Scoping Project for Development:
A Regional Index of Sustainable Economic Well-Being

A research report funded by Natural England and a consortium of Regional Development Agencies

Nef (the new economics foundation)

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Scoping project for development

Regional Index of Sustainable Economic Well-being

centre for well-being, **nef** (the new economics foundation)

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Executive Summary

This report brings together the findings from a project scoping the feasibility of further developing the Regional Index of Sustainable Economic Well-being (R-ISEW). As well as considering the theoretical framework of the R-ISEW, five main areas for development were explored:

1. Incorporating ecosystem services
2. Improvements to the long-term environmental damage component
3. Assessing the contrast between costing consumption and production
4. Checking through other possible component developments, exploring components used in other ISEW and ISEW-type metrics.
5. Assessing the feasibility of a scenario modelling tool, including the development of spreadsheets with which to use it.

The main conclusions were as follows:

Theoretical framework

The ISEW has always been criticised for lacking a clear overall theoretical framework. Whilst such a framework may not be necessary for the indicator to be useful, it would make it easier to explain and promote the ISEW.

The best approach at the moment appears to be to see the ISEW as *the sum of net service flows and the net change in capital stocks, resulting from the productive activity in a given period in a given area*. This can be expressed mathematically as:

$$ISEW = S + \Delta K$$

This formulation is consistent with most elements of the indicator, though modifications to some components would be needed if it were to be taken literally: particularly the costs of long-term environmental damage and the component relating to consumer durables.

Before adopting this approach we recommend dedicating more time to reviewing the literature on the concepts of sustainable income and service flows, as well as consulting with ISEW users and potential ISEW users as to the relative merits of attempting to define the indicator in strict theoretical terms.

Ecosystem services

Our initial intent in this section was to consider how to fully incorporate ecosystem services into the R-ISEW, such that the indicator would include components measuring environmental benefits alongside environmental costs and social costs and benefits. However, it is apparent that the framework of the ISEW would not be consistent with a pure ecosystem services approach. The ISEW remains primarily a measure of the net effect of economic activity – a region with no economic activity would have an R-ISEW of £0, no matter how rich its natural resources were. Furthermore, the ISEW does not measure stocks, only *changes* in stock. As such, it must be remembered that it cannot provide an overall picture of the environmental health of a region.

Having said that, there are definite improvements that can be made to the R-ISEW in this area. Most importantly, we suggest that the component 'loss of natural habitats' should be broadened to include more than just wetlands, and relabelled 'natural habitat change'. There are several valuation projects currently on-going and likely to reach completion in 2010, and these could be used to help provide estimates of the average unit value of different habitats in England.

Another possibility is to explore the potential for introducing to the R-ISEW an additional element – *depletion of renewable resources* – to account for their overexploitation. We consider forests and fisheries as potentially relevant, though in both cases a decision regarding how much effort is justified would need to be made, given the estimated size of the costs.

We recommend seeing change in amount of farmland as one element of natural habitats, and to see soil depletion as part of renewable resource depletion.

Lastly, work towards meeting the Water Framework Directive should provide us with a good basis to update costs of water pollution.

Long-term environmental damage

Currently, this component is based on the sum of greenhouse gas emissions past and present. The total amount of money required to meet the future costs of all these emissions is estimated, and then the amount of money that should be set aside annually to meet this sum is subtracted from a given year's R-ISEW.

However, this methodology is not compatible with the $S + \Delta K$ framework as it treats past emissions in the same way as the flow of costs from a given year. Furthermore, simulations reveal that it is not sensitive to changes in annual emissions - were a region to immediately stop emitting greenhouse gases today, the size of the component would not actually go down as past emissions still imply a cost.

Here, we explore an adaptation of this approach. Past emissions are still assumed to imply a future cost which must be met. But rather than include the cost as a whole in our calculations, we explore only including the interest on that cost. In other words, past emissions are seen as an ecological debt which should be, and is not being, serviced.

We also considered the implications of incorporating the findings from the Stern Review. Using the 'business-as-usual' scenario which Stern uses, the marginal cost of a tonne of carbon is 3.4 times higher than our current figure. Stern himself, since the Review, has suggested that he had previously been too optimistic and many reviews suggest his costings were too conservative. The damage function used in the Stern Review is also considered as this has implications for both the methodologies favoured here.

In future work on this component we would reconsider whether the way in which long-term environmental damage is modelled is compliant with the overarching theoretical basis of the index, as well as any practical requirements such as sensitivity to changes in annual emissions. The valuation of climate damage would also need to be revised either based on Stern's model, or to using some of the more recent estimates on the costs of climate change, bearing in mind the speed with which this field is currently developing.

