



## Tree value; the missing metric in built-environment management

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## Moving on from the 'old forestry' approach to tree value

Few ancient relics are more enduring than the Pyramids of Giza, still showcasing the achievements of one of our oldest civilisations more than 4,500 years after they were built (Cover image). Yet Nature frequently manages to trump our best efforts, with the grove of bristlecone pines (*Pinus longaeva*) in the Inyo National Forest in California, illustrating the point (Figure 1). At 3,000m above sea level in the most hostile of mountain environments, these ancient twisted lumps of gnarled dead wood, with slithers of living bark tissue linking roots to leaves, were already 500 years old when the Pyramids were built, and still alive today after 5,000 years.

Historically, pioneers viewed trees as a natural resource there to be used, and their value has traditionally been expressed as how much the wood was worth, whether it be as sawn timber for construction or as fuel for energy. Indeed, the product sale price has been a foundation of traditional forest management for centuries. In those commercial terms, these bristlecone pines are poor timber and it would only be their firewood value that just lifts them off the bottom of the value spectrum! But, can that really be right? Intuitively, we all know that a 5,000-year old tree must have more than firewood value, and yet these old forestry concepts form the basis for many modern tree management decisions!

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**Figure 1:** Some of the bristlecone pines in Methuselah Grove in California started life 500 years before the Pyramids were built!

Our world is now resource-poor and knowledge-rich, and it is time for thinking to catch up.

Across the UK, the natural capital held within existing trees is frequently squandered ...

'Old forestry' worked fine in a pioneering world that was resource-rich and knowledge-poor, but times have changed, dramatically. As resources dwindle and our understanding increases, the excuses for clinging to old ways are running out. Our world is now resource-poor and knowledge-rich, and it is time for thinking to catch up. 'New forestry', and within that I include arboriculture as urban forestry, is still about value, but the difference from the past is that we now have the knowledge and expertise to include many more tree benefits than would have been considered in the past. Outside the forest, if trees are to be properly factored into the built-environment decision-making process, then a more realistic approach to the value of benefits is needed. The research base to support this more modern view is rapidly accumulating, identifying significant benefits from trees, principally through improved human health and wellbeing, pollution buffering, rainwater runoff buffering, temperature regulation, ecological enhancement, and visual amenity. Furthermore, there is wide political convergence in the UK that urban trees significantly contribute to the delivery of key national policies including transport, housing, health, environment, and climate change adaptation.

## Tree value is being ignored in decision making

There is compelling research support and political aspirations for a more balanced approach to managing trees accounting for their broader value to society, and yet it is not happening on the ground. Across the UK, the natural capital held within existing trees is frequently squandered, with an emerging trend of decreasing urban canopy cover, often driven by local political regimes acting against the wishes of their communities. Two notable examples include:

- **Horse Chestnut Avenue, Wandsworth, London:** In 2017, Wandsworth Council felled more than 50 horse chestnut trees that formed part of an historic avenue on Tooting Bec Common dating from the late 1800s. Some of the trees were in a declining condition; most were structurally sound with the potential to be retained for many decades with normal management; and all had significant heritage value. The Council's justification for the felling relied on 696 responses to a flawed public consultation, despite nearly 10 times that many objections to the scheme (6,573 to date) recorded in a 38 Degrees petition. Wandsworth Council did not publish a valuation of the trees to inform the management process and, despite their value being assessed as more than £2,600,000, they were still felled (Figure 2).

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**Figure 2:** The aftermath of felling the horse chestnut avenue on Tooting Bec Common by Wandsworth Council.

- **Street trees in Sheffield:** By the end of 2017, around 5,500 street trees had been felled by Sheffield City Council's highway maintenance contractor, Amey PLC, working under a 25-year Public/Private Finance Initiative (PFI) contract. Many of those trees were healthy and retainable for decades through a continuation of a normal maintenance regime (Figure 3). The justification for these industrial-scale removals was cited as damage to highway infrastructure, but tree value was not considered.

... 17,500 of the 36,000 street trees are contracted to be felled over the 25 years of the contract.



**Figure 3:** The Chelsea Road elm, one of the 17,500 street trees in Sheffield scheduled for felling by Sheffield City Council against the wishes of the local community.

