can choose to deduct or exempt donations from their personal taxable income or the Income Tax due, reducing the amount of tax they are due to pay.

The limits vary according to the particular incentive scheme and a minimum baseline applies from which donations become eligible for tax relief. So, while for example for general donations, people can donate up to 10% of their taxable income, donations to an entity engaged in the pandemic emergency are currently 30% (of the amount donated) deductible from Income Tax due, capped to 30,000€ (56), and the Art Bonus scheme offers the public a 65% tax credit against the cost of donations to arts or cultural institutions.

The assortment of available Italian tax incentive schemes includes that of donations to Regional and National Park entities which are 100% deductible currently without threshold and cap (57).

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It could be ideally used to structure a Green Aid tax relief through which a qualifying Green Aid participation (**d)** increased by any addition given by government (**m**) starts the Participation process of planting trees. If this is the case, the amount of 168€ is such, supposing that government match (**m**) consists of an all-inclusive cost up to planting the Oak tree in Aguzzano and is already included in that amount. The rebate (**r**) returned by the government relieving taxable income due is 100%. This means that given the total amount of the participation for 168€, it could entail a deduction from the Income Tax due in full besides benefitting personally from impacting in carbon reduction with carbon storage of 0.234 metric tonnes, and carbon gross sequestration of 0.018 metric tonnes/yr.

These can sensibly enhance commitment to participate in the Scheme in Italy and drive public interest, taking into account nevertheless that would be the case to be careful that Green Aid Participation Scheme should not be affected by effective marginal tax rates distortions (58) if the aim is to maintain the goal of high participation in carbon-cutting. Green Aid tax relief should hence be adapted trying to prevent tax-benefit from being partially offset by the combination of taxes increase and benefits reduction when income raises.

Income Tax band 2020	%
0€ - 15.000 €	23%
15.001€ - 28.000 €	27%
28.001€ - 55.000 €	38%
55.001€ - 75.000 €	41%

Table 7: Italy Income tax for individuals 2021

4.2.2. Green Aid™ Tax Relief for Companies Green Aid innovation Regime Scheme

As regards deductions for donations made in 2020 by companies and in general by IRES tax entities, corporate deductions can be capped at 2% of business income, alternatively at 10% of taxable income (with excess not claimable carried forward four years), or finally there can be full deductions of the disbursement from Total Taxable Profit. These alternatives are fairly advantageous conditions that arose as a result of the Covid emergency (D.L. n. 18/2020), but it cannot be excluded that Global Warming emergency can generate full deduction as well.

Besides, businesses should be allowed also to reinvest tax relieved in their Green Innovation and R&D, as a general rule of a global Green Aid Participation Scheme.

Local provisions are for a 20% or 10% tax credit for investments in research and development, technological innovation, and other innovative activities capped at 10 million euros. The credit can vary also according to the geographical location of the business.

4.2.3. Conclusions

Using Green Aid Participation Scheme to Aguzzano Park has provided useful information on how it can be adapted to a small green area, located in a strongly congested city to leverage public engagement in active participation to pollution abatement and be efficient also in terms of public acceptance and viability locally. We have customized Green Aid Tax relief to local instances and provisions adapting Green Aid Participation Scheme to the tax breaks on charitable giving already in use without changing its scope and objectives.

Our case study has combined the valuation system of the local environmental impact assessment of i-Tree Eco Data “Valutazione dei Servizi ecosistemici nel Parco Regionale Urbano di Aguzzano 2017” and the Green Aid tax relief customised to local jurisdiction

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This has meant to set out ecosystem goals and tax benefits to Parco di Aguzzano, a modest size Green Aid Point and see how they could engage committed citizens through direct environmental and fiscal rewards to participate together with governors in removing atmospheric pollutants, and doing so improving on a local scale, the quality of the air, citizen's health, climate, and resilience of the territory.

Using Green Aid Participation Scheme to Aguzzano Park allowed us to consider feasibility in the local jurisdiction and perhaps underline evidence that has never been remarked upon. The inclination to donate to Third Sector in Italy in 2016 was equal to 212€ million out of a declared total income of 843€ billion for Income Tax purposes (IRPEF). with a 5.1% increase compared to the previous year. It was 0.025% of total declared income but data refers to 26% deductions donations only.

Green Aid Participation Scheme can be adapted to this local jurisdiction by taking advantage of the full deduction of donation to Parks. The Scheme enhances participation by engaging the public to act directly planting trees and shrubs and motivates through the double visible effect of a 100% deductibility combined with the action of contributing to Carbon offsetting through a simple route that ensures participants that their donations go directly to achieve environmental outcomes and are an incentive to donate to become eligible to tax relief.

And what to say about Aguzzano Park, the trees' density is already approximately 150 per hectare, well above the average density of 5.2 trees/hectare recorded in the highly urbanized area of the Rome Municipality IV within which the park falls (Rome Open Data, 2016). Open Data, 2016). Canopy cover can be sensibly increased too, allowing to benefit also from multiple ecosystem services.

It should be noted that Green Aid Tax Relief is a sort of donation that returns benefits to participants themselves. Governors achieve more effectiveness from their dispositions, charge taxpayers for maintenance or restoration of public green areas; and can generate additional revenues and develop the economy in the agriculture, forestry, and related sectors. On the other hand, taxpayers are engaged to participate with a specific purpose that concerns them personally and leads them to take advantage of rebates in taxes. This should lead to consider that tax-benefit should not be partially offset by the combination of taxes increases and benefits reduction when income raises. It is advisable then that a Participation Green Aid Scheme should be devised in Italy to not be affected by effective marginal tax rates distortions (58).

5. Conclusions

Green Aid Tax Relief Participation shows the utilization of the tax tool in a wide social contest that organizing and involving people and governments to responsibly participate in common welfare and environmental sustainability, can broaden its efficacy. An environmental tax can be devised to reward the "goods" rather than punish the "bads". It can leverage public expectations to take a sustained collective action together with their governors to responsibly participate to reach the common goal of carbon-cutting, by giving in return direct and visible benefits that motivate participants.

Green Aid Participation Scheme can be an alternative answer to reduce the environmental damage and it can be of great help to achieve carbon neutralization. It structures the combination of a nature-based resource and people's commitment and shares the action between governments and the public towards a common goal. It works in a least-cost way if we just think that the replacement cost would be greater than the cost of participation and that the initial purchase from nurseries is repaid by participants and it costs the State only the amount of tax relieved.

Green Aid can be adapted to local instances and resources to improve on a local scale, the quality of the air, the health of citizens, the climate, and the resilience of the territory, but also for a continuous and constant global contribution.

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Our study on Green Aid Participation Scheme and Green Aid Tax relief as alternative environmental instruments of taxation for achieving the net-zero goal yield several important points:

- **Environmental tax reliefs incorporate impacts into contributions** – Green Aid Tax Reliefs can be used to directly address the effort of taxpayers to take environmental impacts into account by incorporating these impacts into environmental contributions. Taxpayers, through taking tax relief into account in their decisions, become committed to being part of global action together with their governors in tackling climate change.

- **Flexibility** - Relieving tax as a result of the commitment to reduce CO_2 emissions is a free choice for contributors, either individuals or businesses. It's the way to give them the consciousness of the environmental problem, willingness to participate and flexibility about how best to contribute to carbon offset.

- **Certainty** – The quantum of the environmental impact depends on the social commitment and on the level of interest in relieving tax. Participants have certainty of their results.

- **Rewarding** - Participants act at the same time as taxpayers but also as contributors to carbon neutralisation. Their rewards are immediately visible and consist of the measurable CO_2 reduction to the extension desired and of the achievable tax relief. The perceivable reward makes it attractive to participate.

- **Clear and adaptable Structure** - Green Aid has a simple and transparent structure to respond to the aim of being easy to understand and follow. So socially accepted and applicable at a local level for a global action without boundaries and lobbying. Green Aid Tax Relief could be a single fixed tax Scheme to be applied equally to each nation or could be the national tax incentive to promote philanthropy reshaped in the light of the Green Aid tax relief to be adapted to the Green Aid Participation Scheme.