Consumption or production

In this section, we consider the possibility of costing the environmental costs of the R-ISEW at their point of consumption (where a good or service is enjoyed), rather than their point of production. This is particularly relevant in an interdependent world where, increasingly, our lifestyles in the West are dependent on importing goods produced, and causing pollution, in other countries.

We suggest that the R-ISEW splits environmental costs between consumers and those that benefit economically from the relevant economic activity, allowing it to signal change for both groups. However, whilst this may be the goal, we recognise that in practical terms it would dramatically increase the difficulty of calculating the indicator.

We recommend a few key changes to make that would improve the balance between consumers and producers. Some changes can be made now, though others must wait for results to emerge from the EU EXIOPOL project which is due for completion in 2010 and which assesses the inputs and outputs of different industrial sectors and therefore goods and services.

Other developments

The following improvements emerged in this section:

- Service flows from consumer durables. Whilst this component in its current form is not compatible with the S + ΔK framework, there may scope to include a component that tracks the durability of household goods over time.
- Public expenditure. Currently only public expenditure on housing and education is included in the R-ISEW as contributing to economic well-being. We suggest a review of other areas which may be appropriate to include.
- Family breakdown. This is currently costed in terms of divorce. We explore potential to consider family breakdown more broadly than this.
- Leisure time. This is included in other ISEWs, and would be worth considering.
- Non-renewable resource depletion. Looking at other ISEWs suggests our unit cost for a barrel of oil could be improved.

Scenario model tool

In this section we consider the potential for a scenario-modelling tool that allows one to forecast the effect of different policies or projects on the R-ISEW. Two scenarios were considered: the extension of an international airport, and a 30% shift to home-working. Our work suggested that estimating impacts on the R-ISEW is a fairly quick assessment method. However, in the case of the airport, important impacts could not be incorporated given the R-ISEW's rigid framework. We conclude that R-ISEW scenario modelling may not be an appropriate tool for such infrastructure projects, though it may still be useful to provide one piece of information in a more detailed assessment. For examples such as the home-working scenario, R-ISEW scenario modelling did appear to provide useful information. However, even then, it would be advised to carry out more thorough, bespoke multi-stakeholder evaluation where impacts are likely to be significant. We recommend further examples be explored to determine the bounds of the use of the scenario-model tool.

Next steps

The report concludes with a set of recommendations for further research including (with estimated costs):

- Further thought on theoretical framework, in consultation with RDAs, and with further literature review (Section 1; £4,500 - £6,500).
- Identify unit values for natural habitats other than wetlands (Section 2; £12,000 - £16,000).
- Re-evaluate the water pollution component (Section 2; £3,000).
- Develop components for the depletion of renewable resources, specifically fisheries, but possibly also forests (Section 2; £8,000 - £18,000 per resource).
- Decide on LTED costing model (Section 3; £1,300).
- Review updates of the costs of LTED since the Stern Review, and implement in our chosen costing model (Section 3; £9,000 - £13,000).
- Implement rationalisations to the split of environmental costs between consumers and producers (Section 4; £12,000 initially with further work after 2011).
- Assess the possibility of adjusting consumer expenditure to account for real discount rates and changes in product durability (Section 5; £9,000 - £15,000).
- Assess the possibility of including other elements of public expenditure (Section 5; £1,800).
- Assess the possibility of augmenting divorce as a measure of family breakdown (Section 5; £3,000 - £5,000).
- Incorporate leisure time (Section 5; £2,500).
- Continue to follow Stiglitz Commission's work (Section 5; £1,800).
- Explore the potential of the scenario-modelling tools with other non-infrastructure projects (Section 6; £12,000).
- Develop software to automate scenario modelling (Section 6; £4,000 - £15,000, depending on the sophistication of the software).

Introduction

This report brings together the findings from a project scoping the feasibility of further developing the Regional Index of Sustainable Economic Well-being (R-ISEW). The work was carried out by **nef** (the new economics foundation) on behalf of Natural England and a consortium of Regional Development Agencies (RDAs) led by East Midlands Development Agency (***emda***).

Having produced the first full set of R-ISEWs for all nine English regions in 2007,[1] **nef** is currently contracted by the RDAs to carry out annual updates of the R-ISEW for three years from 2008 to 2010. The annual updates – incorporating data going back to 1994 – are being carried out using broadly the same methodology so as to ensure relative consistency of results. At the same time, **nef** and the RDAs have agreed to set development work in motion ultimately to:

1. Refine the methodology of the R-ISEW (potentially developing a simplified R-ISEW).
2. Help policy-makers make use of the R-ISEW.
3. Build international consensus on R-ISEW methodology as to enhance its profile.

