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The Economic Case for a Forest of Dean Biosphere Reserve

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 The team would wish to thank Kate Tobin for comments and data. All mistakes remain the author's own.

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Executive Summary

This report is the result of a collaboration between Forest of Dean Economic Partnership, Forest of Dean District Council and a voluntary team of ONS economists to analyse and estimate the potential economic case to support an application to achieve UNESCO Biosphere Reserve designation for the Forest of Dean. On the 6th December 2018, the Forest of Dean District Council declared a climate emergency and in so doing becoming the first rural council to do so. During 2019, more local authorities declared a climate emergency and on the 1st May 2019 the UK Parliament declared an environmental and climate emergency.

This report aims to build the economic case for the Forest of Dean UNESCO Biosphere Reserve by providing a first-order estimate of the likely net impact of the Biosphere designation on the Forest of Dean area. Estimates will be subject to change as more evidence is collected as the project progresses, if there are any policy changes, or as the project progresses, costs become 'locked-down' such that contingencies and optimism biases can be reduced.

This case follows the standard for evaluating government policy decisions as described in HM Treasury's Green Book[1].

The calculations are focused on tangible economic benefits derived from either Biosphere branding scheme or from two modest incentive schemes which the Biosphere could employ focused on producing tangible products. This report does not attempt to measure any benefits which could arise from changing consumer habits, i.e. through increased purchases of locally produced products, health benefits from increased interaction with the natural environment, opportunity cost benefits from preserving nature or from mitigating future climate change crisis or from biodiversity losses. In this regard this report has maintained a prudent approach and focused on those few areas which have suitable academic studies to support the estimation process. This report has also continued the prudent approach by using a high optimum bias for both benefits and costs to reflect the uncertainty over the estimation process from not having primary data sources to work with.

For the Implementation scenario, this delivers the following:

	(£m NPV)
Discounted Benefits	£61.55m
Minus	-
Discounted Costs	£15.83m
Equals	=
Net Present Value	**£45.72m**
Benefit-Cost Ratio	**3.89:1**

[1] The Green Book: Central Government Guidance on Appraisal and Evaluation (2018); HM Treasury. Available at www.gov.uk/government/publications

Based on the above benefits and costs for the Biosphere Reserve, recognising these to be a limited sub-set of the possible benefits which a Biosphere Reserve could generate, and an indicative costing based on the best data available, one can calculate a prudent and evidenced-based assessment of the BCR of the policy option of the Forest of Dean District becoming a UN Biosphere Reserve.

Even under this prudent approach to the estimation process, the Biosphere Reserve option yields a **BCR of 3.89:1**. That is for every **£1.00 of costs** the Biosphere Reserve option **yields £3.89** as a return over a 30 year period. This would indicate that the Biosphere Reserve Option is a viable policy decision for the Forest of Dean District Council to consider investigating further. Stripping out non-cashable benefits (i.e. environmental benefits) still delivers a benefit cost ratio of 2.95:1.

To help deliver this report, the Office for National Statistics, as part of its corporate social responsibility requirement has made available some of its economist resource for local charities and other institutions to use to develop economic business cases for projects which serve our local community. This was delivered on a voluntary basis by a small group of Office for National Statistics (ONS) government economists.[2]

[2] Neither ONS nor any of the staff involved in this report accept any liability in relation to this report. Institutions and other bodies using this analysis are responsible for undertaking their own quality assurance reviews. This report uses available data to provide an a priori assessment of the likely impact of this policy. Further analysis should be undertaken as this policy evolves to ensure all available emerging local evidence is taken into account.

Introduction

This report is the result of a collaboration between Forest of Dean Economic Partnership, Forest of Dean District Council and a voluntary team of ONS economists to analyse and estimate the potential economic case to support an application to achieve UNESCO Biosphere Reserve designation for the Forest of Dean. On the 6th December 2018, the Forest of Dean District Council declared a climate emergency and in so doing becoming the first rural council to do so. During 2019, more local authorities declared a climate emergency and on the 1st May 2019 the UK Parliament declared an environmental and climate emergency.

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This case follows the standard for evaluating government policy decisions as described in HM Treasury's Green Book[3]. Central to this evaluation is a cost-benefit analysis of the proposed policy, in this case the designation of the Forest of Dean area as a UNESCO Biosphere Reserve, compared against the baseline scenario of no change or alternative policy decisions. The evaluation takes place over a given time horizon, based on the perceived window over which the benefits could accrue, discounted to the current period using standard discount rates, within the Green Book guidance. The perceived benefits are also adjusted to take account of "optimism bias": this compensates for the fact that most policy evaluations have been shown over time to overstate the benefits or underestimate the costs of a given policy. The final output of the appraisal is a single figure called the Benefit/Cost Ratio (BCR). The BCR is defined as the ratio of the present value of benefits to the present value of costs. It provides a measure of the benefits relative to costs.

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Chapter 1: The Bioregional economy, Zero Carbon Britain, the UN Biosphere reserves and Sustainable Development Goals

This first chapter provides some economic context to the development of the economic case for the UN Biosphere Reserve for the Forest of Dean. The following section briefly summarises what a bioregional economy is, the economic rationale for a bioregional economy as proposed by green or ecological economics, the transition to carbon neutrality and the declaration of a climate emergency and how a Biosphere Reserve designation could be used as a tangible response to that declaration. From this basis, this report then examines how the UN Biosphere reserves were established, the international network of UN Biosphere reserves and how these reserves contribute to the sustainable development goals. This chapter ends by looking at how the sustainable development goals can form a series of targets for measuring the performance of an economy (either local or national) while remaining within ecological, and therefore sustainable, constraints.

1.1 What is meant by a bioregional economy?

According to Sale (1991), a bioregion is:

> …any part of the earth's surface whose rough boundaries are determined by natural characteristics rather than human dictates, distinguishable from other areas by particular attributes of flora, fauna, water, climate, soils and landform, and by the human settlements and cultures those attributes have given rise to.
>
> (Sale; 1991; p55)

A bioregion is one whose boundaries relate to landforms and watersheds, that is a topographical or hydrological delineation. From this a bioregional economy is one which is located within a bioregion.