- **No Wedges** – Tax reliefs do not entail sacrifice for contributors and avoid wedges that pricing tools can cause between offer and demand.

- **Incentives** – Green Aid recurs to tax reliefs to generate real incentives to cooperate to the common goal. It can bring to:
  - promote innovation and R&D in the environment.
  - increase labour force and salaries
  - create economies in the related sectors and help to make such alternatives more viable, without a need for direct subsidies
  - give socio-economic benefits to local communities, secure employment in rural and underdeveloped areas
  - reduce carbon footprint and progress monitoring
  - boost countries' economies by developing areas of activity managed or controlled by local government.
  - promote global reforestation, an exciting opportunity for the capital markets and private individuals

- **Educate** – Green Aid Participation Scheme associates sustainable life choices with enjoyable visible benefits and provides better information by improving the knowledge base according to sustainable development goals.

Green Aid is ready for use, for further developments and to be implemented.

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6. Patents

Green Aid is a Trademark.

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www.cescauk.org

Conflicts of Interest: "The author declares no conflict of interest."

Appendix A

Table 5: **Donations declared by individuals completing UK Self Assessments, by tax year**

Number of donors and proportion of Self Assessment individuals who donate, mean and median average donations per donor

		All individuals completing Self Assessment		All Individuals who declared a donation via Self Assessment							
Tax Year		**Number declaring a donation**	as a proportion of all taxpayers	*Total Gift Aid donations, gross of tax*	*Total donations of Shares and Securities*	*Total donations of Land or Buildings*	**Total of these**	Mean donation per donor	Mean ratio of individuals' donations to gross income	Median donation per donor	Median ratio of individuals' donations to gross income
		Thousands	%	*£m*	*£m*	*£m*	**£m**	£	%	£	%
2007-08		**880**	10%	*1,869*	*262*	*24*	**2,155**	2,450	3.0%	380	1.0%
2008-09		**945**	11%	*1,547*	*119*	*16*	**1,682**	1,780	2.9%	360	1.0%
2009-10		**1,015**	11%	*1,782*	*176*	*21*	**1,979**	1,950	3.0%	360	1.0%
2010-11		**1,080**	12%	*1,996*	*177*	*25*	**2,199**	2,040	3.0%	350	1.0%
2011-12		**1,095**	12%	*1,957*	*152*	*44*	**2,153**	1,970	2.8%	350	0.9%
2012-13		**1,198**	12%	*2,145*	*242*	*36*	**2,423**	2,020	2.7%	340	0.9%
2013-14		**1,250**	12%	*2,188*	*206*	*32*	**2,427**	1,940	2.7%	340	0.8%
2014-15		**1,244**	12%	*2,387*	*262*	*33*	**2,682**	2,160	2.7%	340	0.8%
2015-16	Updated	**1,238**	12%	*2,584*	*301*	*60*	**2,945**	2,380	2.6%	340	0.8%
2016-17	Updated	**1,250**	11%	*2,669*	*336*	*35*	**3,040**	2,430	2.6%	340	0.8%
2017-18	Updated	**1,247**	11%	*2,758*	*444*	*27*	**3,229**	2,590	2.6%	340	0.7%
2018-19	New	**1,256**	11%	*2,881*	*378*	*31*	**3,290**	2,620	2.6%	350	0.7%
				58,202	*17,747*						
					643						
Notes					0.006911381	0.691138126					

1 Excludes corrections to tax returns after late 2020 or tax returns submitted after that date (the deadline is 31 January after the end of the tax year).
2 Components may not sum to totals due to rounding.
3 "All Self Assessment individuals" means those who completed and submitted a Self Assessment form to HMRC for that particular tax year, including those with no tax liability or no income.
Direct comparison with other Personal Tax statistics published by HMRC may not be straightforward due to different treatment of corrections and late returns.
4 A "donor" means any individual who entered non-zero donations in the relevant section of a Self Assessment form.
This means that it will include some individuals who did not benefit from the tax reliefs available under these provisions eg due to nil or insufficient taxable income or capital gains, or due to other reliefs reducing their liability.
5 The values declared may not always constitute a donor's total donations for the appropriate tax year as individuals might only enter donations which they claim a tax relief, for example Gift Aid.
As such direct comparison between these statistics and the statistics released in Table 2 is difficult.
For example it is not possible to use total value of grossed up Gift Aid donations for a single year in this table to work out the total higher rate relief given to individuals in the same year as reported in Table 2.
This is because this table will also contain individuals who did not benefit from the Gift Aid higher rate relief (i.e. non-taxpayers or basic rate taxpayers). Furthermore, this table only reports donations made via Self Assessment and excludes Gift Aid higher rate relief by contacting HMRC who will adjust PAYE individual's tax code in order to claim the relief, for example for a taxpayer claiming less than £10k in PAYE only. Whilst figures in Table 2 do take Gift Aid higher rate relief given via PAYE into account, this table looks at Self Assessment only.
6 Calculations of donations as a proportion of income exclude individuals with nil income or where the ratio of donation to income was over 100%.
7 "Updated" means we have revised this row since the last edition of these statistics for corrections to Self Assessment returns and for returns submitted more than four months late.

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Official Statistics

Self Assessment by tax year since 2007. It also provides an indication of the total value of all (grossed) donations, and the mean and median values of all (grossed) donations.

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Table A 1 HMRC, "Table 5: Donations declared by individuals completing UK Self Assessments, by tax year," 2019.