This document reports on the results of a short scoping project aimed at exploring five main areas of development:

1. Incorporating ecosystem services.
2. Applying the Stern Review to the costs of long-term environmental damage.
3. Assessing the contrast between costing consumption and production.
4. Checking through other possible component developments, exploring components used in other ISEW and ISEW-type metrics.
5. Assessing the feasibility of a scenario modelling tool, including the development of spreadsheets with which to use it.

Early on in the project, it became apparent that we would also need to spend a little time considering the overall theoretical framework, with which we shall start this report.

[1] Jackson T, McBride N, Abdallah S, Marks N (2008) *Measuring regional progress: regional index of sustainable economic well-being (R-ISEW) for all the English regions* (London: **nef**).

1. Theoretical framework

It is perhaps fair to say that the original ISEW, developed by Daly and Cobb,[2] was not built from strict economic theory. Instead, it emerged out of a set of criticisms of where national accounts and specifically Gross Domestic Product (GDP) appeared to deviate from a principled understanding of economic welfare and sustainability. The various adjustments made within the ISEW individually generally hold up well to theoretical analysis, but, as a whole, it has been vulnerable to criticisms of a lack of theoretical framework.[3,4]

Such criticisms have not gone unanswered, and several academics have attempted to develop theoretical frameworks which could describe the ISEW.[5,6,7,8] Before outlining several approaches, we shall briefly consider conventional national accounts and GDP.

Our starting point – GDP

GDP can be viewed in three separate ways. First, it can be viewed as the set of all incomes earned in the domestic production of goods and services (income basis). Second, it can be viewed as the total final expenditures made (by households and by the public sector) on domestically produced goods and services or in adding to wealth (expenditure basis). Finally, it can be viewed as the total value added by activities which produce goods and services (output basis).

In conventional national accounts, these three ways are, in theory, equivalent; that is they all lead to the same overall level of GDP. In very simple terms, the reason for this is that incomes are earned only as a result of people's final expenditures on the output from productive activities. The value of the output, the expenditures, and the incomes must be equivalent.

Ultimately, GDP is an accounting identity. It sums up money passing through the domestic economy either as output, as expenditure or as income. Gross National Product (GNP) is a very similar identity accounting for the incomes, outputs, and

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[2] Daly H, Cobb J (1989) *For the common good: Redirecting the economy toward community, the environment, and a sustainable future* (Boston: Beacon Press).
[3] Neumayer E (1999) 'The ISEW – Not an index of sustainable economic welfare' *Social Indicators Research* **48:**77–101..
[4] Ziegler R (2007) 'Political perception and ensemble of macro objectives and measures: The paradox of the Index of Sustainable Economic Welfare' *Environmental Values* **16:**43–60.
[5] Lawn P (2003) 'A theoretical foundation to support the Index of Sustainable Economic Welfare (ISEW), Genuine Progress Indicator (GPI) and other related indexes' *Ecological Economics* 44:105–118.
[6] Lawn P (2006) 'Using the Fisherian concept of income to guide a nation's transition to a steady-state economy' *Ecological Economics 56:*440-453.
[7] Harris M (2007) 'On income, sustainability and the "microfoundations" of the GPI' *International Journal of Environment, Workplace and Employment* **3:**119–131.
[8] Brennan AJ (2008) 'Theoretical foundations of sustainable economic welfare indicators – ISEW and political economy of the disembedded system' *Ecological Economics* **67:**1–19.

expenditures of UK nationals (where ever they may be) rather than of those living in the country.

The inappropriateness of using GDP to assess anything other than what it measures at face value (the volume of market economy activity) has been well-known since the time of its creation, when Simon Kuznets – one of the architects of national accounts – warned of the danger of using it to measure welfare. It does not accurately measure total productivity, because it ignores activity that takes place outside of the market economy – volunteering and household labour. It does not measure economic wealth, because it ignores the depreciation of built capital. It does not measure the service flow gained from current economic activity, because it counts as positive defensive costs. It does not measure total service flow, because some service flows gained from capital stocks, be they built, social or natural, are not monetised in a given period (for example service flows from consumer durables). Given its failure to capture such traditionally economic concepts, it is no surprise that GDP also fails to measure broader concepts such as sustainability and well-being. In terms of sustainability, there is no consideration of the depreciation of natural capital. In terms of well-being, there is no direct assessment of people's quality of life, or their experience of their quality of life.

But what does the ISEW do? Does it address all these concerns? Clearly not. It does not directly assess people's quality of life – it is not a measure of human well-being in the way that **nef**'s *National Accounts of Well-being* are,[9] or the various composite indicators of quality-of-life which are being developed.[10] It does not measure the concept of strong environmental sustainability either, as it allows the substitution of natural capital for man-made capital. Indeed, it would be impossible for it to measure all the concepts noted above. No single figure can represent total productivity, wealth, service flow, well-being and strong sustainability. They are, to some extent, mutually exclusive as defining concepts.