In both cases, local politicians successfully hijacked Technical arguments to justify their decisions

Maturity is the beginning of the period of maximum benefit delivery, not the end

The full value of the removed trees is not known, but an extrapolation based on a detailed study of 448 standing trees scheduled for felling, estimated the lost asset value to be at least £66,000,000. In March 2018, Sheffield City Council was forced to reveal parts of the redacted PFI contract, which revealed a target of 17,500 of the 36,000 street trees are contracted to be felled over the 25 years of the contract.

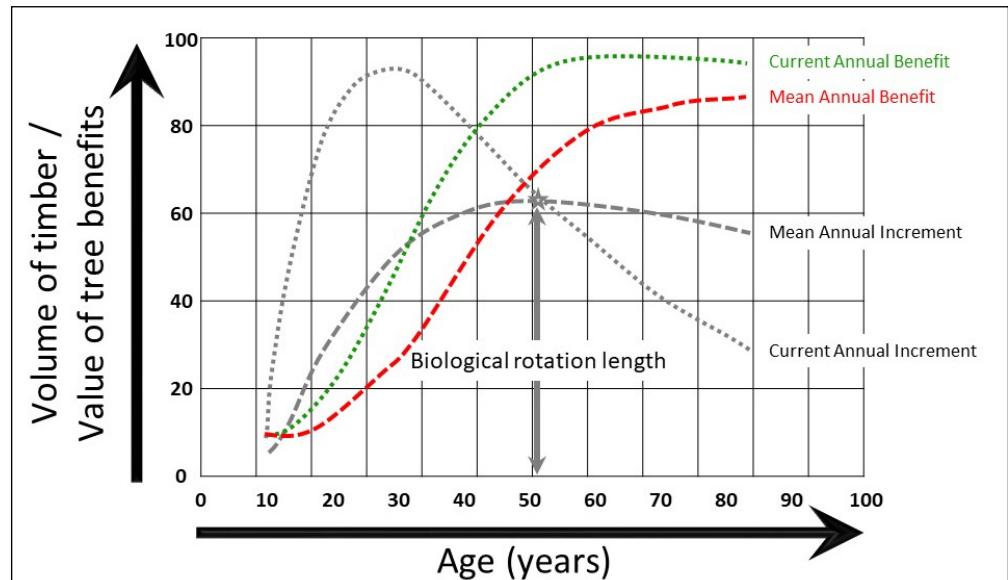
In both cases, local politicians successfully hijacked technical arguments to justify their decisions without any credible expert support and got away with it because there is no formal government policy identifying trees as environmental assets whose value must be factored into decision making. In this policy vacuum, disaffected communities were unable to bring to bear the scrutiny afforded by the Judicial Review process, which is the rearguard for reigning in mismanagement in the public realm.

## The principle of rotation length and its application to urban trees

More specifically, one of the technical arguments misused in both Sheffield and Wandsworth is that the trees were mature, and it is good management to fell and replace. The principle is worth reviewing because although it may be applicable to traditional forest scenarios, there are no credible grounds for it to be transferred across disciplines to urban trees without modification.

