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NATURAL CAPITAL ACCOUNTING - THE UK EXPERIENCE

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NATURAL CAPITAL ACCOUNTING - THE UK EXPERIENCE

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Measuring what matters

The UK Government's White Paper on the Natural Environment, *The Natural Choice*, committed to growing a green economy in which the benefits of nature would be recognised and valued. Natural assets and the services they provide are part of our nation's wealth, and therefore the White Paper commits the UK Government to taking action to capture these values in the nation's balance sheet. A number of international developments, such as the United Nations (UN) led study "*The Economics of Ecosystems and Biodiversity*", the "Stiglitz" report on *Measuring Economic Performance and Social Progress*, the Convention on Biodiversity (CBD) agreement to incorporate the values of biodiversity into national accounting systems by 2020, the World Bank "WAVES" programme and the Rio+20 UN Conference on Sustainable Development, point in the same direction.

Background to the UK interest in natural capital accounting

The importance of measuring and monitoring the use and value of natural assets in order to manage them better was firmly established on the UK agenda through the completion of the UK National Ecosystem Assessment (UK NEA), which was an unprecedented national level ecosystem assessment in terms of scale and depth. The UK NEA is a key source of information about the current state of the UK ecosystems and the ways in which they provide services. The report was supported by an economic analysis which emphasised the broader value of nature as opposed to the direct market benefits or provisioning services and demonstrated how meaningful valuations of these other services at the national scale could be obtained.

System of Environmental-Economic Accounting (SEEA)

Over the last few years, the international community has made progress in a number of areas of Environmental Accounts. Of particular note is the development of a UN framework for environmental-economic accounting under the aegis of the United Nations Statistical Division. Volume I containing the central framework of economic-environmental accounts was approved as an international standard by the UN Statistical Commission (UNSC) in February 2012. Volume II on the UN System of Environmental-Economic Accounting (SEEA) deals with the development of ecosystems accounts. It was presented to the UNSC in February 2013 and was endorsed as a state of the art research document.

The UK is committed to supporting this process, by contributing to the development of the SEEA and by supporting the World Bank's WAVES programme.

Development work within the UK

Following on from the White Paper Commitment, the Office for National Statistics (ONS) published a roadmap in December 2012 setting out the timetable for the development of ecosystems accounts in the UK and the process for managing the programme of work. This is in addition to the maintenance and

further development of the existing environmental accounts, which have been published annually by ONS for over 13 years. The ONS and the UK Ministry of Environment (Defra), together with a wide range of other organisations, are now working on the following priorities, as set out in the roadmap:

- A pilot account for **woodlands**, to be completed in 2013/14. This will enable the conceptual framework to be tested, and will meet policy priorities following recent concerns about the impact of tree diseases and the UK Government's commitment to include the value of ecosystems services within the annual reports of the Public Forest Estate
- Initial work on accounts for **wetlands** and **enclosed farmland** were selected because of policy priorities and the availability of relevant data; it is also intended to commence in 2013 on the development of accounts for the **marine environment**, which will raise new conceptual and data challenges
- We are committed to developing **cross-cutting accounts for carbon**, **water and soils**, with carbon accounts being identified as an early priority
- Work has begun in 2013 in developing wider natural capital estimates within the framework of **comprehensive wealth accounts**, in order to provide an immediate overview of the value of natural capital within the UK

Key challenges

The implementation of natural capital accounting and the development of ecosystem accounts in the UK raise a number of challenges:

- The need to ensure the engagement and support of the Finance and Environment Ministries. Within the UK this will at least partly be achieved through the aegis of the Natural Capital Committee (NCC), which was established in 2012 as an independent expert body advising the Economic Affairs Committee (chaired by the Chancellor of the Exchequer) on the sustainable use and efficient management on natural capital. The NCC and the Ministry of Environment are both closely involved at a senior level in the development of ecosystems accounts within the UK
- The identification of priorities for the development of the accounts. This is made easier in the UK because of the availability of the National Ecosystem Assessment. Nevertheless the roadmap was only agreed after extensive consultation and a formal review of progress in two years time will be needed in order to ensure that the correct priorities have been identified
- The need to manage stakeholder expectations. In the UK we have tried to balance the demand for quick wins (through the development of pilot woodlands accounts and immediate improvements to the overarching estimates of natural capital) with a longer term research agenda (for example on marine ecosystem accounts). Regular stakeholder engagement is seen as a key component of the workplan. It should also be recognised that ecosystem accounts do not address all sustainability issues: whilst trade-offs can be analysed within the accounting framework, they will need to be extended in order to assess irreversible depletion or damage in relation to environmental limits/thresholds
- The need for a coherent conceptual framework. Ecosystems accounting is a relatively unexplored area and further conceptual work will be required before the accounts can prove their value. There are few established practitioners in this area and with the different professions involved (statisticians, economists, scientists) there is also a need to ensure that stakeholders have the same understanding of terms and concepts. We are addressing this need through the publication of discussion papers which will set out the framework we are working to and some of the issues we are trying to resolve
- Data and valuation issues. These relate particularly to the need for spatially detailed data and to the challenges of valuing services which have no market price. Clearly data providers need to be

involved at an early stage. The suitability and reliability of various valuation techniques is a potentially contentious issue and one which we intend to manage by close collaboration with both UK and international experts in this area. It will clearly be important to be as open and transparent as possible about the accuracy and compatibility of valuations derived using different approaches.

There are a number of challenges in developing natural capital accounts for those habitats and resources for which market prices are not available; however, due to limited non-monetary data and different valuation techniques there are a lot of challenges even for valuing those natural capital for which market price exists. In June 2013, ONS published the first estimates of UK timber resources. It is widely believed that timber is a data rich natural resource; however, a number of issues were encountered not even monetising timber resources, but also getting non-monetary data right in the first place. This paper discusses the methodology, data sources and issues that were encountered in developing monetary asset accounts for timber resources.

Monetary valuation of UK timber resources

Methodology

In the UK all timber resources can be regarded as available for wood supply (according to FAO guidelines) and therefore ONS included all the timber resources within UK woodland in timber valuation. By assuming all timber is available for wood supply, ONS did not make an assumption that woodland in the UK is only managed for timber. The focus was to value the timber resources as an asset regardless of whether they provide other ecosystem services.

Valuation of timber resources

Ideally, observable market prices should be used to value timber resources and the ideal source of these prices are values observed in markets in which each asset traded is completely homogeneous. SEEA Central Framework indicates that it is important to value an environmental asset in situ – the asset itself as it is in the ground – rather than after its removal. The UK timber resources were valued in situ and theoretically the value of the timber resource is the discounted future stumpage price paid by the buyer to the owner of the forest for standing timber.

The average price of coniferous standing sales[1] (per cubic metre over bark) by the Forestry Commission, 2013 is available for Great Britain. Coniferous species account for over 90% of all timber harvested in the UK, and the Forestry Commission accounts for around half of all coniferous timber sold. Assuming that broadleaved species, which are not traded as regularly, have the same stumpage price as coniferous species, ONS used the average price of Forestry Commission coniferous standing sales as the average stumpage price for all timber. Due to limited available data on stumpage price this was a fair assumption and was verified with experts from the Forestry Commission.

Since the future flow of benefits of timber resources need to be valued, the NPV method given below is used to estimate the discounted future stream of income to value UK timber resources.

[1] Average prices for Forestry Commission sales of coniferous standing timber are published in the Forestry Commission's National Statistics release "Timber Price Indices"

Net Present Value (NPV)

1. The measurement of returns on environmental assets

SEEA suggested that the resource rent for timber resources could be estimated more directly by using estimates of the stumpage price[2]. However, using stumpage price as the resource rent presents a risk that the management cost and normal return is not deducted. Furthermore, the market stumpage price reflects the value of wood in those woodlands which are currently relatively easily accessible, and may overstate the price for less accessible woodlands which are not currently managed for timber.