It is vital that we are clear which concept, or combination of concepts, defines the framework of the ISEW. It is also vital that we define the limits of what we are measuring – in geographical and temporal terms. In doing so, we may decide that some components of the ISEW are not appropriate and should be excluded in future developments of the methodology. We may have to make decisions between comprehensiveness and interpretability. In other words, we might have to decide whether to include some components that are clearly important to sustainability or well-being, but do not fit easily into the ISEW framework.

Net psychic income

The Australian academic Philip Lawn has suggested that the ISEW should be thought of as a measure of *net psychic income*.[11] He argues that the measure should not focus on the production of consumer goods, or strictly on the expenditure on them, but rather the utility that flows from their consumption. This, Lawn argues, is the real measure of the welfare enjoyed by the population. The figure is further adjusted based on whether or not the capital base that allows this consumption is maintained, based on measures of loss of natural capital services.

Lawn's framework is still slightly problematic. The concept of psychic income is very much about 'the moment'. It implies not including exports and investments as positives in the ISEW as these do not add directly to psychic income. Depreciation of durables, it

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[9] Michaelson J, Abdallah S, Steuer N, Thompson S, Marks N (2009) *National Accounts of Well-being: bringing real wealth onto the balance sheet* (London: **nef**).
[10] **nef** recently carried out a review of well-being and quality of life indicators for Eurostat, and found around 50 approaches being operationalised worldwide.
[11] Lawn (2003) *op cit.*

argues, *is* a positive, as it is in effect the same as the enjoyment of those durables. This 'flows' framework, which does not attempt to capture *economic* sustainability, sits oddly with attempts to include *environmental* sustainability through incorporating the costs of long-term environmental damage (LTED) and resource depletion.

Lawn's treatment does not appear to resolve the challenge of establishing a framework that captures both the notions of *sustainability* and *economic well-being* in a single conceptually unitary index. Eric Neumayer,[12] who calls himself a 'constructive' critic of the ISEW, believes that the two concepts should be held separately. More recently, Lawn himself has come to the conclusion that something like the ISEW *cannot* truly capture sustainability as it allows too much substitution between natural resources and economic benefits. Lawn argues that sustainability would be better measured through comparison between a nation's ecological footprint and its biocapacity.[13] The ISEW's role then becomes more a measure of *weak* sustainability, allowing as it does trade-offs between economic well-being gains and sustainability costs (though some practitioners such as Redefining Progress in the USA argue that it is a measure of strong sustainability[14]).

Hicksian income

nef's approach to the ISEW has been shaped more by the concept of Hicksian income: 'the amount which [one] can consume [in the present] without impoverishing themselves [in the future]'.[15] Whilst Hicks did not believe he had found the perfect way to operationalise this concept, he felt the closest approximation was the concept of Net National Product (NNP) – income plus net capital accumulation.[16] This approach was supported by Weitzman's calculations that, admittedly by making some heroic assumptions, NNP was equivalent to the level of 'constant equivalent consumption' for future years.[17]

The ISEW as it stands, however, goes further than the classic formulation of NNP. Like Weitzman has implied is necessary in more recent papers, it considers the depreciation of other forms of capital besides built capital, namely natural capital.[18] It also adjusts for inequality, excludes defensive expenditure, adds value from household labour and volunteering, measures the service flow from consumer durables, and incorporates some externalities which appear to impact negatively on our well-being (such as the psychological costs of crime, or time spent commuting). It is clearly *not* simply a form of NNP that considers natural capital. Nor, it seems, would such a measure address all that many of the concerns that have been raised with regard to GDP. In which case, what is the ISEW?

A potential approach: S + ΔK

One promising approach which has emerged during the scoping project is described in this section.

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12 Neumayer (1999) *op cit.*
13 Lawn P (2008) 'Response to "Income, sustainability and the 'microfoundations' of the GPI"' *International Journal of Environment, Workplace and Employment* **4:**59–81.
14 Talberth J, Cobb C, Slattery N (2006) *The Genuine Progress Indicator 2006: A tool for sustainable development* (Oakland, CA: Redefining Progress).
15 Hicks J (1939) *Value and capital: An inquiry into some fundamental principles of economic theory* (Oxford: Oxford University Press)
16 Harris (2007) *op. cit.*
17 Weitzman M (1976) 'On the welfare significance of national product in a dynamic economy' *Quarterly Journal of Economics* **90:** 156–162.
18 Weitzman M (1998) 'On the welfare significance of national product under interest-rate uncertainty' *European Economic Review* **42:**1581–1594.