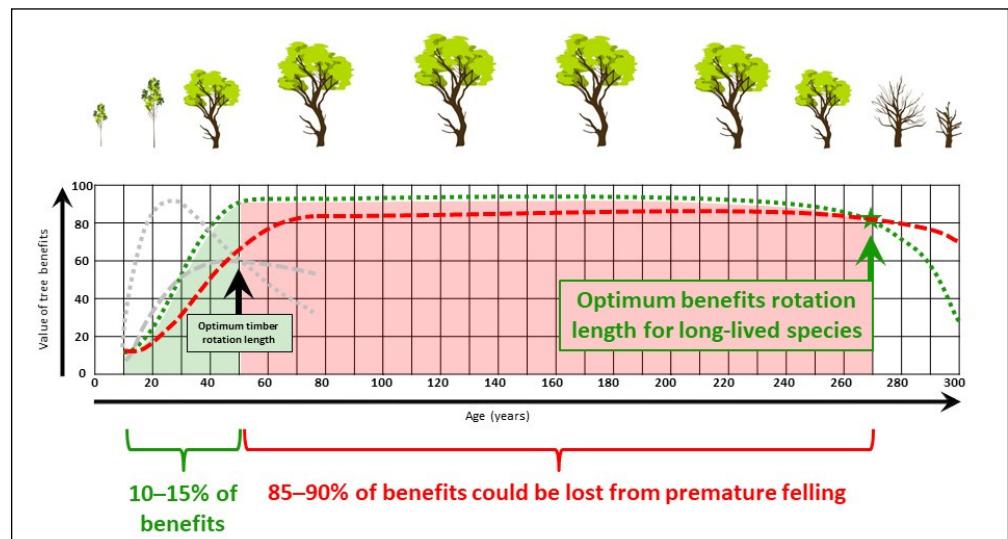
A primary objective of production forestry is to maximise the return from the crop, with centuries of measurement and experience referenced to develop the concept of biological rotation length (Figure 4). In theory, and most of the time in practice too, felling the crop and replanting new trees at the biological rotation (grey annotation) is the most economically efficient way to maximise the volume of timber produced. However, the conceptual extrapolations for the total of all benefits (coloured annotation) is more closely related to crown volume than trunk volume, and the curves are likely to take a different form. As trees grow bigger, so does the benefit delivery, gradually increasing to stabilise for the duration of maturity, often into over maturity, and sometimes past death as well.

The onset of maturity is the change from rapid juvenile growth to a slower, but stable growth that is maintained until the tree begins to decline and dies. It is well-documented that maturity can last many decades and often centuries for common urban tree species, which is where the recent political interpretations fall apart. Maturity is the beginning of the period of maximum benefit delivery, not the end, and to fell prematurely has the potential to deprive communities of 85–90% of the benefits available (Figure 5). Of course, this is a conceptualisation based on estimates to demonstrate the principle, and it should be applied intelligently, taking full account of the individual circumstances of each situation.



**Figure 4:** From conventional forest management theory for optimising timber volume production, the most efficient point to fell and replant is where the current annual increment (the volume of wood grown in the current year shown by the grey dots) and mean annual increment (the average annual growth to date shown by the grey dashes) curves cross. This is called the biological rotation length and is at about 51 years in this example. Extrapolating this principle to urban trees and considering the delivery of tree benefits rather than timber products, the current annual benefits curve (green dots) and the mean annual benefits curve (red dashes) are likely to take a different form, not crossing within the 80-year time frame common in most forestry scenarios.

Tree life expectancy will vary with species and growing conditions, and these variables will affect the length of time that individual trees can be retained. However, Figure 5 articulates the real concern that the rigid application of the forestry principle of fell and replace at maturity to urban trees can result in significant adverse impact on adjacent communities.



**Figure 5:** Using this conventional forestry wisdom and applying it to the urban context, where the current and mean annual benefits curves cross will represent the theoretical rotation length for the optimum delivery of benefits (around 270 years of age in this example). Although this is a conceptualisation, there is reliable evidence that many common urban trees have life expectancies of 150–300 years, with potential to deliver peak benefits for the bulk of that period. Of course, the length of time individual trees can be expected to provide benefits will vary with species and growing conditions, but irrespective of those variations, when urban trees reach maturity, it is not the end of their cycle, it is the start of their peak benefit delivery, which can often last decades, if not centuries. Maturity and beyond is where trees payback all the investment it has taken to grow them, illustrating the nonsense of felling at the point of maximum return. For long-lived urban species such as plane, sycamore, lime, horse chestnut, beech, and oak, up to 90% of the potential benefits (red shading) could be sacrificed through premature removal.

## Credible methods for assessing tree value

Neither are perfect, but both are credible tools for built-environment managers wishing to pay more than just lip-service to sustainability.

CAVAT takes a slightly different approach to i-Tree, but is equally as useful in the UK.