The term bioregional economy was formulated by green and ecological economists as a way of describing the size of a resilient local economy and therefore enabling discussions on how much of what we consume could be produced within it. Cato (2013) goes into some detail on the topic of the bioregional economy and the reasons for why it is necessary to transition to a resilient local economy basis for economic activity in contrast to the current globalised economy. These reasons can be summed up in the fact that the global economy is dependent on a ready supply of oil, which is itself a non-renewable resource, so the current economic system is by its design ultimately self-limiting. In addition, the current agro-industrial approach to farming is leading to dramatic rates of soil depletion and bio-diversity loss and the resulting emissions from our economic activity is leading to changes to the world climate which maybe non-reversible. Therefore, based on these and other points a strong case can be made to start the transition to a different economic system to mitigate the affects of the current self-limiting economic system to one which is sustainable and provides benefits to the local population.

The transition to a carbon neutral Britain was placed onto concrete terms through a modelled scenario of what a zero carbon Britain could look like in the year 2030 (Centre for Alternative Technology; 2013). This model scenario of a zero carbon Britain was achieved through changing the energy mix, land usage, the habits of the UK population and increasing the carbon sequestration in

restored peat bogs, standing biomass and soil stores. The scenario was based on using already available technology and to meet the following aims:

- Net zero carbon emissions by 2030;
- Keep the lights on and keep everyone warm; providing enough energy to meet demand at all times;
- Make sure we all eat enough, and eat well;
- Keep a decent standard of living, with the benefits of a modern society;
- Support biodiversity – making space for the natural world we rely on;
- Look at how to help adapt to a changing climate – building resilience into our systems to be able to respond to the foreseen and unforeseen effects of climate change;
- Weigh up the costs and benefits (not just monetarily) of our options.

Centre for Alternative Technology (2013) can be seen as adding some tangible steps to achieve what is sketched out in Cato (2012) to address the issues of climate change and biodiversity loss while maintaining a standard of living compatible with a modern society using already available technology. This report was followed up in 2017 with an additional report looking at the barriers to making the zero-carbon Britain a reality and how these could be overcome based on research from a range of disciplines; Centre for Alternative Technology (2017).

This then in a brief section summarises the baseline economics which underpins the United Nations concept of the Bioregional reserves and how theoretically a zero-carbon society could be achieved through changing the energy mix, land usage and consumer habits; all of which would be compatible with the UN Biosphere reserves broad principles.

1.2 Climate Emergency and a tangible response.

On the 6th December 2018, the Forest of Dean District Council declared a climate emergency and in so doing becoming the first rural council to do so. During 2019, more local authorities declared a climate emergency and on the 1st May 2019 the UK Parliament declared an environmental and climate emergency. While the UK Parliament declaration does not legally require the UK government to act it does demonstrate the level of concern on this issue. This declaration was one of the key demands of the environmental activist group Extinction Rebellion who had held a series of protests during the first part of 2019.

It is now on the Forest of Dean District Council to demonstrate what it intends to do following the declaration of a climate emergency. It could be argued that a wider tangible policy response to this climate emergency declaration could be seeking Biosphere Reserve designation so signalling to the local community that living in harmony with the local biosphere and protecting biodiversity was a key target for the Forest of Dean District Council.

This then provides some context to why Forest of Dean District Council is exploring the possibility of achieving UN Biosphere Reserve designation. The next section looks at the Biosphere Reserve network and how other UK areas have achieved designation already.

1.3 United Nations Network of Biosphere reserves

A UNESCO biosphere reserve is a "site of excellence to explore and demonstrate approaches to conservation and sustainable development on a regional scale". They are the world's only internationally recognised accolade for demonstrating excellence in sustainable development practice. The biosphere reserve designation is awarded by the United Nations Educational, Scientific, and Cultural Organisation (UNESCO) to areas renowned for their special environments which are valued by local people. A UNESCO Biosphere reserve delivers three linked Biosphere functions:

- Nature conservation;
- Sustainable socio-economic development; and
- Developing and sharing knowledge, learning and awareness.

These three functions should be interlinked and mutually reinforcing and are situated within three zones of the Biosphere reserve. These zones are:

- A core zone – devoted to nature conservation and legally protected
- A buffer zone – which incorporates an area where only activities compatible with conservation objectives of the core zone are allowed; and
- A transition zone – where sustainable development objectives are encouraged and enacted, this where most people live and work and can include cities and market towns.

The route map towards developing a Biosphere for the Fens (2018) defines a series of key ingredients which makes an area suitable to become a Biosphere Reserve. These are:

- An area with a strong identity;
- An area globally recognised for:
    - Exceptional environment and biodiversity;
    - Significant cultural heritage;
    - Commitment of a wide range of stakeholders working together towards a sustainable future;
- An area demonstrating excellence in sustainable development, for nature and for people and local communities;
- An area demonstrating good examples of using and preserving its resources; and
- It is neither restrictive nor exclusive as to what happens in the Biosphere – apart from management within the legally designated core area(s).

Currently, there are 701 Biosphere Reserves in 124 countries with corresponding opportunity to share and learn about sustainable development practices within that wide network. In the United Kingdom, as of the start of 2019, there are six Biosphere reserves. These are:

- Biosffer Dyfi;
- Brighton and Lewes Downs;
- Galloway and Southern Ayrshire;
- Isle of Man;
- North Devon; and
- Wester Ross.

In addition, three other areas are considering applying for Biosphere Reserve designation. These are:

- Cambridgeshire Fens;
- The Wash; and
- Isle of Wight (nomination form submitted in June 2018).

The UNESCO Biosphere reserves are part of the Man and the Biosphere programme, which was launched in 1971. This programme aims to establish a scientific basis for the improvement of the relationship between people and the environment, as such it is a multi-disciplinary programme combining the natural and social sciences, economics and education to improve human livelihoods and the equitable sharing of benefits, and to safeguard natural and managed ecosystems, thus promoting innovative approaches to economic development that are socially and culturally appropriate, and environmentally sustainable. In 2016, the Man and the Biosphere (MAB) strategy, along with the World Network of Biosphere Reserves (WNBR), was refreshed to work towards the Sustainable Development Goals and contribute to implementing the 2030 Agenda for Sustainable Development both within biosphere reserves and through global dissemination of sustainable development models developed in biosphere reserves.

This MAB strategy update means that the UK Biosphere Reserves should be contributing to the UK attainment of the Sustainable Development Goals as measured by the Office for National Statistics. The 17 sustainable development goals are:

1. No Poverty;
2. Zero hunger;
3. Good Health and well-being;
4. Quality education;
5. Gender equality;
6. Clean water and sanitation;
7. Affordable clean energy;
8. Decent work and economic growth;
9. Industry, innovation and infrastructure;
10. Reduced inequalities;
11. Sustainable cities and communities;
12. Responsible production and consumption;
13. Climate action;
14. Life below water;
15. Life on land;
16. Peace, Justice and strong institutions; and
17. Partnership for the goals.