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Total Estimates for Trees in London by Land Use and Species													
Series: City	Time Period: 2014			stored tonnes		tonnes							
		Number of Trees		Carbon (¹mt)		Gross Seq (¹mt/yr)		Net Seq (¹mt/yr)		Leaf Area (km2)		Leaf Biomass (¹mt)	
Land Use	Species	Val	Standard Error	Val	SE	Val	SE	Val	SE	Val	SE	Val	SE
Inner London	Acer pseudoplatanus	78,381	22353	40257.04	17530.5	1197.02	417.8	1081.07	376.8	14.248	5.71	996.39	399.3
Inner London	Quercus robur	48,988	19333	63150.2	30886.5	1241.52	496.9	1032.35	423.44	14.699	6.31	978.6	420.1
Inner London	Betula pendula	68,583	29878	8439.17	3438.24	586.84	233	549.82	218.61	5.917	2.89	351.42	171.4
Inner London	Crataegus monogyna	53,887	29625	3003.78	1552.96	225.25	111.7	210.9	105.11	2.218	1.43	279.04	180
Inner London	Malus	93,077	34442	2099.43	798.65	375.64	143.8	359.89	139.34	2.893	1.23	249.43	106.3
Inner London	Cupressus	9,798	6910	1767.28	1484.65	71.38	53.47	64.53	47.9	2.379	1.94	372.51	303.9
Inner London	Fraxinus	34,291	17538	5797.99	3535.71	235.76	125.1	226.13	120.21	3.465	1.85	312.2	166.7
Inner London	Salix	4,899	4898	4542.8	4542.33	115.29	115.3	105.04	105.03	0.031	0.03	1.91	1.91
Inner London	Prunus	58,785	27464	10372.38	5511.61	538.67	245.2	438.57	218.65	5.796	3.36	448.46	260
Inner London	Prunus avium	14,696	8441	1396.88	956.04	115.42	73.92	110.88	70.79	2.879	2.24	222.73	173.4
Inner London	Quercus	58,785	36510	35452.77	21509.5	733.08	404.6	562.77	349.32	7.571	4.08	747.18	402.2
Inner London	Acer platanoides	34,291	18863	18737.98	11760.2	540.97	326.1	482.84	286.5	12.388	7.65	668.62	413.1
Inner London	Betula	186,154	171995	1939.41	1742.96	550.9	497.8	529.8	478.25	6.83	6.68	426.9	417.5
Inner London	Castanea	4,899	4898	5763.8	5763.21	182.97	183	160.81	160.8	1.352	1.35	94.8	94.79
Inner London	Ilex	53,887	25229	4725.54	2417.63	394.34	199.8	376.08	190.71	3.081	1.78	411.83	238.2
Inner London	Tilia x vulgaris	97,976	34723	23504.48	10508.3	775.87	313.6	525.22	322.81	14.755	6.84	686.27	318.3
Inner London	Carpinus betulus	44,089	31287	558.75	325.13	91.62	54.19	89.19	52.8	0.753	0.46	45.38	27.49
Inner London	Platanus hybrida	68,583	24563	73058.07	34400.7	2207.94	965.3	2115.14	934.79	19.415	7.88	847.82	343.9
Inner London	Tilia cordata	39,190	16782	13701.23	6837.08	437.18	200.5	375.79	170.13	15.715	7.29	1177.17	546.4
Inner London	Acer campestre	9,798	6910	2016.4	1978.22	92.35	85.2	84.53	77.54	0.711	0.66	40.03	37.09
Inner London	Chamaecyparis	14,696	14695	848.87	848.78	58.58	58.58	55.2	55.19	0.242	0.24	60.46	60.45
Inner London	Ulmus	14,696	10931	311.5	289.11	56.3	49.57	54.89	48.3	0.527	0.39	35.86	26.51
Inner London	Aesculus hippocastanum	19,595	9722	39763.98	24125.3	578.68	416.4	-2123.95	2647.5	10.019	6.11	700.6	427.5
Inner London	Taxus baccata	4,899	4898	1174.68	1174.56	43.67	43.67	39.13	39.13	1.582	1.58	247.74	247.7
Inner London	Pinus	9,798	6910	2004.16	1939.61	71.69	62.29	63.96	54.9	1.647	1.59	158.71	153.4
Inner London	Sorbus	24,494	12876	5793.43	3965.51	300.17	190.9	278.44	175.55	1.048	0.57	83.16	44.98
Inner London	Taxus	24,494	16194	760.16	503.86	67.28	44.16	64.33	42.25	1.194	0.76	186.95	118.3
Inner London	Tilia	19,595	15466	3211.4	3096.11	160.71	149.6	158.03	147.37	3.801	2.89	176.78	134.2
Inner London	Pyrus	4,899	4898	377.46	377.42	39.5	39.5	37.95	37.95	0.508	0.51	38.07	38.07
Inner London	Griselinia littoralis	44,089	44085	2354.89	2354.65	172.72	172.7	158.52	158.5	0.931	0.93	69.71	69.71
Inner London	Prunus domestica	9,798	9797	229.29	229.26	49.71	49.71	48.67	48.67	0.594	0.59	45.99	45.99
Inner London	Sorbus aucuparia	14,696	8441	1164.78	801.58	113.7	71.24	108.94	68.04	1.251	0.95	99.26	75.44
Inner London	Magnolia	4,899	4898	570.35	570.3	49.6	49.59	47.29	47.28	0.314	0.31	21.01	21
Inner London	Prunus sargentii	14,696	10931	329.22	266.28	29.93	29.92	8.89	35.17	0.161	0.16	12.43	12.43
Inner London	Alnus cordata	19,595	11948	2843.39	2084.71	172.3	112.1	161.27	104.15	2.62	1.86	190.98	135.4
Inner London	Ficus	4,899	4898	329.41	329.38	36.42	36.41	35.05	35.05	0.541	0.54	40.52	40.52
Inner London	Salix alba	4,899	4898	140.43	140.42	26.04	26.03	25.42	25.41	1.982	1.98	125.53	125.5

Table A.2 Case Study London Urban Forest - Carbon By Species Inner London - Valuing London's Urban Forest Results of the London i-Tree Eco Project

Total Estimates for Trees in London by Land Use and Species													
Series: City	Time Period: 2014			stored tonnes		tonnes							
		Number of Trees		Carbon (¹mt)		Gross Seq (¹mt/yr)		Net Seq (¹mt/yr)		Leaf Area (km2)		Leaf Biomass (¹mt)	
Land Use	Species	Val	Standard Error	Val	SE	Val	SE	Val	SE	Val	SE	Val	SE

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Inner London	Acer saccharinum	9,798	6910	6581.83	5028.08	137.05	99.35	115.03	82.25	5.638	4.84	296.73	254.9
Inner London	Robinia pseudoacacia	19,595	19593	3361.72	3361.38	156.98	157	141.6	141.59	1.628	1.63	87.65	87.64
Inner London	Betula utilis	4,899	4898	162.32	162.31	30.44	30.44	29.72	29.72	0.149	0.15	8.86	8.86
Inner London	Prunus pissardii	4,899	4898	1939.81	1939.61	75.7	75.69	71.26	71.25	1.486	1.49	114.94	114.9
Inner London	Laurus	9,798	6910	2336.7	1815.98	136.21	98.51	126.99	91.54	0.346	0.27	25.94	20
Inner London	Populus nigra	9,798	6910	14936.34	14116.8	265.92	219.9	231.09	188.53	4.582	4.28	330.43	308.7
Inner London	Thuja plicata	9,798	6910	62.17	59.16	3.9	3.55	3.65	3.32	0.393	0.38	75.55	72.97
Inner London	Fagus	4,899	4898	5662.97	5662.39	170.71	170.7	148.98	148.96	6.149	6.15	307.71	307.7
Inner London	Populus alba	4,899	4898	2532.22	2531.96	77.13	77.13	71.39	71.38	1.006	1.01	87.52	87.51
Inner London	Pyrus communis	4,899	4898	103.05	103.04			-28.33	28.33				
Inner London	Fagus orientalis	14,696	14695	5676.24	5675.66	277.7	277.7	255.52	255.49	4.55	4.55	227.66	227.6
Inner London	Malus domestica	14,696	14695	5090.83	5090.31	180.14	180.1	142.86	142.85	2.132	2.13	183.77	183.8
Inner London	Prunus subhirtella	14,696	10931	2520.78	2332.64	186.65	156.4	184.81	154.7	0.396	0.38	30.61	29.37
Inner London	Quercus/live ilex	14,696	10931	3382.24	2794.6	142.19	104.3	133.34	97.61	1.874	1.58	184.97	156
Inner London	Rhododendron	14,696	14695	294.78	294.75	31.64	31.64	29.66	29.66	0.088	0.09	17.68	17.67
Inner London	Amelanchier arborea	4,899	4898	97.69	97.68	12.26	12.26	11.85	11.85	0.036	0.04	2.17	2.17
Inner London	Cotoneaster	4,899	4898	163.86	163.84	27.99	27.98	27.27	27.27	0.318	0.32	23.82	23.81
Inner London	Laburnum	4,899	4898	332.78	332.75	36.68	36.68	35.31	35.3	0.357	0.36	26.77	26.76
Inner London	Ulmus procera	4,899	4898	168.3	168.28			-27.35	27.34				
Inner London	Catalpa bignonioides	9,798	6910	17177.12	16439	286.6	249.6	248.16	213.13	1.612	1.14	86	60.77
Inner London	Quercus petraea	9,798	6910	32509.2	25697.5	368.51	260	269.8	190.28	8.312	7.22	820.34	712.3
Inner London	Acer cappadocicum	4,899	4898	559.96	559.91	32.31	32.3	31	31	1.311	1.31	73.78	73.78
Inner London	Betula borealis	4,899	4898	135.35	135.34	16.1	16.09	15.53	15.53	0.261	0.26	15.5	15.5
Inner London	Betula papyrifera	4,899	4898	392.51	392.47	46.39	46.38	44.75	44.75	0.084	0.08	5.85	5.85
Inner London	Cercis	4,899	4898	44.02	44.02	13.44	13.44	13.22	13.22	0.07	0.07	4.46	4.46
Inner London	Cupressus sempervirens	4,899	4898	56.61	56.6	11.38	11.38	11.13	11.13	0.03	0.03	4.65	4.65
Inner London	Eucalyptus	4,899	4898	573.94	573.88	49.05	49.04	46.73	46.72	0.439	0.44	56.76	56.76
Inner London	Lawsonia	4,899	4898	344.2	344.16	37.47	37.46	36.05	36.04	0.053	0.05	3.95	3.95
Inner London	Larix decidua	4,899	4898	398.52	398.48	19.41	19.41	17.86	17.86	2.441	2.44	131.57	131.6
Inner London	Laurus nobilis	4,899	4898	323.38	323.34	23.94	23.94	23.18	23.18	0.368	0.37	27.54	27.54
Inner London	Liquidambar	4,899	4898	487.12	487.07	18.29	18.29	16.41	16.41	1.718	1.72	78.85	78.84
Inner London	Pinus nigra ssp. salzmannii	4,899	4898	361.87	361.83	24.92	24.92	23.48	23.48	0.348	0.35	33.56	33.55
Inner London	Prunus cerasifera var. nigra	4,899	4898	3320.15	3319.81	134.29	134.3	121.42	121.4	1.455	1.46	112.55	112.5
Inner London	Salix caprea	4,899	4898	81.81	81.81	11.13	11.13	10.93	10.92	0.329	0.33	20.81	20.81
Inner London	Ulmus x hollandica	4,899	4898	2010.51	2010.3	65.95	65.94	61.38	61.37	0.545	0.55	37.09	37.09
Inner London	Viburnum rhytidophyllum	4,899	4898	2324	2323.76	77.27	77.26	71.98	71.98	0.401	0.4	30.05	30.04
Inner London	Total	1,587,205	226798	498999.62	73679.2	15922.74	1815	11471.02	2987.4	216.96	26.3	15228.52	1903