Historically, factoring trees into built-environment decision-making had little traction because there was no reliable way to articulate their benefits in a way that accountants understood, i.e. monetary value. However, the last decade has seen a rapid evolution of the theory, and we now have two credible approaches with evidence-based provenance that are difficult to brush aside as the aspirational musings of slightly eccentric tree-huggers. Neither are perfect, but both are credible tools for built-environment managers wishing to pay more than just lip-service to sustainability.

i-Tree (<https://www.itreetools.org/>) is an advanced computerised assessment tool devised by the US Department of Agriculture, which is being used in hundreds of cities around the world to quantify the annual monetary value of benefits from their trees. For example, the programme takes air pollution data in the context of local weather patterns, tree size, and species, to quantify the pollutants trees remove and compares that to the known cost of achieving the same result using conventional pollution-scrubbing technology. Other benefits, including carbon sequestration, rainwater runoff buffering, and temperature moderation, are added together to calculate the annual tree contribution, allowing them to be managed as essential infrastructure assets rather than nice afterthoughts. However, a gap in the i-Tree approach is that the researchers have yet to factor in several other important benefits, two of which are ecological and human health impacts, but these will come over time, and what we presently have is a useful starting point.

Capital Asset Value for Amenity Trees (CAVAT) (<https://www.ltoa.org.uk/resources/cavat>) takes a slightly different approach to i-Tree, but is equally as useful in the UK. It neatly sidesteps some of the current i-Tree limitations by embracing the concept that amenity, i.e. the totality of all tree benefits, is closely related to tree size, functional efficiency, and life expectancy. Instead of calculating the annual flow of benefits, it assesses the cost of replacing trees as they stand. It then links this to the local population density, which accounts for the number of people who enjoy the benefits, to arrive at a community-oriented value. This is particularly useful for planners attempting to weight and balance competing design priorities to deliver outcomes that work for individuals and the wider community.

Both approaches also have the strategic support needed to guide their evolution and improvement into the future. i-Tree has recently secured significant funding, which is likely to allow its missing elements to evolve, facilitating its progress towards becoming an international and universally accepted mechanism for justifying trees as an integral part of sustainable development. Similarly, CAVAT also has a bright future, with its development now overseen by a managing executive board consisting of Chris Neilan, who devised the method, the London Tree Officers Association (LTOA), and the Municipal Tree Officers Association. The method is described in an imminent paper in the Arboricultural Journal, supported by revised guidance notes to be published on the LTOA website (<https://www.ltoa.org.uk/resources/cavat>).

## Strengthening the prospects for successful Judicial Review

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There is an urban tree policy gap, which is why the UK needs a tree strategy ...

There is an indisputable and increasing evidence base that trees, both rural and urban, are essential to sustainable development and societal wellbeing, and we need more of them, not fewer. With i-Tree and CAVAT, we now have reliable technical tools for factoring tree value into decision-making, but the failure to account for tree value in Sheffield and Wandsworth demonstrate that it can all come to nothing unless national government regulates to ensure compliance at the local level. The Judicial Review process is a mechanism for holding local government to account, but there must be a legal basis for any challenge, which does not currently exist relating to factoring tree value into built-environment decision making.

The Government has recognised the importance of valuing natural capital in its draft proposals for the natural environment '*A Green Future: Our 25 Year Plan to Improve the Environment*', published in February 2018. This recognition of the importance of the natural environment is to be applauded, but the document has a strong rural and maritime focus with very little mention of the built environment, despite it being the place where most people live! The Ministry of Housing, Communities & Local Government published a draft text for consultation for the '*National Planning Policy Framework*' on 5<sup>th</sup> March 2018. Again, a very important policy document, but although there is reference to veteran and ancient trees in a habitat context, there is no direct reference to urban trees!

Of course, veteran and ancient trees are irreplaceable environmental assets deserving special consideration, but what about all the individual ordinary urban trees whose combined presence makes an extraordinary contribution to societal wellbeing? It seems that the special trees got all the attention in these flagship government policies, and the forgotten heroes that do all the sustainability grunt-work remain invisible. There is an urban tree policy gap, which is why the UK needs a tree strategy to framework a national approach to optimise societal benefit from all trees, both rural and urban.

A National Tree Strategy would significantly improve departmental co-ordination on tree issues within government and, more importantly, strengthen the prospects for successfully using Judicial Review to drive the use of tree value in decision making at the local level.



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