This then provides a brief overview of what a UNESCO Biosphere is and what they aim to achieve through the interlinking and mutually reinforcing three biosphere functions and we've established how MAB and the WNBR have committed themselves to the UN Sustainable Development Goals and by implication how the UK Biosphere Reserves can contribute to the UK achievement of these 17 goals. The final section of this first chapter closes the circle by returning to recent developments in economics concerning sustainable development and how the social sustainable development goals along with the ecological limits provides metrics for measuring the performance of an economy whether local, national, bioregional or of a Biosphere Reserve.

1.3 Re-defining the Goal.

The majority of modern economics is focused on achieving economic growth, meaning the growth rate of Gross Domestic Product (GDP). This single metric is then used to make inferences about well-

being, living standards, etc. The concept of continuous economic growth was challenged by Jackson (2010; 2017) in his pioneering work on prosperity without growth which laid the ground work for an alternative metric for measuring economic development and progress which was put forward by Raworth (2017). Raworth (2017) relies on a series of social foundations, which are described by the social dimensions of the sustainable development goals, as the aims of economic progress and development. These are then coupled with the ecological limits beyond which ecosystems are damaged. This means that an economy measures its performance based on achieving social foundations while remaining within eco-systemic limits and therefore being sustainable. This might seem irrelevant for Biosphere Reserves but looking at achieving social foundations as measured by a series of indicators and measuring whether the economic activity to achieve those social foundations remain within ecological limits looks to encapsulate the founding principles of the MAB programme and in some ways is a lot easier to measure locally than a regional GDP measure. It also has a more tangible nature for determining whether a Biosphere Reserve is achieving its goals of sustainable development while conserving the ecosystems within its boundaries.

This chapter has briefly encapsulated the economic underpinnings of the UNESCO Biosphere Reserve and considered how it is currently possible to transition to carbon neutrality using available technologies. It then discussed what a Biosphere Reserve is, how they link to national sustainable development goals and how it is possible to localise those sustainable development goals coupled with ecological limits to measure how a Biosphere Reserve or local economy is performing in terms of social foundations and sustainability. The next chapter briefly looks at the characteristics of the Forest of Dean area so describing the area which will be considered for Biosphere Reserve designation.

Chapter 2: Characteristics of The Forest of Dean Area

Forest of Dean is a local government district in Gloucestershire, England, named after the Forest of Dean. Its council is based in Coleford. Other towns and villages in the district include Blakeney, Cinderford, Drybrook, English Bicknor, Huntley, Littledean, Longhope, Lea, Lydbrook, Lydney, Mitcheldean, Newnham and Newent

The district was formed on 1 April 1974 under the Local Government Act 1972, as a merger of the East Dean Rural District, Lydney Rural District, Newent Rural District and West Dean Rural District, and from Gloucester Rural District the parishes of Newnham and Westbury-on-Severn.

The Forest of Dean District covers 526.4 km^2 . The district has 13,864 hectares of woodland, with 9,990 hectares owned by Forest Enterprises and 3,874 hectares in private ownership.

The 2018 National Forest Inventory gives the woodland coverage as 13,605 hectares, of which 10,839 hectares is Ancient Woodland and the mix of woodland types are as given in Table 2.1

Table 2.1: Woodland Type in the Forest of Dean (National Forest Inventory 2018).

Woodland Type	**Area in hectares**
Broadleaved	6,864.4
Conifer	4,759
Mixed- predominately broadleaved	343.6
Mixed – predominately conifer	443.0
Coppice	11.7
Young trees	653.1
Low density	14.3
Assumed Woodland	56.2
Ground prepared for new planting	52.2
Shrub	14.2
Felled	393.7

Information provided by the Biosphere team indicates that of this 9,989.8ha are within the National Forest estate. This means 73.4% is in public ownership, meaning 26.6% (3,615.2 ha) is in private ownership.

The Forest of Dean currently has 24.6% woodland coverage which is over twice the national average and is 95% rural in nature.

The main sectors of employment in Forest of Dean District are given in Table 2.2.

Table 2.2 Employment by activity type in the Forest of Dean District

Sector	% employment
Agriculture, fisheries and forestry	6.9
Manufacturing	15.9
Wholesale/retail	11.9
Transport/Storage	4.0
Accommodation & hospitality	6.9
ICT	2.8
Finance/insurance	1.6
Construction	5.9
Real Estate	1.4
Professional & scientific	5.9
Admin & support services	5.9
Public admin	2.4
Education	11.9
Health & Social	11.9
Arts & entertainment	2.0

The population of the Forest of Dean district is 86,543 (mid 2018 estimate).

Chapter 3: The process of building an economic case

The process used for building the economic case for the Forest of Dean designation as a UNESCO Biosphere Reserve is the same process used by Government economists for evaluating government policy decisions as described in HM Treasury's Green Book[5]. Central to this evaluation is a cost-benefit analysis of the proposed policy, in this case the designation of the Forest of Dean area as a UNESCO Biosphere Reserve, compared against the baseline scenario of no change or alternative policy decisions. The evaluation takes place over a given time horizon, based on the perceived time over which the benefits could accrue, discounted to the current period using standard discount rates, provided within the Green Book guidance. The perceived benefits are also discounted to take account of "optimism bias", this is the fact that most policy evaluations have been shown overtime to overstate the benefits or underestimate the costs of a given policy. The final output of the appraisal is a single figure called the Benefit/Cost Ratio (BCR). The BCR is defined as the ratio of the present value of benefits to the present value of costs. It provides a measure of the benefits relative to costs.

The economic case is the essential core of a business case and it assesses the economic costs and benefits of a proposal to society as whole and spans the entire time period of the proposal. The process for developing an economic case goes through several stages which can be summarised as follows:

1. Determining the scenarios to be assessed
2. For each scenario create a long list of costs and benefits relevant
3. Evaluate the long list of costs and benefits for whether they are quantifiable
4. For the quantifiable costs and benefits determine the formulae for estimation
5. Source relevant data and populate formula
6. Calculate the net present value (NPV) for each cost or benefit
7. Evaluate the optimism bias for the benefits and costs
8. Calculate the Benefit/Cost Ratio (BCR)
9. Option analysis

The first step in the process is the determination of the scenario of interest to the economic case, one of which will always be a do nothing or do minimum case (if a do nothing is not possible). These scenarios form the factual case (the proposal) and the counterfactual(s) (the alternative options). For the economic case for the Forest of Dean, this report addresses to two options:

Option One (Base-case): A 'do nothing' option whereby the Forest of Dean continues to be an Area of Outstanding Natural Beauty (AONB).