Income is only interesting in as much as it allows expenditure. ISEW practitioners have always seen the expenditure basis of GDP as the most promising starting point for adaptations. Furthermore, expenditure is only interesting in as much as it provides some sort of service, either in the present or the future. The difference between NNP and the ISEW can therefore be seen as a shift from a focus on income to service flows. Rather than measuring sustainable income, as Hicks attempts to do, it measures sustainable service flow. In a sentence it could be described as:

> *The sum of net service flows and the net change in capital stocks, resulting from the productive activity in a given period*.

This is embodied in the equation:

ISEW = S + ΔK

Where S is the service flow and K is the total stock of capital, including financial (Kf), built (Km) and natural (Kn). There are a couple of options in terms of how to apply geographical boundaries to the equation. Restricting the R-ISEW to service flow and capital change within the region in question would be, perhaps, the simplest option, but makes it difficult to capture key environmental costs such as LTED and resource depletion, as these typically work at the global level. The other option would be to consider the region of analysis as defining where *productive activity is taking place or where its principal economic benefit is being enjoyed* – this shall be discussed further in Section 4.

Adopting this approach would have the following impacts on the ISEW:

- Service flow should be measured at the *individual* level in terms of the benefits of consumer and public expenditure. It would make no sense to measure service flows to (and therefore consumption by) business, as they are not the ultimate beneficiaries. Investments made by business do, however, in theory, provide future service flow to individuals and so should be counted within the ΔK component.
- The idea of *net* service flow offers quite substantial scope for incorporating non-monetary negative impacts of productive activity – including the loss of leisure time and harm to the local environment.
- Stock can be assets in terms of financial, natural and built capital, but can also be *liabilities* in terms of debt and future damages.
- Different types of stock are substitutable in this formula; hence it is a measure of weak sustainability, not strong sustainability. Also, whilst we have not attempted to do so thus far, this formula highlights the potential to value social and human capital (Ks and Kh) in the ISEW.
- Expenditure on durable goods has the combined effect of increasing the capital stock and providing service flows within a given year. Provided the price of consumer durables is appropriate, it can therefore be assumed that all expenditure on durable goods in a given year could go into the ISEW (which is *not* our current approach).
- The balance of payments should be included as it leads to changes in financial capital.
- The ISEW would only consider service flows and change in capital from *productive activity*, including the formal economy, volunteering and household labour (as well as natural rates of depreciation of built capital). It would be impossible to include in the ISEW all the service flows, for example, from the natural environment as these are theoretically infinite. What it could do, instead,

is assess how the productive activity of a given year affects the stock of natural capital from which future service flows can be provided.

- The ISEW would only consider service flows and change in capital from productive activity *within the given time period*. Whilst in theory it may be desirable to be able to capture service flows resulting from past productive activity –this would get us closer to a truer measure of economic well-being – it seems in practice hard to measure. It has proven challenging enough to estimate the service flows from consumer durables purchased in previous years. We have not even attempted to capture the service flows from other stocks of built capital (such as roads and hospitals), and this would indeed be a challenge. Also, it would be near impossible to capture the *net* service flow from past activity – i.e., what negative impacts, in terms of pollution or loss of natural environments, has past economic activity had on current service flows. Including all this would take us further away from the Hicksian idea of sustainable income, as service flows from previous activity cannot be expected to continue into the future indefinitely. Also, it would take us further away from the metaphor of GDP which is very much focused on a given time period.

Is this formulation of the ISEW consistent with the idea of Hicksian income? Well, it could be considered more like a 'Hicksian service flow', the *service flow* which we can enjoy without impoverishing ourselves in the future. The fact that we would be measuring the service flow rather than the income, would imply more concern about the actual use of the outputs of our productive activity, whereas the idea of 'Hicksian income' does not explicitly concern itself with how our income is used. Importantly, it would suggest a particular interpretation of 'impoverishing ourselves' –reducing our stock of capital in a given year, thereby reducing our possibilities to enjoy service flows in the future. Note that this would be a weaker interpretation than some others that have been implied. For example, given Weitzman's finding, one might want to interpret Hicksian income as being that consumption of service flow which can be enjoyed indefinitely. As we have already suggested, however, this does not seem so easy to assess.

Implications for current R-ISEW

How would the current R-ISEW methodology fit with this framework? The next section answers this question component-by-component. The following key is provided:

- ● No change required
- ● Minor change required or significant change advisable
- ● Significant change required

- ● **Consumer expenditure.** Service flow. Given that the framework sets the geographical boundaries as demarcating the area where productive activity has taken place (not where service flows are being enjoyed), there may be a case for using total wages within the region as this is closest connected to productive activity. Doing so would automatically bring into the ISEW a component that is currently not considered – change in personal financial capital. It could be argued that, if we do not use wages instead of consumer expenditure, we should add a separate component to count personal debt. Further discussion is required on this point.
- ● **Income inequality.** Service flow adjusted to account for the diminishing returns of ever higher consumption.
- ● **Household labour and volunteering.** Service flow resulting from unpaid productive activity.