Table A.2 Case Study London Urban Forest - Carbon By Species Inner London- Valuing London's Urban Forest Results of the London i-Tree Eco Project

Total Estimates for Trees in London by Land Use and Species													
Series: City	Time Period: 2014			stored tonnes		tonnes							
		Number of Trees		Carbon (¹mt)		Gross Seq (¹mt/yr)		Net Seq (¹mt/yr)		Leaf Area (km2)		Leaf Biomass (¹mt)	
Land Use	Species	Val	Standard Error	Val	SE	Val	SE	Val	SE	Val	SE	Val	SE

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Outer London	Acer pseudoplatanus	577,704	109778	176156.58	50040.5	6382.11	1512	5521.51	1340	103.358	23.3	7227.85	1626
Outer London	Quercus robur	564,575	134626	418644.76	119539	10159.72	2636	8979.78	2438.7	89.616	19.7	5966.42	1314
Outer London	Betula pendula	452,973	186525	55723.47	22704	3384.92	1153	3181.47	1101.3	39.775	14.7	2362.23	870.5
Outer London	Crataegus monogyna	466,102	155673	39325.04	16778	2173.23	817	1946.6	696.78	23.798	8.01	2993.47	1007
Outer London	Fraxinus excelsior	374,195	95842	163217.17	64107.6	3816.95	1039	2895.75	796.37	59.763	16.3	6357.81	1731
Outer London	Malus	242,898	51892	17661.51	4864.43	1576.16	353.2	1480.84	332.68	10.061	3.08	867.34	265.1
Outer London	Cupressus	295,417	72905	23897.96	6803.06	1402.9	362	1310.29	336.88	29.43	8.51	4608.85	1332
Outer London	Fraxinus	249,463	90386	40385.18	18612.8	1883.19	689.6	1757.61	649.46	28.868	14.6	2600.74	1320
Outer London	Salix	256,028	92941	131627.6	60999.4	2015.69	659.5	1646.38	528.03	35.249	12.5	2175.89	772.6
Outer London	Prunus	196,945	41698	27957.59	9025.19	1813.1	466.6	1716.17	443.65	14.02	4.56	1084.78	352.6
Outer London	Prunus avium	236,334	61467	28632.03	9452.48	1966.66	531.2	1863.21	502.35	20.098	6.69	1555.04	517.6
Outer London	Quercus	170,685	65279	113864.87	50270.7	2342.6	908.5	2081.6	871.63	33.681	12.6	3323.93	1241
Outer London	Acer platanoides	164,121	83061	22540.74	7679.27	1209.48	390.6	1150.49	374.77	23.81	9.17	1285.09	494.7
Outer London	Betula	6,565	6564	350.29	350.26	46.7	46.7	46.44	46.43	0.111	0.11	6.92	6.92
Outer London	Castanea	157,556	105314	92945.96	74443.4	1929.86	1243	1749.52	1097.2	22.738	13	1594.05	909
Outer London	Cupressocyparis leylandii	150,991	69532	13470.29	6530.78	596.53	272.6	433.69	233.2	12.311	6.14	1927.97	961.9
Outer London	Ilex	85,343	28395	4609.92	1759.18	510.64	180.8	487.67	172.38	3.425	1.34	457.83	178.7
Outer London	Tilia x vulgaris	39,389	22696	9671.56	5107.49	397.92	205.8	365.2	189.15	7.573	4.48	352.23	208.5
Outer London	Carpinus betulus	78,778	32003	23097.21	10953.3	791.63	339.6	652.77	330.51	11.232	5.73	676.65	345.2
Outer London	Platanus hybrida	45,954	23605	69991.53	40667.4	1178.24	596.2	1051.52	551.62	20.808	13.3	908.67	580.4
Outer London	Tilia cordata	72,213	39842	26043.06	17537.2	852.82	535.1	750.52	465.96	17.011	11.6	1274.24	865.8
Outer London	Acer campestre	91,908	38100	9070.63	4823.04	602.39	316.6	563.65	298.52	9.087	4.4	511.46	247.7
Outer London	Chamaecyparis	78,778	60122	7439.06	6030.89	429.23	357.7	396.61	333.86	6.337	5.62	1584.25	1405
Outer London	Ulmus	78,778	35823	2691.4	1375.63	148.46	78.04	36.26	87.98	1.699	0.84	115.69	57.22
Outer London	Sambucus nigra	78,778	27662	5009.77	2417.61	270.86	104.7	-91.29	270.22	2.933	1.38	219.62	103.3
Outer London	Aesculus hippocastanum	59,083	23549	27285.06	13595	892.9	398.8	720.74	323.47	10.379	4.74	725.8	331.3
Outer London	Taxus baccata	72,213	26906	15076.74	7547.98	485.51	219.9	436.08	195.27	19.399	8.59	3037.93	1345
Outer London	Pinus	59,083	21638	13700.56	7960.62	373.96	165.6	307.67	137.22	8.171	4.43	787.49	426.8
Outer London	Populus x canescens	65,648	65643	7647.32	7646.74	348.53	348.5	343.12	343.09	2.718	2.72	196.13	196.1
Outer London	Prunus spinosa	65,648	48198	2515.52	2185.13	172.58	139.5	137	105.23	2.012	1.71	155.69	132.5
Outer London	Sorbus	39,389	18504	2167.77	1136.12	212.71	117.7	191.22	117.04	1.655	1.07	131.32	84.65
Outer London	Quercus cerris	59,083	59079	11735.01	11734.1	570.73	570.7	543.64	543.6	1.653	1.65	163.13	163.1
Outer London	Taxus	32,824	17325	1372.25	1035.76	71.77	42.37	69.61	41.21	2.436	1.43	381.48	223.9
Outer London	Fagus sylvatica	52,519	26181	9078.46	5578.1	518.68	295.8	500.6	285.16	9.611	5.37	480.96	268.8
Outer London	Picea abies	52,519	29294	5811.1	2879.29	324.44	146.8	303.57	136.74	7.723	4.61	1287.09	769
Outer London	Tilia	26,259	16053	7519.68	5673.85	306.53	200.1	277.37	179.33	6.752	4.41	314.02	205.2
Outer London	Pyrus	39,389	18504	3461.15	1591.76	280.44	140.6	168.25	164.63	2.984	1.67	223.42	125.3
Outer London	Prunus domestica	32,824	14622	3725.55	2680.63	283.42	158.3	268.38	148.15	0.739	0.51	57.2	39.75
Outer London	Sorbus aucuparia	26,259	16053	1796.28	1327.08	164.88	99.63	158.89	95.28	0.809	0.52	64.17	41.18
Outer London	Alnus	39,389	27823	13269.52	9373.64	505.59	357.2	485.65	343.05	6.845	5.16	378.18	285
Outer London	Corylus avellana	39,389	18504	2125.62	1171.94	207.29	105.9	201.07	102.56	2.926	1.74	203.16	120.5
Outer London	Ilex aquifolium	39,389	22696	936.84	597.88	97.58	59.18	96.87	58.74	2.144	1.49	286.59	199.2
Outer London	Ostrya	39,389	39386	10906.31	10905.5	416.61	416.6	408.94	408.91	4.176	4.18	272.63	272.6
Outer London	Prunus cerasifera	39,389	18504	2426.09	1490.43	276.48	143.6	270.61	140.76	1.519	0.96	92.26	58.39
Outer London	Prunus laurocerasus	39,389	22696	2492.61	1324.89	297.61	154.5	287.21	149.17	0.896	0.53	69.29	41.13
Outer London	Magnolia	32,824	14622	1727.25	892.98	203.94	96.08	196.74	92.47	1.726	0.93	115.3	62.26