Option Two (Implementation): Designation as a UNESCO Biosphere Reserve of the Forest of Dean area.

Based on these scenarios the long list of costs and benefits can be determined. In this stage all possible costs and benefits for the scenarios under consideration are listed regardless, at this stage, of whether you think they can be quantifiable or not. The next step is then to evaluate the costs and benefits on the long list against whether they are quantifiable and what level of assumptions are

[5] The Green Book: Central Government Guidance on Appraisal and Evaluation (2018); HM Treasury. Available at www.gov.uk/government/publications

required. The result of this stage is a shorter list of costs and benefits which can be estimated with supportable level of assumptions being made. After this, formulae to estimate the short list costs and benefits for each of the scenarios are identified and resultant cost and benefit streams calculated across the time period under consideration as relevant data is sourced. The analysis then discounts those costs and benefit streams to reach net present value estimates, due to the fact that spending on costs and receiving of benefits is more valuable now rather than 5 or 10 years later. These estimates are then evaluated for optimism bias or sensitivity to changing assumptions to get an idea of the robustness of the estimate. The final stages is to calculate the BCR and to evaluate the factual against the counterfactual to reach a conclusion concerning whether there is an economic case for the proposed policy.

Chapter 3 sets out the "do nothing" option whereby the Forest of Dean continues as an Area of Outstanding Natural Beauty but incurs no further costs and no further benefits. This chapter looks at the limited costs and benefits of this option and calculates its BCR. Chapter 4 sets out the option for the Forest of Dean of being designated as a UNESCO Biosphere Reserve. The costs and benefits which where considered as possible and the final set of costs and benefits which were carried forward to the calculation stages. Finally, Chapter 5 draws everything together and discusses the recommendations reached based on the economic case. It also discusses the limitations of this current piece of work and how it could be improved.

The Process from this report forward

This report delivers an *a priori* evaluation of the potential benefits and costs using information derived from various available academic research papers and case studies of equivalent schemes. These relate to the best and most relevant available sources, although these may be from other Biospheres rather than the Forest of Dean. These might be outside the UK.

Because the individual circumstances of implementation in the Forest of Dean may cause outcomes to differ from those analysed by the available research, benefits are generally subject to 'optimism bias' whereby this report scales down these benefits in the light of uncertainty of the scale of any differences which might emerge. Similarly, costs are augmented with 'contingency' to account for the facts that these may be greater than currently perceived. This is a normal and prudent stage in this process, allowing a pragmatic assessment to be undertaken of whether the project has merit from a cost-benefit analysis perspective.

Importantly this report is not 'the end of the road' for analysis of this project. As more work to develop the scheme is undertaken, more evidence should be gathered and existing uncertainties addressed such that the true value of costs and benefits can be better exposed, hopefully in the process allowing 'optimism biases' and 'contingencies' to be reduced until, upon delivery these can be removed from the analysis completely. As such further iterations of this analysis should be undertaken. This report should be considered a prudent estimate of the likely first order magnitude of costs and benefits, in the light of available evidence, but not as a final or firm estimate. As the project develops new evidence is likely to be gathered around the exact model for implementation of this policy in the Forest of Dean which may cause these estimates to grow or shrink.

Chapter 4: The baseline scenario

The baseline scenario for the economic case for the Forest of Dean UNESCO Biosphere Reserve is a "do nothing" scenario. In this scenario, the Forest of Dean area continues to be an area of outstanding natural beauty, but with no further incentive programmes are implemented to augment the nature conservation or to improve the ecological services provided by the area.

This means in the baseline scenario, the benefits to be estimated fall into two groups: environmental and economic.

Environmental benefits

The most significant environmental benefits relate to carbon sequestration services provided by the trees within the Forest of Dean area.

The formulae for estimating this carbon sequestration is given by:

$$\left(\frac{FoD\ tree}{Eng\ tree} \times Eng\ net\ seq\right) \times carbon\ price = £\ FoD\ net\ seq$$

Where:

$FoD\ tree$ = Forest of Dean Woodland coverage (in hectares)

$Eng\ tree$ = Woodland coverage of the England region (in hectares)

$Eng\ net\ seq$ = Net carbon sequestration of England region in tonnes of CO2 equivalents per year

$carbon\ price$ = Central non-traded carbon price[6]

$£\ FoD\ net\ seq$ = Value of Forest of Dean Woodland net carbon sequestration

This modelling assumes that:

1. The rate of net carbon sequestration obtained by the England region is representative of the Forest of Dean area;
2. Forest of Dean Woodland cover estimate taken from Chapter Two;
3. For the latest years this report used Greenhouse Gas Initiative (GGI)[7] data for net carbon sequestration rates and land use, land-use change and forestry (LULUCF)[8] activities for later projections and assumes a constant carbon sequestration rate from 2050 onwards.

Economic Benefits

In the base-case this report captures all 'gross value added' from the Forest of Dean area. 'Gross value added' is the extra value added to goods and services through the process of production, illustrating the gains made over and above the value of the raw components. A simple example is, if the flour and other ingredients used in a loaf of bread costs 10p, and a baker sells his loaf of bread

[6] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/794186/2018-short-term-traded-carbon-values-for-appraisal-purposes.pdf

[7] https://www.iiasa.ac.at/web/home/research/researchPrograms/Energy/GGI-SD.en.html

[8] https://unfccc.int/topics/land-use/workstreams/land-use--land-use-change-and-forestry-lulucf

for 60p, the gross value added equates to the 50p difference. In general terms this equates to employee earnings and profits made. These two: employee earnings and profit, are the real benefits earned by an area through its industry, and because inputs are stripped out, prevent double-counting (so if the flour comes from a local miller, the miller would earn the GVA of the flour, and the baker the GVA of the bread).

Due to the particular benefits analysed in this study this report presents the GVA of the Forest of Dean area divided into three blocs:

- Agricultural GVA
- Forestry GVA
- All other GVA

The value of total GVA is drawn from ONS regional GVA estimates[9]. The agriculture estimate is derived from *'The Scale and Impact of the farming, food, drink and rural economy in Gloucestershire*' by Rural Agricultural University/Collinson (2019), pro-rating to the Forest of Dean area based on the percentage area the Forest of Dean District area is of the Gloucestershire county land area (20.8%) and applying this to Gloucestershire agricultural output.