- **Public expenditure.** Service flows resulting from public expenditure on health and education. As will be noted in Section 5, there may be justification for including other elements of public expenditure as positive additions to the ISEW.
- **Difference between service flow and expenditure on consumer durables.** Whilst a distinction can be made between the immediate service flow enjoyed from the consumption of a consumer durable, and the increase in capital in terms of its durable nature, both these components are included in the framework for a given year and, therefore, there is no need to separate them. In other words, this component could be removed.
- **Costs of commuting, crime, car and industrial accidents.** Costs are either defensive or reductions of service flow and fit framework.
- **Costs of family breakdown**. Defensive costs and costs in terms of reduced longevity are and should be included. But see Section 5 for some further recommendations of how to improve this component.
- **Costs of pollution control, water pollution, air pollution and noise pollution.** As defensive costs or reductions in service flow these would all be acceptable. However, see Section 4 for discussions of how we could adjust the calculations used so that costs are split between consumers and producers of goods and services creating such pollution.
- **Loss of natural habitat and farmland. ΔKn.** As it stands, this component is fairly small and so worrying about the balance of costs between the region which is losing its natural habitats and the region where the consumers of products requiring this loss of natural habitats may not be necessary (Section 4). However, if new elements are brought into this component (Section 2), then further work may be required.
- **Non-renewable resource depletion. ΔKn**. See Section 4 for further consideration, as well as Section 4 for speculation on new costings.
- **Long-term environmental damage**. Our current methodology, incorporating past emissions, would not fit the framework of S + ΔK. In Section 3, we consider ways that the methodology could be adapted. One approach would be to see past emissions as an ecological debt which grows regardless of current emissions, due to interest rates, and which we need to service (through adaptation). The annual growth in this hypothetical debt would represent an increase in a negative component of capital and therefore a - ΔK. Also, for a consideration of how this cost should be split between consumers and producers, see Section 4.
- **Capital growth. ΔKm**.
- **Net international position. ΔKf.** This component is the main determinant of change in a nation's external debt. It is, however, not the only factor. The balance of payment identity also includes financial transactions, including remittances and returns on investment. Technically, it may be appropriate to include these components to calculate change in external debt.

Next steps

It appears that adopting the S + ΔK framework would force us to rethink some of the components of the R-ISEW. In some cases, particularly that of long-term environmental damage, it might lead to a sizeable reduction of a cost, which could make the R-ISEW a less accurate measure of sustainability. For example, were CO_2 emissions to stop overnight, the long-term environmental damage component would become zero, implying that such damage is no longer an issue. However, this implication would not be accurate. Whilst such an end to emissions would of course be an incredibly positive step towards sustainability, the amount of CO_2 in the atmosphere has already reached levels that will cause, and indeed are causing, long-term environmental damage. As such, imposing such a framework would reduce the comprehensiveness of the R-ISEW as a measure of sustainability.

An alternative approach would be to abandon attempts to identify a specific theoretical framework, and see the R-ISEW more as a practical tool than a clear concept. This would ensure greater flexibility in the future, allowing stakeholders in the development of the R-ISEW greater say in what should be measured and what need not be measured. The danger with this approach, however, is that it makes it hard to promote and explain the R-ISEW, and it makes the figures generated less interpretable.

The main developments considered in this scoping document will take as a starting point the theoretical framework we have outlined, and address some of the question marks raised in the previous list of bullet points. However we do recommend that a further review of the theoretical literature around the ISEW and green GDP measures, as well as consultation with users of the ISEW, to assess whether this framework is the best approach we can take, to determine whether anything closer to the Weitzman interpretation of Hicksian income can be achieved, and to reach a decision as to whether we do indeed need a theoretical framework.

2. Ecosystem services

Recent advances in the field of environmental economics and the valuation of natural resources and ecosystem services provide a strong case to review how the ISEW captures environmental elements. But theory in this field is still decades ahead of practical implementation. For example, there are no clear ecosystem service units ready to be integrated into green accounting frameworks.

In this section, we explore ways to strengthen the environmental dimension of the R-ISEW. We outline the theory and key challenges related to the incorporation of ecosystem services into the R-ISEW; we review existing approaches and methodologies to measure change in natural capital; and finally we provide a set of recommendations to further develop the R-ISEW.

We conclude that adopting an approach fully based on ecosystem services may not be compatible with the R-ISEW framework as it stands, but that there are a number of actions that can be taken today to improve components of the R-ISEW.