Table A.3 Case Study London Urban Forest - Carbon By Species Outer London- Valuing London's Urban Forest Results of the London i-Tree Eco Project

Total Estimates for Trees in London by Land Use and Species													
Series: City	Time Period: 2014			stored tonnes		tonnes							
		Number of Trees		Carbon (¹mt)		Gross Seq (¹mt/yr)		Net Seq (¹mt/yr)		Leaf Area (km2)		Leaf Biomass (¹mt)	
Land Use	Species	Val	Standard Error	Val	SE	Val	SE	Val	SE	Val	SE	Val	SE

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Outer London	Prunus sargentii	19,694	11348	3410.63	2627.19	204.53	126.9	194.1	119.09	2.259	1.4	174.82	108.6
Outer London	Juglans regia	32,824	19659	10575.99	6286.19	537.24	320.3	482.98	291.43	13.123	7.79	553.12	328.5
Outer London	Pinus sylvestris	32,824	27053	3542.5	3514.23	141.19	134.7	138.59	132.24	4.302	4.15	414.61	399.5
Outer London	Alnus cordata	13,130	9274	2490.44	2395.14	139.9	118.5	130.47	109.36	3.49	3.13	254.47	228
Outer London	Ficus	26,259	16053	2746.57	1992.52	216.34	137.6	205.3	130.18	1.632	1.39	122.18	104.2
Outer London	Salix alba	26,259	20746	5044.92	4841.17	239.03	206	234.71	202.51	3.664	3.66	232.07	231.9
Outer London	Acer saccharinum	19,694	14667	4861.59	3470.18	168.54	120.6	160.79	115.84	2.906	2.26	152.94	118.7
Outer London	Prunus serrulata	26,259	13091	4308.59	3812.45	262.26	174	257.23	171.06	0.677	0.39	52.4	30.27
Outer London	Robinia pseudoacacia	6,565	6564	1374.25	1374.15	84.37	84.37	78.94	78.93	1.538	1.54	82.83	82.82
Outer London	Betula utilis	19,694	14667	716.89	506.52	120.36	87.13	118.02	85.62	1.124	0.89	66.78	52.94
Outer London	Prunus pissardii	19,694	11348	3417.16	2345.49	250.01	152.4	243.91	148.71	2.131	1.57	164.92	121.6
Outer London	Laurus	13,130	13129	712.78	712.73	81.69	81.69	78.73	78.73	2.22	2.22	166.26	166.3
Outer London	Populus nigra	13,130	9274	19669.34	14105.5	504.28	373.2	441.75	325.6	0.92	0.66	66.36	47.4
Outer London	Thuja plicata	13,130	9274	2610.25	2577.12	61.9	58.36	51.94	48.55	5.874	5.86	1129.69	1128
Outer London	Trachycarpus	19,694	11348	82.49	53.2	1.86	1.35	1.53	1.18	0.698	0.54	116.99	90.21
Outer London	Fagus	13,130	9274	39565.06	39386	103.11	75.52	-44.68	89.29	21.142	21	1057.98	1053
Outer London	Populus alba	13,130	13129	3027.05	3026.82	119.55	119.5	112.62	112.62	1.811	1.81	157.5	157.5
Outer London	Pyrus communis	13,130	9274	453.47	336.48	69.64	49.55	67.69	48.14	0.307	0.28	23.01	20.85
Outer London	Alnus glutinosa	13,130	9274	6703.42	6637.86	222.8	212	197.22	186.54	1.055	1	76.91	72.87
Outer London	Carpinus	13,130	9274	13302.8	12951.7	403.1	374.9	352.62	325.32	5.316	4.78	320.27	288.2
Outer London	Crataegus crus-galli	13,130	9274	957.06	765.36	103.33	75.45	101.81	74.49	0.424	0.34	31.93	25.72
Outer London	Fraxinus angustifolia	13,130	9274	6434.52	4818.82	232.57	167.9	214.37	153.33	3.731	2.81	265.62	200.4
Outer London	Gleditsia	13,130	13129	3751.08	3750.79	154.23	154.2	145.64	145.63	1.76	1.76	184.25	184.2
Outer London	Juniperus	13,130	9274	317.65	258.9	36.67	26.99	35.35	25.95	0.203	0.15	56.49	42.86
Outer London	Liriodendron tulipifera	13,130	9274	4246.69	3004.87	197.83	139.8	181.27	128.11	1.243	0.88	73.25	52.07
Outer London	Olea	13,130	9274	304.68	246.47	56.77	42.38	55.43	41.32	0.545	0.45	40.82	33.47
Outer London	Prunus padus	13,130	9274	1908.28	1789.34	135.09	109.6	133.24	108.19	0.344	0.28	26.64	21.57
Outer London	Viburnum tinus	13,130	13129	334.62	334.6	35.1	35.1	-0.77	0.77	0.432	0.43	32.34	32.33
Outer London	Amelanchier arborea	6,565	6564	83.05	83.05	21.63	21.63	21.56	21.56	0.027	0.03	1.67	1.67
Outer London	Cotoneaster	6,565	6564	62.95	62.95	18.46	18.46	18.16	18.16	0.346	0.35	25.94	25.94
Outer London	Laburnum	6,565	6564	219.58	219.57	37.5	37.5	35.16	35.15	0.022	0.02	1.63	1.63
Outer London	Ulmus procera	6,565	6564	113.12	113.11			-31.1	31.1				
Outer London	Acer palmatum	6,565	6564	40.92	40.91	11.93	11.93	11.65	11.65	0.04	0.04	2.24	2.23
Outer London	Acacia	6,565	6564	496.03	496	33.5	33.5	31.53	31.53	0.495	0.5	119.6	119.6
Outer London	Amelanchier	6,565	6564	55.98	55.98	17.35	17.34	17.07	17.07	0.05	0.05	3.77	3.77
Outer London	Amelanchier canadensis	6,565	6564	83.73	83.73	21.76	21.76	21.37	21.37	0.129	0.13	9.74	9.74
Outer London	Ceanothus	6,565	6564	107.52	107.51	24.56	24.56	23.36	23.36	0.112	0.11	8.4	8.4
Outer London	Cercis siliquastrum	6,565	6564	129.06	129.05	27.75	27.74	27.16	27.16	0.146	0.15	9.33	9.33
Outer London	Chamaecyparis lawsoniana	6,565	6564	566.43	566.38	36.22	36.22	33.98	33.97	0.385	0.39	96.35	96.35
Outer London	Clerodendrum	6,565	6564	103.02	103.01	24.37	24.37	24.29	24.28	0.124	0.12	9.28	9.28
Outer London	Cordyline australis	6,565	6564	12.05	12.05	0.47	0.47	0.42	0.42	0.073	0.07	12.18	12.18
Outer London	Corylus colurna	6,565	6564	759.8	759.74	66.89	66.89	66.33	66.33	0.311	0.31	21.63	21.62
Outer London	Crataegus pedicellata	6,565	6564	85.07	85.07	22.01	22.01	21.94	21.93	0.123	0.12	9.28	9.28
Outer London	Cupressus macrocarpa aurea	6,565	6564	22.22	22.22	5.84	5.84	5.69	5.69	0.025	0.03	3.95	3.95
Outer London	Frangula	6,565	6564	94.3	94.3	21.76	21.76	21.33	21.33	0.353	0.35	26.42	26.42
Outer London	Larix leptolepis	6,565	6564	935.93	935.86	37.4	37.39	36.74	36.73	0.698	0.7	45.06	45.05
Outer London	Litchi chinensis	6,565	6564	526.39	526.35	53.35	53.34	51.19	51.18	0.318	0.32	23.78	23.78
Outer London	Phoenix	6,565	6564	26.14	26.14	0.96	0.96	0.86	0.86	0.065	0.07	10.93	10.93
Outer London	Picea	6,565	6564	460.69	460.65	28.03	28.03	27.7	27.7	0.331	0.33	56.19	56.19
Outer London	Platanus x acerifolia	6,565	6564	3349.78	3349.52	140.85	140.8	138.49	138.48	1.389	1.39	63.81	63.81
Outer London	Populus	6,565	6564	33027.38	33024.9	412.3	412.3	338.67	338.65	5.053	5.05	341.41	341.4
Outer London	Prunus lusitanica	6,565	6564	1417.78	1417.67	104.39	104.4	98.72	98.72	0.075	0.08	5.82	5.82
Outer London	Salix x sepulcralis Simonkai	6,565	6564	2523.18	2522.99	119.2	119.2	109.35	109.35	1.476	1.48	93.53	93.52
Outer London	Sequoia	6,565	6564	344.55	344.52	8.68	8.68	6.37	6.37	0.047	0.05	7.33	7.33
Outer London	Tamarix	6,565	6564	216.77	216.75	37.16	37.16	36.22	36.21	0.318	0.32	23.85	23.85
Outer London	Tilia euchlora	6,565	6564	3344.53	3344.27	114.01	114	101.12	101.11	7.142	7.14	332.16	332.1
Outer London	Tilia platyphyllos	6,565	6564	592.49	592.45	48.13	48.12	47.69	47.69	1.403	1.4	83.03	83.02
Outer London	Washingtonia robusta	6,565	6564	76.56	76.55	1.47	1.47	1.18	1.18	0.425	0.43	65.62	65.61
Outer London	Total	6,833,979	577805	1867549.67	224725	61275.4	5362	54062.49	4863.8	830.441	73.9	69073.63	6276
CITY TOTAL	Total	8,421,185	620722	2366549.29	236495	77198.14	5661	65533.51	5708	1047.401	78.5	84302.15	6558