Table 4.1: Forest of Dean Farm Output 2017 based on Gloucestershire county values.

Enterprises		Gloucestershire £m	Forest of Dean £m
output of cereals of which	Wheat	33.1	6.9
	Barley	16.1	3.3
	oats	1.8	0.4
output of industrial crops of which	oilseed rape	15.5	3.2
	protein crops	2.9	0.6
	sugar beet	0.2	0.0
	other industrial crops	0.2	0.0
Output of forage plants		7.5	1.6
Output of horticultural products of which	fresh vegetables	4.2	0.9
	plants and flowers	12.2	2.5
Output of potatoes (including seeds)		3.4	0.7
Output of fruit		14.0	2.9
Output of other crops incl. seeds		5.2	1.1
	Total crop output	**116.2**	**24.2**
Output of livestock primarily for meat of which	cattle	35.8	7.4
	pigs	7.5	1.6
	sheep	10.8	2.2
	poultry	43.0	8.9
Gross fixed capital formation (investment in breeding stock) of which:	cattle	8.9	1.9
	pigs	0.0	0.0
	sheep	2.3	0.5
	poultry	4.6	1.0
Output of livestock products of which	milk	60.7	12.6
	eggs	6.3	1.3
	other livestock products	0.9	0.2
	Total Livestock output	**180.9**	**37.6**
Other agricultural activities		16.7	3.5
Inseparable non-agricultural activities		18.9	3.9
	Output (at market prices)	**332.7**	**69.2**
	Total intermediate consumption	**230.9**	**48.0**
	Gross value added at market prices	**101.7**	**21.2**

[9] https://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/regionalgrossvalueaddedbalancedbylocalauthorityintheuk

Source: Rural Agricultural University/Collinson (2019)

Given the rural nature of the Forest of Dean area this is probably an underestimate of the farm output. The intermediate consumption is then calculated from the Gloucestershire county technical coefficient (intermediate consumption/output = 0.694)[10].

The forestry estimate is calculated as a 'bottom-up estimate calibrated to comply with the 'Agriculture, Fisheries and Forestry' ONS estimate, leaving a small allowance for fisheries. From the ONS tables, the Forest of Dean GVA of the agricultural, fisheries and food sector equates to around £47m in 2016. Stripping out a small amount for fisheries (£5.5m), and removing the agricultural component as above, this leaves an estimate for forestry by residual (£20m). This analysis replicates this in a bottom-up fashion by the following formula:

((Total hectares of woodland – Estimates Private hectares of woodland currently 'unmanaged') x Coppiced woodland yield per hectare x Revenue per tonne of wood x Uplift factor to convert coppicing to felling)- Total hectares of woodland x cost pf harvesting a hectare of coppiced woodland)

Using a coppicing to felling uplift factor of 2.5 (assumed) provides an estimate which mirrors the residual method to within the nearest million. The analysis considers this method as meriting further investigation and refinement but satisfactory at this time to provide a baseline for comparison.

'All other GVA' is calculated by deleting agriculture and forestry estimates from the 'Total'. Therefore, all Forest of Dean GVA is accounted for, but classification may vary through time dependent on the assumptions made in relation to forestry.

Within 'All Other GVA' it is possible to estimate the tourism direct spend. This is based on Collison & Associates Limited (2019) report on the Gloucestershire economy which gave tourism direct spend for 2017 for the Forest of Dean. This report estimated that there were 0.97 million visitor nights for staying visitors which generated £62.7 million spend and there were 2.25million day visitors which generated £68.9 million spend. So, for 2017 the total direct spend of tourists to the Forest of Dean was £131.6 million, of which £42.3 million was on food and drink. At the current point there is insufficient data to gain strong information on how Biosphere status may impact ecotourism, so for this report these benefits have been aside.

[10] This report assumes the Gloucestershire county farm technical coefficient is representative of the Forest of Dean Farm technical coefficient.

Chapter 5: The Biosphere Reserve scenario

5.1 Possible benefits of the Biosphere reserve

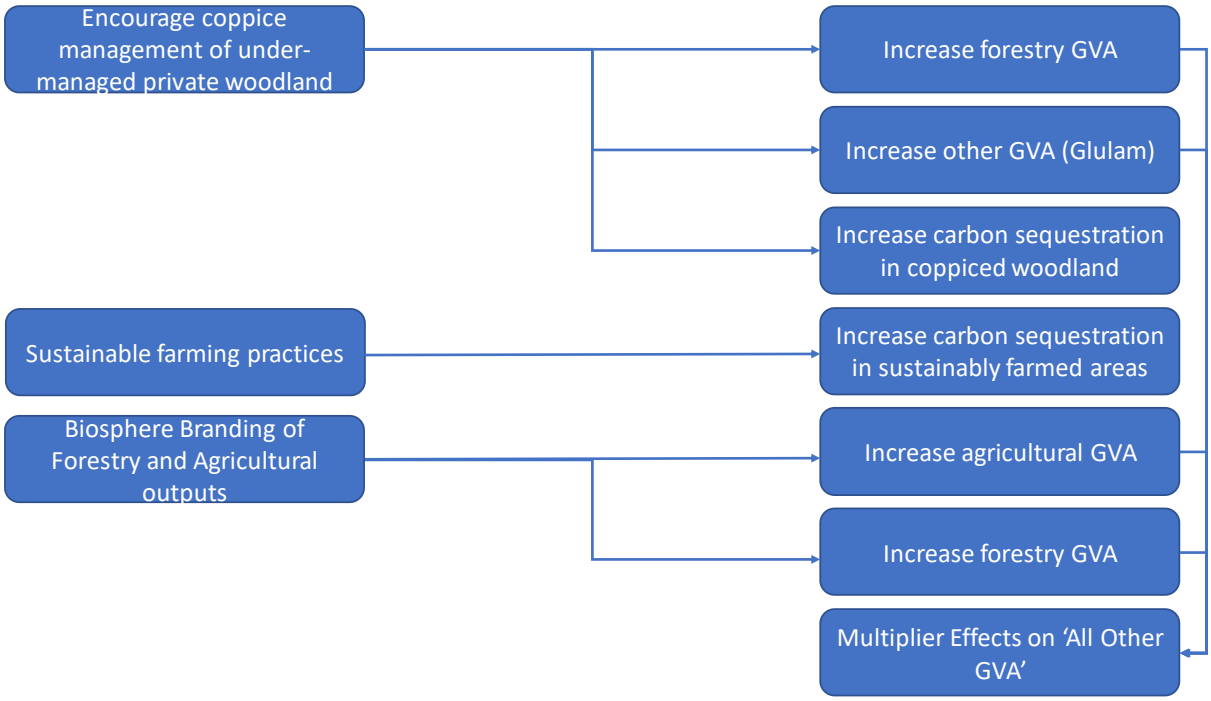
This analysis identified a long-list of viable benefits which could accrue from Biosphere status, although at this time this report has not been able to quantify the benefits of all of these. The complete list is:

- Improved carbon sequestration
- Reduction in other pollutants
- Increases in agricultural GVA
- Increases in forestry GVA
- Increases in other GVA
- Reductions in the costs of flooding
- Improvements in research efficiency
- Increased working from home delivering lower commuting costs
- Housing values rise
- Health benefits
- Increased happiness of local population.

The following section outlines the short list of policy levers which could result in benefits in these outcomes.

5.2 The selected benefits of the Biosphere reserve used in the economic case

For the purposes of the economic case of the Forest of Dean this analysis concentrates on the following benefit levers which deliver the following outcomes:



Other levers, including increased ecotourism and increased carbon sequestration and improved wildlife from 'green corridors', are expected to deliver quantifiable benefits, but at this time this analysis has not been able to cost these.

The following section goes through the three levers and their impact on these outcomes in greater depth.

5.2.1 Estimating the selected benefits

Incentive scheme to introduce a coppicing woodland management. (based on study of sweet chestnut coppicing; Brasika et al (2017))

Carbon Capture

This process is premised on calculating the additional biomass and carbon sequestration from coppicing based on Brasika et al. (2017). Broadly, regularly coppiced and managed woodland will act as a more efficient carbon sink than permitting trees to grow without coppicing / management. Brasika identifies a 25 year coppicing cycle and a carbon sequestration rate for mixed woodland from a study on calculating a carbon account for woodland in the Cumbria National Park (Sandwood Associates (2012)).

This is based on private woodland not captured in baseline case coming under a woodland management scheme (coppicing). Possible options for which the biomass produced could be used for is either to make a biofuel, as proposed by Centre for Alternative Technology (2013) or to produce glulam, a wood-based construction beam. This analysis has sourced a retail price per tonne for wood pellets (sourced from the Centre of Alternative Technology website). Processing plant cost needs estimating.

Estimation formulae:

$$no.ha\ of\ coppice\ land \times participation\ rate \times \frac{1}{25} per\ year \times carbon\ tonnes\ per\ ha\ per\ year \times carbon\ price/tonne$$

Assumptions:

Private woodland available for coppicing: 3,615.2 ha (based on National Forest Inventory), of which this analysis assumes 30% is potentially available for entering into coppice management or 1,086 ha.

1/25 for coppicing cycle per annum to reflect increased carbon capture as more of the estate is coppiced over time.

Carbon sequestration rate of 6.6 carbon tonnes per ha per year (mixed woodland)

Participation rate: 0.1 raising to 0.9 in increments of 0.1 (assumption).

Carbon sequestration starts in year +1 following coppicing.

The model includes two equations – one which removes carbon sequestration on the old basis and one which adds carbon sequestration on the new basis. This analysis assumes that unmanaged hectares will lose 50% of their carbon sequestration (6.6 tonnes) when coppiced, but the year after will gain 60% of the carbon sequestration, which will then be sustained for the next 24 years until that hectare is coppiced again. These are cautious assumptions.

Increasing forestry GVA from harvested wood from coppiced woodlands

This is based on calculating the value of the harvested timber, stripping out the costs of harvesting:

Estimation formulae:

$$\left(no.\,ha\ of\ coppice\ land \times participation\ rate \times \frac{1}{25} per\ year\right) \times ((yield\ in\ tonnes\ per\ ha\ per\ year \times price\ per\ tonne) - (cost\ of\ harvesting\ per\ ha\ per\ year))$$

Harvesting costs of £215/ha (2017 prices)

Biomass yield/ha: 13.42 tonnes

Revenue £250 per tonne (derived from the price of wood pellets, assuming tonnes of wood pellet equivalent to tonnes of biomass harvested)

Increasing other GVA from Glue-lamination (Glulam)

It is assumed that a Glue-lamination facility to make use of coppiced timber to manufacture timbers and other materials will be created to support the coppicing industry. This will deliver benefits by generating GVA from selling Glulam products.

Estimation formulae:

$$total\ yield \times (revenue\ from\ Glulam\ products) - (cost\ of\ manufacturing))$$

Total yield is total coppiced timber as calculated above. Note this does not include any current coppicing output from Forest of Dean, *or* any coppiced timber being brought into the Forest of Dean rom elsewhere. This report has not been able to undertake an analysis of this market across the UK.

Revenue from Glulam products assumes £250 per tonne.

Costs of manufacturing include labour and other costs of production and are assumed to be 60% of the sales revenue.

<u>An incentive scheme to introduce sustainable farming techniques</u>

Estimation Formulae:

$$no.\,ha\ farm\ land \times participation\ rate\ \times rampup\ factor \times 1.93\ carbon\ tonnes\ per\ ha\ per\ year \times carbon\ price$$

It is assumed that the net cost of changing practices are zero.

Estimate of farm land in the Forest of Dean district is sourced from the Forest of Dean Landscape Strategy[11].

Soil carbon sequestration rates are calculated from Stanley et al. (2017), which estimates a soil carbon sequestration rate of 3.59 metric tonnes per hectare per annum from using the technique of mob-grazing for pasture land and the Soil Association, which provides a soil carbon sequestration

[11] https://www.fdean.gov.uk/media/4204/landscape-strategy.pdf (page 21)

rate of 0.27 metric tonnes per hectare per annum which was the average sequestration rate found for zero-input organic farms. Averaging these two soil sequestration rates gives a rate of 1.93 metric tonnes per hectare per annum as a combined rate for pasture (mob-grazing) farming and organic farming techniques.

It is assumed that 40% of farmland could participate, stepping up in increments of 10% per year up to a maximum of 90% (0.9 x 0.4 = 0.36 of all farmland is therefore the maximum participation).