We make specific recommendations for improving certain components – costs of habitat loss, farmland loss, and water pollution – and suggest the inclusion of an additional component to account for the depletion of renewable resources. We outline how this could be done and review existing data, concluding that despite the relevance of renewable natural resources, it may not currently be cost-effective to incorporate this element at a regional level.

Finally, we emphasise that, given that there are a number of ongoing initiatives addressing some of the key challenges, further exploration should be made when these begin to produce results as to how to restructure the environmental components of the R-ISEW in a way that favours the incorporation of ecosystem services values.

The ISEW from an environmental perspective

The question to ask here is whether the productive activity in regions is increasing or reducing natural capital stocks, where ever they may be? Are stocks being managed so as to ensure a long-term flow of services? Or are they being overexploited? If current levels of consumption result in natural capital depreciation – affecting the potential to provide goods and services – this needs to be adjusted for. Section 1 of this report interprets the ISEW as the sum of service flow and change in capital resulting from productive activity in a given region in a given time period ($S + \Delta K$).

Services are measured as consumption (household expenditure + public investment) corrected for various factors. The adjustments include corrections for consumption that does not add to our economic well-being, such as defensive expenditure, and factors that diminish our economic well-being that can be connected to productive activity (e.g., air pollution). The ISEW also corrects for change in capital – i.e., the appreciation or depreciation of the different forms of capital in a particular region: man-made (K_m), natural (Kn), and financial (Kf); theoretically, it could also include changes in human (Kh) and social (Ks) capital. By contrast, standard national accounts are mostly focused on produced assets.

It is important to note that given the theoretical framework presented in Section 1, the ISEW is still inherently connected to productive activity. A region where there is no productive activity, should theoretically have an R-ISEW of £0, even if it has a rich ecosystem providing substantial service flows. In this sense, all regions start from a ‘level playing field’ with regard to their natural endowments.

What the ISEW should measure though, with regard to environmental factors, is two things. Most straightforwardly, it should measure how productive activity changes the stock of natural capital (which will affect future service flows). But it should also measure how productive activity affects the service flows drawn from the natural environment in the current time period. For example, noise pollution may not have any long-term effect on capital stocks. However, it does reduce service flows in the time period in which it is produced, and this should be captured by the ISEW. In other words, with regard to the natural environment, the ISEW captures not the total service flow from the natural environment in a given time period but the amount that this natural service flow is affected by productive activity.

As a result, the ISEW on its own cannot capture the environmental health of a region. Furthermore, whilst in reality this will prove hard to achieve (see Section 4), it theoretically should focus on the outcomes of productive activity within a region, not the state of the ecosystem within that region. For example, pollution pumping into a river in region A from a factory in region B should be counted against region B’s ISEW, not region A’s. As we shall see in Section 4, we also feel it would be appropriate to attribute at least some of the costs of this pollution to region C, where the consumer of the products produced in the factory resides. Regional authorities therefore need to pay attention to other indicators to monitor what is happening in their own ecosystems.

Currently, all environmental elements of the R-ISEW are framed as costs. In this scoping project, we considered the inclusion of environmental benefits in the R-ISEW, but the reality is that this is unlikely, given its over-arching purpose. ISEWs intend to capture the impacts of productive activity on non-economic domains such as the environmental and social. Generally, whilst it can have a neutral effect, productive activity does not tend to have a positive effect on environmental stocks and flows. The only environmental components of the current R-ISEW that can make a positive contribution to the overall figure are those called ‘loss of natural habitats’ and ‘loss of farmland’. Both of these count a loss relative to a given start date – currently 1930. If stocks of habitat and farmland have actually increased since that start date, then the component can have a positive effect. As such, it would be more appropriate to frame these components as ‘change in natural habitats’ and ‘change in farmland’.

But before going into detail about how to further develop the R-ISEW, we shall look at how other green accounting measures incorporate environmental elements.

Genuine savings

Gross National Savings (GNS) – represents the total amount of produced output that is not consumed. It can be interpreted as a country’s provision for the future.

Net National Savings = GNS - depreciation of fixed capital

Genuine savings involves adjusting net national savings to account for depreciation of other assets (human capital, natural capital, etc.) and damage costs of pollution.

A World Bank report estimates genuine savings for all countries.[19] This requires measuring all forms of capital. In its methodology natural resource depletion enters as total rents on resource extraction and harvest, where rents are the difference between value of production at world prices and total costs of production, including depreciation of fixed capital and return on capital. For living resources (i.e., forests, fish) the correction to the net savings rate is not rent on timber/fish extraction, but rather rent on that portion of timber/fish extraction that exceeds natural growth. If growth exceeds harvest, this figure is set to zero (nothing is subtracted). LTED is accounted for using an estimated marginal global damage cost of carbon at $20 per tonne emitted.