Table A.3 Case Study London Urban Forest - Carbon By Species Outer London- Valuing London's Urban Forest Results of the London i-Tree Eco Project

Specie	Frequenza %	Superfice fogliare %	V.I.
Platanus x acerifolia	10,80	34,30	45,10
Ailanthus altissima	22,00	6,70	28,70
Robinia pseudoacacia	14,70	4,20	18,90
Pinus pinea	2,70	11,00	13,70
Prunus cerasifera	8,70	4,20	12,80
Populus x canadensis	5,80	6,00	11,80
Ulmus minor	6,10	4,60	10,70
Quercus ilex	3,80	6,50	10,20
Tilia platyphyllos	2,70	5,00	7,70
Populus alba	5,00	1,20	6,20
Juglans regia	1,60	4,60	6,20
Celtis australis	1,30	1,30	2,50
Acer negundo	1,40	1,00	2,40
Prunus spinosa	1,40	0,90	2,30
Salix alba	1,30	0,90	2,20
Crataegus monogyna	1,20	0,90	2,10
Ficus carica	0,50	1,60	2,10
Pyrus communis	1,80	0,30	2,10
Fraxinus ornus	1,80	0,20	2,00
Corylus avellana	0,90	1,00	1,80
Laurus nobilis	0,90	0,70	1,60
Punica granatum	0,50	0,60	1,10
Maclura pomifera	0,20	0,90	1,00
Quercus robur	0,50	0,40	0,90
Malus sylvestris	0,50	0,30	0,80
Thuja occidentalis	0,50	0,20	0,70
Prunus persica	0,20	0,20	0,40
Acer campestre	0,20	0,20	0,40
Gleditsia triacanthos	0,20	0,20	0,30
Pinus pinaster	0,20	0,20	0,30
Pyracantha coccinea	0,20	0,10	0,30
Ligustrum lucidum	0,20	0,00	0,20
Olea europaea	0,20	0,00	0,20

Table A.4 Case Study Aguzzano Park – Value of Importance (VI) – Valutazione dei servizi ecosistemici nel Parco Regionale Urbano di Aguzzano

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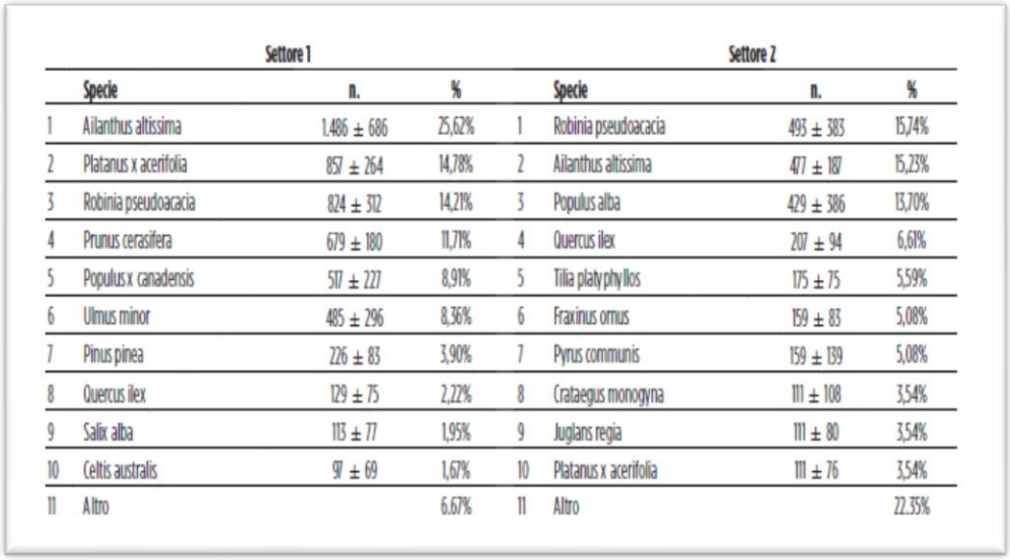

	Settore 1			Settore 2		
	Specie	n.	%	Specie	n.	%
1	Ailanthus altissima	1.486 ± 686	25,62%	Robinia pseudoacacia	493 ± 383	15,74%
2	Platanus x acerifolia	857 ± 264	14,78%	Ailanthus altissima	477 ± 187	15,23%
3	Robinia pseudoacacia	824 ± 312	14,21%	Populus alba	429 ± 386	13,70%
4	Prunus cerasifera	679 ± 180	11,71%	Quercus ilex	207 ± 94	6,61%
5	Populus x canadensis	517 ± 227	8,91%	Tilia platyphyllos	175 ± 75	5,59%
6	Ulmus minor	485 ± 296	8,36%	Fraxinus ornus	159 ± 83	5,08%
7	Pinus pinea	226 ± 83	3,90%	Pyrus communis	159 ± 139	5,08%
8	Quercus ilex	129 ± 75	2,22%	Crataegus monogyna	111 ± 108	3,54%
9	Salix alba	113 ± 77	1,95%	Juglans regia	111 ± 80	3,54%
10	Celtis australis	97 ± 69	1,67%	Platanus x acerifolia	111 ± 76	3,54%
11	Altro		6.67%	Altro		22.35%