Biosphere branding scheme (based on Knaus et al.(2017))

Knaus et al (2017) provides estimates of GVA uplift factors, 2% for agriculture products and 19% forestry products, based on a study of a UN Biosphere Reserve in Entlebuch who had a Biosphere branding scheme. The logic here is that adding a 'Biosphere' branding to the output of the Forest of Dean agriculture and forestry outputs will cause these to be viewed as 'premium' products which can charge a higher price. The higher price, with the same production costs causes the gross value added in the locality to increase.

These rates (2% and 19%) are applied to baseline agriculture and forestry GVA respectively.

Local Multiplier effects

This analysis takes into consideration a local multiplier effect, to reflect the amount of money earned from the selling of local products and which is then spent again within the Forest of Dean area. This local multiplier is sourced from academic studies into local multipliers. This local multiplier provides a measure of the benefits of local products remaining within the local region, Annex A provides a survey of studies estimating local multipliers in the UK; for comparison Knaus et al (2017) use a local multiplier for the Entlebuch UN Biosphere Reserve of 25%. This report uses the smallest local multipliers given in Annex A, that is 5.9% as it was felt that the Forest of Dean District is a very open economy with little of the spend in the area remaining within the District for further spending.

For prudency the lower rate of 5.9% is applied to the total of:

- All additional agriculture and forestry GVA generated in the scenario.

Benefits Optimum Bias

To calculate the benefits for the economic case, this analysis is using predominately secondary sources, in the form of academic studies. From these, benefits are estimated for the Forest of Dean district based on pro-rating Gloucestershire county statistics or UK national statistics. Across the analysis the judgement has been taken to apply a 40% optimism bias to the benefits calculated. This level of optimism bias reflects guidance given in the HM Treasury Green Book for dealing with low quality data, where quality relates to direct applicability. This report considers that this is appropriate due to the level of uncertainty around what the actual values would be if collected from primary sources for the Forest of Dean District itself, once the Biosphere Reserve was in place. The effect of applying this optimum bias to the benefit streams is to reduce the calculated benefits by 40%, at this stage this appears to be the prudent strategy for the economic case.

5.3 The costs of the UN Biosphere reserve scenario

In determining the costs for the UN Biosphere Reserve designation and on-going functioning of the reserve this report assumes the following:

Forest of Dean District Council Project initiation

£100,000 is set aside for each of the first two years to fund proposal writing and supporting research to augment and further develop the appraisal in this report.

Forest of Dean District Council Biosphere co-ordination:

One of the main costs for the UN Biosphere Reserve both in the designation phase and on-going is that of a project officer(s) to co-ordinate the application process and for co-ordinating the Biosphere partner group and work of the Biosphere Reserve. This report assumes 1.5 FTEs with a cost of £40,000 per annum per FTE. This is based on the North Devon Biosphere Reserve's experience.

Forest of Dean District Council Biosphere communication:

Similarly, there is a need for a communications officer and communications budget to raise awareness in both the business and local communities of what a UN Biosphere Reserve is and what the aims are of the Biosphere Reserve once it reaches designated status. For the purposes of this economic case this analysis assumes that there will be 1 FTE communications officer costing £40,000 per annum per FTE and a communications budget of £15,000 per annum. Both of these costs are on-going costs for the initiation phase of the project and for the operation of the Biosphere Reserve.

Biosphere Reserve education

For a successful initiation and operation of the Biosphere Reserve it was felt that there was a need for a public education process concerning the Biosphere Reserve and to raise awareness, to increase participation rates in the local nature areas and to influence consumer habits (i.e. to buy locally, to choose organic option and to lower carbon footprints). The funding for the education budget is assumed to be available from the Biosphere Reserve partner organisations. It is assumed that there will be 5 partner organisations each contributing £10,000 per annum to the Biosphere Education budget.

Physical Infrastructure

There are two elements to the physical infrastructure costs, these are:

UN Biosphere Reserve signage; and

The costs of setting up of the Glulam/Biofuel factory.

UN Biosphere Reserve signage

It is assumed that there will be a one-off cost of £10,000 to produce and erect signs announcing that you are entering the Forest of Dean UN Biosphere Reserve following the successful designation and change of status. This cost is based on the experience of the North Devon UN Biosphere Reserve.

Glulam/Biofuel Factory

This is the counter-part cost to one of the benefit streams, namely dealing with the output of the induced woodland management scheme (coppicing) by processing into either glulam construction beams or into a biofuel (i.e. wood pellets), as one of the initiatives following Biosphere Reserve designation.

The factory costs are broken down into the following

Land acquisition: £2,500,000

Construction costs: £1,000,000

Capital investment: £2,000,000 (with re-investment in 2035)

Maintenance costs: £105,000 per annum

This paper makes no assessment of the standalone viability of a glulam facility, in either economic, financial or cashflow terms. This is because valid assumptions cannot be made at this time around:

- Market demand for Glulam products
- The current state of the UK and international Glulam markets
- The degree to which existing coppiced timber from the Forest of Dean, or the wider UK would prefer this unit to other competitors in either the UK or internationally.

To manage the risks around this area, the costs are calibrated to broadly equal the benefits created, so as to not affect the headline net present value.

Costs Optimum Bias

Again, to be prudent and after considering the input quality to our assumptions regarding costs this analysis uses an optimum bias of 40%, to treat the cost inputs as having a low data quality. This has an effect of increasing the costs by 40% within the calculations.

Chapter 6: Headline Results

The project has been evaluated over a thirty year window (2018-2048).

Benefits

Base-case (Do Nothing)

Over the thirty year window, in nominal prices, the benefits streams deliver the following benefits:

Benefit Stream	**Nominal Benefits (£m)**
Carbon sequestration	£242.5m
Agriculture GVA	£810.8m
Forestry GVA	£766.1m
All other GVA	£66,397.9m
Total Nominal Benefits	£68,217.3m

The following table converts these nominal benefits first into real (by stripping out core inflation) and secondly into discounted terms (to take account of social time preference (the preference for jam today over jam tomorrow) and catastrophe risk (the threat that in the long-term an event could occur which affects the value generated – such as war etc).

Basecase Benefits	
Total Nominal Benefits	£68,217.3m
Total Real Benefits	£50,042.4m
Total Discounted Benefits	£31,302.9m

This table shows the impact of these factors over 30 years, reducing the numerical value by over 50%, but by doing so this analysis is able to more consistently compare the value today of different benefits over time.

Because GVA is a net figure and the costs of delivering forestry and farmland management are inherent within the costs netted out of GVA, these figures express the benefits received over the costs, so costs do not need to be separately shown.