Alternatively resource rent could be estimated by the widely used residual value method which is estimated by deducting the user cost of produced assets from gross operating surplus after adjustment for any specific subsidies and taxes. However, this requires a number of assumptions and the data are currently not available.

The stumpage price, as discussed above, was used as the unit resource rent (URR) of UK timber resources. The URR was assumed to be constant over the asset life, so the volatility of the URR could affect the expected resource rent. To smooth out these URR fluctuations, five year average was applied:

$$Adjusted\ URR = \frac{URR_{t-2} + URR_{t-1} + URR_t + URR_{t+1} + URR_{t+2}}{5}$$

Where t is the current time period

The value of timber resources as at 1 April 2011 is based on the stumpage price of conifers in real terms (2011 prices) as follows:

Table 1: Stumpage price of conifers sold by Forestry Commission

Year to	31-Mar-09	31-Mar-10	31-Mar-11	31-Mar-12	31-Mar-13
Average price per cubic metre overbark	9.66	9.99	13.87	13.99	12.99

Source: Timber Price Indices: Data to March 2013, Forestry Statistics

The data in Table 1 feed into the equation above and gives an adjusted URR of £12.10. The adjusted URR was used to estimate the expected resource rent for the timber resources.

2. Pattern of expected resource rents and asset life

The critical factor in the valuation of timber resources is determining the expected pattern of the resource rent. Expected patterns are not observed and hence assumptions concerning the flows must be made. The pattern of the expected extraction of timber resources would determine its asset life.

In general, the URR is very volatile but in the absence of any robust forecasts of future patterns, it is not possible to incorporate future price changes in the Net Present Value model. Therefore, the URR (stumpage price) is held constant based on the current estimates of adjusted URR. There are a number of ways to determine the patterns of the expected resource rent for timber resources:

1. One way is to project the future extraction. However, in the absence of information on future cost, prices and extraction rates it is not possible to estimate a reliable extraction projection. The Forestry

[2] Source: SEEA Central Framework Chapter 5, Page 181

Commission is running a project on the production forecast of timber resources. The medium term (25 years) forecast for conifers has been released recently while forecasts for broadleaves and longer term forecasts are still in progress. A long term projection is needed due to longer timber rotation, if this option is chosen

2. A second way is to assume that the current extraction rate and the natural growth rate are constant. If this option is chosen, the possibility of over-exploitation and afforestation may not be captured in the value

3. A third way is to consider the age structure of the timber resources. Generally, timber resources have different growth rates – higher growth rates when they are young, constant rate close to harvesting, and declining growth rate after maturity. Considering these growth patterns, an optimum harvesting age can be derived using the Faustmann rule or the maximum mean annual increment concept.

The Faustmann rule gives the present value of the income stream of the forest rotation and provides the optimal harvesting age. This rule is popular in the economics of forest management, as it takes into account the economic efficiency and gives an optimal age of timber resources which maximises the return of timber. However, this method requires a number of assumptions and information on the value of forests, expected prices and associated costs, which are not readily available.

The mean annual increment is the average annual increase in the volume of a tree at a certain age. The maximum mean annual increment concept is based on different growth rates in timber resources throughout its life span. However, the average age of the maximum mean annual increment is currently not available for UK timber resources. Further work needs to be carried out to determine an average age of the maximum mean annual increment across different species in UK woodland. For the calculation we assumed that the harvesting age is in the 41-60 class. The mid-point for this class is 50 years and this is assumed as the harvesting age in this monetary asset account. The selection of this harvesting age has been supported by the sensitivity analysis. From the analysis, it was found that within the parameters of the model set out in this paper the optimal harvesting age class is 41-60. This supports our selection of a harvesting age of 50 years.