Table A.5 Case Study Aguzzano Park – Plants Distribution by Land Use and Species – Valutazione dei servizi ecosistemici nel Parco Regionale Urbano di Aguzzano

Zone 1				
Ailanthus altissima	1,486	±	686	25,62%
Platanus x acerifolia	857	±	264	14,78%
Robinia pseudoacacia	824	±	312	14,21%
Prunus cerasifera	679	±	180	11,71%
Populus x canadensis	517	±	227	8,91%
Ulmus minor	485	±	296	8,36%
Pinus pinea	226	±	83	3,90%
Quercus ilex	129	±	75	2,22%
Salix alba	113	±	77	1,95%
Celtis australis	97	±	69	1,67%
Altro				6,67%
Zone 2				
Robinia pseudoacacia	493	±	383	15,74%
Ailanthus altissima	477	±	187	15,23%
Populus alba	429	±	386	13,70%
Quercus ilex	207	±	94	6,61%
Tilia platyphyllos	175	±	75	5,59%
Fraxinus ornus	159	±	83	5,08%
Pyrus communis	159	±	139	5,08%
Crataegus monogyna	111	±	108	3,54%
Juglans regia	111	±	80	3,54%
Platanus x acerifolia	111	±	76	3,54%
Altro				22,35%

Table A.6 Case Study Aguzzano Park – Plants Distribution by Land Use and Species – Valutazione dei servizi ecosistemici nel Parco Regionale Urbano di Aguzzano

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 21 December 2021 doi:10.20944/preprints202112.0336.v1

Species	Carbon Storage (tonne)	Carbon Storage (%)	CO_2 Equivalent (tonne)	Gross Carbon Sequestration (tonne/yr)	CO_2 Equivalent (tonne/yr)
Acer campestre	0.30	0,0%	1.00	0.04	0.15
Acer negundo	6.30	0,5%	23.10	0.51	1.87
Ailanthus altissima	36.30	3,0%	133.00	5.22	19.13
Celtis australis	5.70	0,5%	21.00	0.62	2.28
Corylus avellana	1.90	0,2%	6.90	0.39	1.44
Crataegus monogyna	1.10	0,1%	3.90	0.26	0.96
Ficus carica	4.50	0,4%	16.60	0.60	2.21
Fraxinus ornus	0.30	0,0%	1.10	0.19	0.71
Gleditsia triacanthos	0.40	0,0%	1.50	0.12	0.43
Juglans regia	4.60	0,4%	16.80	0.59	2.16
Laurus nobilis	6.80	0,6%	24.80	0.59	2.16
Ligustrum lucidum	0.50	0,0%	1.90	0.05	0.20
Maclura pomifera	6.40	0,5%	23.40	0.45	1.66
Malus sylvestris	0.70	0,1%	2.40	0.11	0.41
Olea europaea	0.10	0,0%	0.20	0.01	0.05
Pinus pinea	135.70	11,4%	497.70	5.51	20.21
Pinus pinaster	6.30	0,5%	23.30	0.25	0.92
Platanus acerifolia 'Columbia'	611.80	51,3%	2243.40	24.70	90.57
Populus alba	6.40	0,5%	23.30	1.17	4.30
Populus x canadensis	170.30	14,3%	624.60	11.02	40.43
Prunus cerasifera	26.20	2,2%	96.00	2.67	9.78
Prunus persica	4.00	0,3%	14.70	0.46	1.67
Prunus spinosa	4.70	0,4%	17.10	0.54	1.99
Punica granatum	0.50	0,0%	1.90	0.11	0.42
Pyrus communis	0.40	0,0%	1.60	0.28	1.04
Pyracantha coccinea	0.10	0,0%	0.40	0.02	0.08
Quercus Quercus/live ilex	78.70	6,6%	288.50	6.20	22.75
Quercus robur	0.80	0,1%	3.00	0.24	0.87
Robinia pseudoacacia	28.30	2,4%	103.60	3.53	12.95
Salix alba	7.10	0,6%	26.20	0.97	3.57
Thuja occidentalis	0.50	0,0%	2.00	0.08	0.31
Tilia platyphyllos	7.30	0,6%	26.90	0.87	3.18
Ulmus minor	26.60	2,2%	97.50	1.56	5.74
Total	**1191.60**	**100%**	**4369.50**	**69.97**	**256.59**

Table A.7 Case Study Aguzzano Park – Carbon Storage and Sequestration – Valutazione dei servizi ecosistemici nel Parco Regionale Urbano di Aguzzano

References

1. **Leicester, Andrew, Peter Levell and Imran Rasul .** *Tax and benefit policy: insights from behavioural economics.* The Institute for Fiscal Studies. London : s.n., 2012.

2. **Asmis, Elizabeth.***The state as a partnership: cicero's definition of "res publica" in his work "on the state".* 4, s.l. : JSTOR, 2004, History of Political Thought, Vol. 25, pp. 569-598.

3. **Agency, European Environment.** *Environmental Taxes Implementation and Environmenta lEffectiveness.* Copenhagen : EEA, 1996.

4. **OECD.** *Taxation, Innovation and the Environment.* Paris : OECD Publishing, 2010.

5. **World Bank Group.** *2019. State and Trends of Carbon Pricing 2019.* Washington, DC : World Bank, 2019.

6. **Criqui, Patrick, Jaccard , Mark and Sterner, Thomas.** 22, s.l.*Carbon Taxation: A Tale of Three Countries.* : MDPI, 2019, Sustainability, Vol. 11.

7. **Leiserowitz, A, et al.** Climate Change in the American Mind: April 2020. [Online] 20 April 2020. [Cited: 6 January 2021.] https://climatecommunication.yale.edu/publications/climate-change-in-the-american-mind-april-2020/.

8. **Colback, Lucy.** The role of business in climate change. *Financial Times.* 18 December 2020.

9. **Mauracher, Christine, Procidano, Isabella and Valentini, Marco.** 5, s.l.*How Product Attributes and Consumer Characteristics Influence the WTP, Resulting in a Higher Price Premium for Organic Wine.* : MDPI, 2019, Sustainability, Vol. 11.

10. **Yokessa, Maïmouna and Stéphan Marette.** *A Tax Coming from the IPCC Carbon Prices CannotChange Consumption: Evidence from an Experiment.* 18, 2019, Sustainability, Vol. 11.

11. **Poortinga, Wouter and Louise Whitaker.** *Promoting the Use of Reusable Coffee Cups through Environmental Messaging, the Provision of Alternatives and Financial Incentives.* 3, 2018, Sustainability, Vol. 10.

12. **House of Commons Environmental Audit Committee.** Disposable Packaging: Coffee Cups Second Report of Session 2017–19. *Report, together with formal minutes relating to the report Ordered by the House of Commons .* London : House of Commons, 19 Decembre 2017.

13. **Italian Parliament.** Legislative Decree 20 giugno 2017, n. 91 and Conversion law n. 123 of 3 August 2017. *Gazzetta Ufficiale - Serie generale.* Rome : s.n., 20 June 2017. 141.

14. **HMRC.** Claim Income Tax reliefs. [Online] May 2020. https://www.gov.uk/income-tax-reliefs.

15. **Investopedia.** Tax Relief. [Online] 18 Jan 2021. https://www.investopedia.com/terms/t/tax-relief.asp.

16. **Foundation, The Renewable Energy.** The Renewable Energy Foundation, Gift Aid explained. [Online] chrome-extension://oemmndcbldboiebfnladdacbdfmadadm/https://www.ref.org.uk/attachments/article/50/giftaid_explained_5.pdf.

17. **HMRC.** *Table 5: Donations declared by individuals completing UK Self Assessments, by tax year.* 2019.

18. **NAO University of Birmingham Tax Centre.** Who benefits from Gift Aid? Ask the new Tax Centre. [Online] NAO University of Birmingham Tax Centre, 8 February 2018. https://www.nao.org.uk/naoblog/gift-aid-and-the-tax-centre/.