Implementation Scenario

The implementation scenario captures all costs and benefits over and above the basecase value. Because the basecase can be treated as a constant this analysis looks only the additional components:

Benefit Stream	Nominal Benefits (£m)
Carbon capture lost through coppicing	-£4.5m
Carbon capture gained through coppicing	£5.2m
Carbon capture gain from sustainable farming	£42.3m
GVA agricultural sector – branding	£8.9m
GVA forestry sector - coppiced timber	£3.9m
GVA forestry sector – branding	£80.1m
GVA other sectors	£17.3m
Multiplier effect	£6.5m
Total Nominal Benefits	£159.7m

The following table again converts these nominal benefits into real and discounted terms.

Scenario Benefits	
Total Nominal Benefits	£159.7m
Total Real Benefits	£110.8m
Total Discounted Benefits	£61.6m

Compared to this, the costs are as follows:

Cost Stream	Nominal Costs (£m)
Communications	£0.20m
Physical Infrastructure	£0.01m
Project Staff	£4.61m
Education	£2.96m
Glulam Facility	£17.37m
Total Nominal Benefits	£26.19m

The following table again converts these nominal benefits into real and discounted terms.

Scenario Costs	
Total Nominal Costs	£26.19m
Total Real Costs	£20.95m
Total Discounted Costs	£15.83m

Chapter 7: Conclusions and areas of further research

The purpose of an economic case is to evaluate the net present value (NPV) of the sum of the discounted benefit stream and the discounted cost stream over the length of the project and to calculate the Benefit to Cost ratio (BCR) of the policy option under consideration.

The calculations are focused on tangible economic benefits derived from either Biosphere branding scheme or from two modest incentive schemes which the Biosphere could employ focused on producing tangible products. This report does not attempt to measure any benefits which could arise from changing consumer habits, i.e. through increased purchases of locally produced products, health benefits from increased interaction with the natural environment, opportunity cost benefits from preserving nature or from mitigating future climate change crisis or from biodiversity losses. In this regard this analysis maintains a prudent approach and focuses on those few areas which have suitable academic studies to support the estimation process. This report also continues the prudent approach by using a high optimum bias for both benefits and costs to reflect the uncertainty over the estimation process from not having primary data sources to work with.

For the Implementation scenario, this delivers the following:

	(£m NPV)
Discounted Benefits	£61.55m
Minus	-
Discounted Costs	£15.83m
Equals	=
Net Present Value	**£45.72m**
Benefit-Cost Ratio	**3.89:1**

Based on the above benefits and costs for the Biosphere Reserve, recognising these to be a limited sub-set of the possible benefits which a Biosphere Reserve could generate, and an indicative costing based on the best data available, this analysis calculates a prudent and evidenced-based assessment of the BCR of the policy option of the Forest of Dean District becoming a UN Biosphere Reserve.

Even under this prudent approach to the estimation process, the Biosphere Reserve option yields a **BCR of 3.89:1**. That is for every **£1.00 of costs** the Biosphere Reserve option **yields £3.89** as a return over a 30 year period. This would indicate that the Biosphere Reserve Option is a viable policy decision for the Forest of Dean District Council to consider investigating further.

This BCR is a first order estimation and further research should be continued to improve the accuracy of the estimation of both costs and benefits as the project proceeds and the level of certainty concerning the benefits and costs increases.

Importantly, these benefits and costs are both 'cashable' relating to financial incomes and costs, and 'uncashable' – particularly those which relate to environmental factors such as carbon sequestration. This NPV therefore should not be used to automatically assume that the 'cashable' financial benefits will deliver a net gain to the Forest of Dean economy.

Stripping out the 'non-cashable' benefits (all the costs are financial costs) delivers the following:

Scenario Cashable Benefits	
Total Nominal Benefits	£116.7m
Total Real Benefits	£81.9m
Total Discounted Benefits	£46.6m
Net Present Value (Benefits – Costs)	£30.8m
Benefit Cost Ratio	2.95:1

This suggests that again, on our initial assessment, over a thirty year period, is present value terms, this delivers a net cashable benefit. Users should note that this does not imply cashflow or financial feasibility. In particular, no borrowing costs in relation to the Glulam investment are assumed – it is assumed this investment is purchased at the time of construction without a mortgage or other such loan.

In terms of areas captured in this report which would most benefit from further research, the following have been identified:

- The carbon sequestration benefits of coppicing.
- The branding impact on the particular agricultural products and distribution networks experienced by Forest of Dean
- The market for Glulam products and the financial feasibility of a Glulam facility; the necessary investment, the scale of the opportunity and the cashflow and profitability implications of a successful business model, to better map the economic impact for inclusion in this analysis.

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Data sources are listed in footnotes for ease of navigation.

Annex A: Local Keynesian Multipliers.

Study	University	Keynesian Multiplier	Comments
Brownrigg (1974)	Stirling University	1.24 & 1.54	
Mckenzie (1982)	Bolton Institute of Higher Education	3.0	Assumed value, Generally seen as an overestimate
Bowers et al (1981)	Yorkshire & Humberside HEIs	1.3	
NETUSIU (1982)	Southshields & Hebburn Colleges	1.3	Multiplier taken from Bowers et al (1981)
University of East Anglia (1982)	University of East Anglia	1.2	
Braddon et al (1982)	Bristol Polytechnic	1.15	
Mallier & Rosser (1986)	Lanchester Polytechnic (Coventry)	1.5	Assumed mid-value of estimates (1.2-1.7) from previous studies
Lewis (1988)	Wolverhampton Polytechnic	Urban: 1.027 Region: 1.103	
Southampton University (1991)	Southampton University	1.197	
Bleaney et al (1992)	Nottingham University	1.059	
John Moores University (1993)	Liverpool & John Moores Universities	1.45	Assumed value – mid-range of previous studies
Armstrong (1993)	Lancaster University	Staff earnings: 1.20 Student spending: 1.25 Other: 1.15	Armstrong (1993) approach has since been recognised as an example of good practice, in that he calculated separate multipliers for different types of spending.
McNicholl (1993)	Strathclyde University	Output: 2.15 Income: 1.66	Multiplier values based on the 1989 Scottish Input-Output Tables
Battu et al (1998)	Aberdeen University	1.46	Relatively closed region
Kopainsky et al (2008)	Swiss Case Study regions	Agriculture: 1.21-1.51 Value added: 1.13 – 1.23	
Knaus et al (2017)	Entlebuch UN Biosphere Reserve	1.25	Only local multiplier from a Biosphere Reserve.