Since timber grows until it is harvested, the expected volume of standing timber for each age class is assumed to be fixed at the harvesting age. Table 1 shows the various age classes for UK timber resources. The stocked area and actual volume of timber in that area for each age class is shown in column 2 and 3 respectively. The last column shows the estimated volume per hectare for each age class, calculated by dividing the actual volume of timber by stocked area of the respective age class. Since the harvesting age is assumed to be between 41–60 years, the expected volume per hectare at harvest for each age class is fixed at 304 m^3 overbark/hectare for the NPV calculations in Table 2.

It can be seen from Table 2 that there are timber resources in the UK that are older than the harvesting age - known as overdue timber - with volume above 304 m^3overbark/hectare. This additional volume is not considered in the valuation of the timber resources.

Table 2: Calculating volume per hectare[3]

Age Class	Stocked area	Actual volume	Volume per hectare
Unit	hectare	million cubic metres overbark	m^3/hectare
0-20	622,176	15.46	25
21-40	865,776	173.64	201
41-60	**645,676**	**196.20**	**304**
61-80	284,676	91.44	321
81-100	134,876	54.61	405
100+	126,276	53.96	427
Total	2,679,454	585.31	

3. Choice of discount rate

A discount rate is required to convert the expected future stream of resource rents into prices for the current period. A discount rate expresses a time preference - the preference for the owner of an asset to receive income now rather than in the future. It also reflects the owner's attitude to risk. The use of discount rates in NPV calculations can be interpreted as an expected rate of return on the environmental assets. There are two broad types of discount rates – market (individual) discount rates and social discount rates.

Market discount rates are usually higher than social discount rates as individuals or enterprises tend to demand a quicker return from ownership of an asset. The use of a market discount rate provides a stronger comparison across different types of assets and the trade off between assets can be considered. On the other hand, social discount rates place a higher relative importance on income earned by future generations.

To be consistent with the SNA Accounting principles a market discount rate should be used, but since environmental assets are of long term value to society, they should be valued from a societal perspective. Therefore, we applied the social discount rate from the HM Treasury Green Book (Table 3).

Table 3: Social Discount Rate

Period of years	0-30	31-75	76-125	126-200	201-300	301+
Discount rate	3.5%	3%	2.5%	2%	1.5%	1%

Source: HM Treasury's Green Book

[3] Sources: National Forest Inventory Report:
- Standing volume of broadleaves in woodland in Great Britain
- Standing timber volume for coniferous trees in Britain

Application

The following NPV formula is used to estimate UK timber resources at 1 April 2011:

$$Total\ Value\ of\ UK\ timber\ resources = \Sigma \frac{resource\ rent}{(1+r)^t} = \Sigma \frac{avq}{(1+r)^t}$$

p = Unit resource rent (stumpage price)
av = Represent the expected volume of standing timber at the harvesting age
r = Social discount rate
t = Asset life (harvesting age minus age class)

The unit resource rent (p) of £ 12.10 is multiplied by the expected volume of standing timber (q) of respective age class to estimate the future receipts. The expected volume of standing timber is calculated by multiplying stocked area with volume per hectare at harvesting age. Estimates of stocked area at 31 March 2011 by age classes, and actual timber volume is taken from the NFI (Table 2). As discussed earlier, the volume per hectare is fixed at 304 m^3overbark/hectare for all age classes. This ensures that the expected natural growth for age classes 0-20 and 21-40 are accounted in the NPV model.

A midpoint for all the age classes is calculated to obtain the asset life corresponding to each age class. The midpoint for harvesting age class (41-60) is 50 years and therefore, 50 years is used as the harvesting age. To estimate the asset life of timber resources in each age class, the midpoint is subtracted from the harvesting age. For example, for class 0-20 the midpoint is 10, which is subtracted from the harvesting age of 50 years to obtain an asset life of 40 years. Timber resources above 50 years are valued at their expected volume of 50 years instead of their actual volume.