19. **HM Government.** *Giving White Paper.* London : s.n., 2011.

20. *Explaining Variations in Public Acceptability of Road Pricing Schemes.* **Jaensirisak, S, Wardman, M and May, A. D.** 2, May 2005, Journal of Transport Economics and Policy, Vol. 39, pp. 127-153.

21. **Smith, Sarah.** *Increasing charitable giving – what can we learn from economics?* Centre for Market and Public Organisation, Bristol Institute of Public Affairs University of Bristol. Bristol : s.n., 2012. pp. 6 -18, Working Paper No. 12/291.

22. **European Commission,.** EU Environment Action Programme to 2020. [Online] European Commission. https://ec.europa.eu/environment/action-programme/.

23. **Harris, N L, et al.** *Global maps of twenty-first century forest carbon fluxes.* 21 January 2021, Nature Climate Change, Vol. 11, pp. 234-240.

24. **Game , E.T., et al.***Cross-discipline evidence principles for sustainability policy.* s.l. : Springer Nature, 1 September 2018, Nature Sustainability, Vol. 1, pp. 452–454.

25. **Busch, J and et al.***Reforestation is a Cost-Effective Climate Solution.* 6, 2019, Nature Climate Change,, Vol. 9, p. 463.

26. **BuschJ, et al** *Potential for low-cost carbon dioxide removal through tropical reforestation.*. 6, 2019, Nature Climate Change volume, Vol. 9, pp. 463-466.

27. **Busch, J and et Al.** 7*Monitoring and evaluating the payment-for-performance premise of REDD+: the case of India's ecological fiscal transfers.*, s.l. : Taylor Francis, 2018, Ecosystem Health and sustainabilitS, Vol. 4, pp. 169-175.

28. **Loft, L, et al.** 1,*Risks to REDD+: potential pitfalls for policy design and implementation.* 2017, Environmental Conservation, Vol. 44, pp. 44-55.

29. **Busch et, Busch, J and et Al.** 7,*Monitoring and evaluating the payment-for-performance premise of REDD+: the case of India's ecological fiscal transfers.* **Al,** 16 June 2018, Ecosystem Health and Sustainability, Vol. 4, pp. 169-175.

30. **Funk , J M, et al.** 7*Securing the climate benefits of stable forests.*, London : s.n., 15 April 2019, Climate Policy, Vol. 19, pp. 845-860.

31. **Federal Ministry of Food and Agriculture.** *German Forestry.* s.l. : Federal Ministry of Food and Agriculture, 2021.

32. **De Vries, G** *Public Communication as a Tool to Implement Environmental Policies.*. 1, 6 November 2019, Vol. 14, pp. 244-272.

33. **OECD.** Behavioural Insights and Public Policy Lessons from Around the World. s.l. : OECD Publishing, 2017, pp. 17-25.

34. **World Bank Group.** *World Development Report 2015 : Mind, Society, and Behavior.* Washington, DC: : World Bank, 2015.

35. **Lunn, Pete.** Regulatory Policy and Behavioural Economics. 2014, pp. 35-52.

36. **Hertwig, R and Grüne-Yanoff, T.***Nudging and Boosting: Steering or Empowering Good Decisions.* 6, 2017, Perspectives on Psychological Science, Vol. 12, p. 174569161770249.

37. **Flamholtz, Eric G.** The Role of Reward Systems in Control. *Effective Management Control.* Boston, MA : Springer, 1996, pp. 99-115.

38. **OECD** *Global Forum on Environment and Economic Growth OECD 24/25 October 2016.*. Paris : s.n., 2016. Towards Quantifying the Links Between Environment and Economic Growth.

39. **Eurostat the statistical office of the EU.** Environmental tax revenues Eurostat. [Online] E2: Environmental statistics and accounts, sustainable development, 03 December 2020. https://ec.europa.eu/eurostat/statistics-explained/index.php/Environmental_tax_statistics.

40. **OECD.** Environmentally related tax revenue. [Online] OECD.Stat, 20 December 2020. [Cited: 25 January 2021.] https://stats.oecd.org/viewhtml.aspx?datasetcode=ERTR&lang=en.

41. **Assembly Mayor of London.** Publicattion London UPlan Dec 2020. [Online] 10 Decembre 2020. [Cited: 9 March 2021.] https://www.london.gov.uk/what-we-do/planning/london-plan/new-london-plan/publication-london-plan.

42. **Forest Research.** COMMUNITREE: Connecting tree databases to the public, improving urban tree data for business, government and research. [Online] 2021. https://www.forestresearch.gov.uk/research/urban-tree-benefits/communitree-connecting-tree-databases-public-improving-urban-tree-data-business-government-and-research/.

43. **GIGL.** Key London Figures - Borough tree inventories, collated by GiGL. [Online] 2019. https://www.gigl.org.uk/keyfigures/.

44. **Assembly Mayor of london London.** London Tree Map. [Online] Marcg 2021. https://www.london.gov.uk/what-we-do/environment/parks-green-spaces-and-biodiversity/trees-and-woodlands/london-tree-map.

45. **Rogers , K, et al.** *Valuing London Urban Forest Results of the London i-Tree Eco Project.* 2015.

46. **Government UK.** Ancient Woodland (England) Last updated: 30 April 2021. [Online] OGL, 30 April 2021. https://data.gov.uk/dataset/9461f463-c363-4309-ae77-fdcd7e9df7d3/ancient-woodland-england.

47. **i-Tree.** Valuing London's urban forest. [Online] 28 May 2019. https://www.itreetools.org/support/resources-overview/project-profiles/valuing-londons-urban-forest.

48. **Dept for Business, Energy & Industrial Strategy Na.** *2019 UK greenhouse gas emissions.* London : OGL, 2019.

49. **European Environment Agency.** CO2 emissions from new passenger cars. [Online] 2021. http://co2cars.apps.eea.europa.eu/subscription/targeted-subscription#dashboard-tab.

50. **Lindgren, BW and McElrath, GW.** 8, *Introduction to Probability and Statistics.. London.* 1969., Journal of Applied Mathematics and Mechanics, Vol. 52, p. 498.

51. **Greater London Authority, GLA.** London Energy and Greenhouse Gas Inventory (LEGGI). [Online] Data Press, https://data.london.gov.uk/dataset/leggi#:~:text=London's%20per%20capita%20emissions%20have,transport%20were%2028.84%20million%20tonnes..

52. **BBC Reality Check Team.** Climate change: Is the UK on track to meet its targets? Forestry Commision. [Online] 22 October 2021. https://www.bbc.com/news/58160547.

53. **Petrella, S, et al.** Valutazione dei Servizi Ecosistemici nel Parco Regionale Urbano di Aguzzano 2017. [Online] ://oemmndcbldboiebfnladdacbdfmadadm/https://www.itreetools.org/documents/335/Parco_Aguzzano_Report.pdf.

54. **Data, i- Tree.** *Carbon Storage and Carbon Sequestration per trees species - Courtesy S Petrella.* Rome : Casale Podere Rosa, 2017.

55.T**heWorldBank.**CO2Emissions.[Online]2021. https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?locations=IT.

56. ***Gazzetta Ufficiale n. 70Art. 66 Decreto Legge "Cura Italia"1, del 17 March.* 2020.**

57. ***Agenzia delle Entrate - Art. 59, 3, L n. 388 / 2000, Circolare del 19/08/2005 n. 39 - Direzione Centrale Normativa eContenzioso*. 2005.**

58. Di Nicola, , F, Boschi, M and Mongelli, G. ***MEF Effective marginal and average tax rates in the 2017 Italian tax-benefit system.* Roma : MEF, 2018.**

60. AVERT, EPA. National weighted average CO2 marginal emission rate, year 2018 data. U.S. Environmental Protection Greenhouse Gases Equivalencies Calculator - Calculations and References. [Online] 2020. https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references.