A social discount rate as shown in table 3 is then applied to discount the future receipts to estimate the value of timber resources at each age class. Since the harvesting age is set between the 40 and 60 age class, the future receipts from 60+ age classes are not discounted, as these trees could (by assumption) be harvested now. The total receipts from all age classes of timber resources give the total value of UK timber resources.

Table 4: Monetary value of UK timber resources at 1 April 2011

Age structure	Stumpage price per cubic metres **£**	Stocked area ***hectare***	Volume per hectare at harvesting age m^3/ha	Midpoint of age class	Asset life[4]	Discount Rate	Value for each age class	Value for each age class **£** ***million***
	p	a	v		t	r		
0-20	12.10	622,176	304	10	40	3%	$\frac{pav}{(1+r)^t}$	701
21-40	12.10	865,776	304	30	20	3.5%	$\frac{pav}{(1+r)^t}$	1,600
41-60	12.10	645,676	304	50	0	0%	$\frac{pav}{(1+r)^t}$	2,374
61-80	12.10	284,676	304	70	0	0%	$\frac{pav}{(1+r)^t}$	1,047
81-100	12.10	134,876	304	90	0	0%	$\frac{pav}{(1+r)^t}$	496
100+	12.10	126,276	304	100	0	0%	$\frac{pav}{(1+r)^t}$	464
						Total value of stock	$\Sigma\frac{pav}{(1+r)^t}$	6,682

It should be noted that the above valuation does not take account of any restocking after harvesting.

[4] Calculated by taking the harvesting age less age class.

Results

The monetary value of UK timber resources is estimated to be £6.7 billion at 1 April 2011 by applying NPV under the following assumptions:

- The stumpage price is the same across all the timber resources
- A 5 year average unit resource rent is constant across the account asset life
- The net return or resource rent is received when the timber is harvested. The harvesting age is 50 years and all timber is available for wood supply
- As the timber grows until it is harvested, the expected volume of standing timber for each age class is fixed at harvesting age
- Non-uniform social discount rate

The valuation of timber resources was undertaken on all standing timber. All the standing timber stock was being valued as if it was used solely as timber without considering the other ecosystem services they provide. Therefore, the value derived is an asset value of timber resources when they are being removed and used as timber products. The ecosystem services, other than removal, provided by UK woodland will be captured in a separate ecosystem service account.

Table 4 shows that the estimated monetary value of timber resources above 60 years of age is around £2 billion. This value is based on the assumption that the timber is overdue and could be harvested at anytime. This approach is consistent with SEEA Central Framework and the System of National Accounts (SNA), which states that any asset which is used for economic production has an economic value. The timber resources above 60 years are available for wood supply and therefore they need to be valued. The asset value derived in this paper is based on the SNA principle and could be incorporated into the UK Environmental Accounts.

However, there is a possibility that these timber resources are unlikely to be harvested and might have been grown for other purposes than timber, for example, to provide other ecosystem services, or both. Therefore, as discussed in the introduction section, the value derived in Table 4 for timber resources does not take into account the value of the other ecosystem services that they provide. In fact, the value that society attributes to these trees is likely to be much higher; however, that is beyond the scope of this paper.

Issues

Asset Life

In the absence of any information, the asset life of UK timber resources was assumed to be 50 years. If the asset life is changed to 30, 70 or 90, the result is significantly different. Studies elsewhere assumed different asset life. World Bank took 25 years as the asset life and some studies have even taken asset life for timber to be infinite.

Prices

There was no data available on broadleaves prices and therefore it was assumed that broadleaves have the same prices as conifers. However, due to the different characteristics of conifers and broadleaves, it may be possible to portray these separately within the model. This would require separate harvesting ages (from different average maximum mean annual increments) and different average stumpage prices. Constructing an estimate of stumpage price, or another form of price, for conifers and broadleaves may enable the account to reflect their differing values.

Interest rates

The issue of discount rate is something that the environmental economics literature has wrestled with. Social discount rate is the rate that the government would choose in allocating the resources across generations and should be used to value the environmental assets. Social discount rates were used to convert the expected future stream of resource rents from UK timber resources into prices for the current period.

However, the use of social discount rate is not shared widely yet. SEEA suggests using market discount rate if the valuation needs to be consistent with the SNA principles. We are not entirely agreed in the UK on what rate to use to value the environmental assets but can see the argument of using a single non-prescriptive (in the sense used in the SEEA) rate. Although social discount rate was used to convert the expected future stream of resources rents, we used a high social discount rate. A social discount rate of 3.5% as recommended by HM treasury Green Book was applied.

Management Practices

The monetary value of UK timber resources is not the total value of UK woodland; it is just the value of the timber resources that are located in UK woodland. The total value of UK woodland is the sum of both the timber assets and other woodland ecosystem assets.

However, there is a trade-off issue between timber resources and other ecosystem services. Trees in the woodland are grown for two main purposes – supplying wood and providing ecosystem services. Depending on the management practices, all timber resources could be available for wood supply, or all timber resources could be protected to provide ecosystem services, or a combination of both. However, even if all timber resources are available for wood supply, they could still provide ecosystem services until they are harvested. Therefore, it is important to understand the management practices of timber resources. More specific assumptions about management would be needed to combine valuations of multiple ecosystem services into an overall asset value.

Valuation issues

The valuation of timber resources was undertaken on all standing timber. All the standing timber stock was being valued as if they were used solely as wood/timber without considering the other ecosystem services they provide. Therefore, the value derived was an asset value of timber resources when they are being removed and used as wood products. The ecosystem services, other than removal, provided by UK woodland will be captured in the ecosystem asset account. However, depending on the assumptions made, there are two ways to value the ecosystem asset.

First, if the main objective for all standing trees is for timber production, the ecosystem services can be valued based on the extraction profile set described in the methodology above. If this extraction profile is adopted, the ecosystem services, excluding removals, will keep on declining and the value of ecosystem assets is likely to be small. Under this method, the sum of the ecosystem asset value and the timber resources value derived above will give the woodlands value as a whole under the assumption that timber product is the main objective.

Secondly, an assumption could be made that all the timber is not removed to find the maximum ecosystem asset value from UK woodland. This is an opposite assumption to the one that the ONS has used. This will allow a comparison between the maximum value of standing trees with a timber production focus and the maximum value of standing trees with other ecosystem services as the focus. However, the sum of these two values will not be equal to the total value of woodland because there will be double

counting issues. This is because if the trees are removed for timber production, it cannot provide other ecosystem services (or at least lower services as no trees).

The principle of the valuation accounting is likely to follow the second approach. Analysis can be made on the trade off between these two aspects to identify how many percent of timber resources should be kept as wood products which could be removed and how many percent of timber resources should be kept to provide ecosystem services to maximise the value of the woodlands.

However, this should be noted that this only relates to the ecosystem services provided by standing trees themselves. Woodland provides other ecosystem services which are not provided by standing trees directly.

Future Plans

In December 2012, the Office for National Statistics (ONS) published a roadmap "**Accounting for the value of nature in the UK**" to incorporate natural capital into the UK Environmental Accounts. As part of the roadmap, ONS outlined a plan to improve the natural capital estimates within the framework of comprehensive wealth accounts – the so called "top-down approach", in order to provide an immediate overview of the value of natural capital within the UK.

ONS is planning to take the following approach to develop the natural capital estimates:

2013/14

- Develop the first UK natural capital estimates by the end of 2013 /early 2014 using the World Bank data because of the broad consistency of the methodology with UK Continental Shelf oil & gas reserves and UK timber estimates developed by the ONS
- Wherever possible, improve the estimates with the data sources available in the UK
- Include additional components of natural capital into the estimates for which data are available but which are missing from the World Bank estimates.

2014/15

- Improve the natural capital valuation methodology to provide the best possible estimates for the UK
- Explore the IWR methodology to estimate the UK natural capital
- Explore the inclusion of ecosystem services into the natural capital estimates.

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