It is worth noting that while there are clear methodologies for accounting for the depletion of renewable and non-renewable natural resources, environmental degradation and pollution can enter national accounts in several ways. The depreciation of produced assets could account for pollution damage, but in practice it doesn't. The same could be said for the depreciation of other forms of assets. The value of certain ecosystem services (natural capital) might be reduced because of pollution, and it can also affect labour productivity through impacts on human health (human capital). This is something worth bearing in mind to avoid the risk of double-counting when calculating the R-ISEW.

Incorporating ecosystem services into green accounting

Since the publication of the *Millennium Ecosystem Assessment* in 2005,[20] ecosystem services have captured the public's attention and have been at the centre of public debate and policy-making. Growing realisation that the healthy functioning of ecosystems is essential to guarantee basic supply of services and goods – not only to sustain human life on Earth but also to secure a good level of well-being – has led to several initiatives aimed at gaining further understanding between these links.

The economic valuation of ecosystem goods and services is increasingly becoming a key tool for policy-making. However, we do not have a clear methodology to incorporate ecosystem services into green accounting measures. Boyd[21] argues that most attempts to do so have failed because there are not well-defined units of account to measure the contributions of ecosystems to human welfare. A key step to integrate ecosystem goods into the market economy is to define the appropriate units of account that are consistent with conventional national accounting. These units need to be clearly defined, ecologically and economically defensible, and consistently measured.

Nature benefits society in a wide variety of ways providing food, water, opportunities for recreation and regulating the global climate. *Ecosystem services* are the aspects of nature that society uses, consumes, or enjoys to experience those benefits. They are the end products of nature that directly yield human well-being.[22]

Boyd and Banzhaf[23] propose a definition of ecosystem service units comparable with the definition of conventional goods and services found in GDP and the other national accounts. It is based on the following principles:

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[19] Hamilton K (2006) *Where is the wealth of nations?* (Washington DC: World Bank).
[20] Millenium Ecosystem Assessment (2005) *Ecosystems and human well-being: Synthesis* (Washington DC: Island Press)
[21] Boyd J (2006) *The nonmarket benefits of nature. What should be counted in GDP?* Resources for the Future; www.rff.org/rff/Documents/RFF-DP-06-24.pdf.
[22] Boyd J, Banzhaf S (2006) *What are ecosystem services? The need for standardized environmental accounting units.* Resources for the Future; www.rff.org/Documents/RFF-DP-06-02.pdf.
[23] *ibid*

- **Ecosystem services as end products of nature,** not the intermediate products. The reason is that the value of intermediate goods and processes is included in the value of the final good.
- **Ecosystem services must be counted at fine spatial and temporal scales:** Units should be counted in such a way that they can be distinguished spatially and temporally.
- **Ecosystem services are benefit-specific:** Wetlands should be counted as services associated with flood protection because they directly protect against floods and are substitutes for constructed flood control; however, wetlands should not be counted as services for the water quality benefits they provide. The water quality itself should be counted because that is what people directly value.

Implications for our research

This set of principles provides a good basis to guide the integration of ecosystem services into the ISEW.

In the case of changes to stock, the total value of ecosystems can be included. This will involve the transformation of figures for annual ecosystem services for different ecosystems into valuations of the capital they represent (as discussed in the next sub-section). In terms of incorporating ecosystem services into the current service flow aspect of the ISEW, care needs to be taken to exclude aspects which are already incorporated into the market economy.

For example, consumer expenditure figures incorporate the value of ecosystem final products such as fish, tomatoes and other food products; but they do not incorporate the value of leisure and recreational opportunities provided by many ecosystems, They do not incorporate the value of ecological processes (nutrient recycling, etc.) that contribute to the generation of the final products either; however these intermediate services should not be accounted for because they are already captured in the final product. For example, GDP counts the final value of loaves of bread only; it does not add up the value of the wheat and the water, and the labour invested in producing that loaf of bread.

Given some of these difficulties, and that the impacts of productive activity to non-marketable service flows from the natural environment are likely to be smaller than to the impacts on natural capital, it may be more fruitful for improvements to the R-ISEW to focus on the latter.

Measuring natural capital

The notion that natural resource assets should be placed on the national balance sheet so that their depletion or appreciation is recorded has been discussed for many years. Such 'green accounts' need not value the resource, but must at least provide a framework for organising the data.[24]

Natural capital is the sum of non-renewable (i.e., oil, gas, minerals, etc.) and renewable resources. Renewable resources include those goods and services generated on land (i.e., cropland, pastureland, forest, wetlands, etc.) and in marine habitats (i.e., fish stocks).

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[24] Atkinson G, Hamilton K (1996) 'Accounting for progress: indicators for sustainable development' *Environment* 38:16-44, cited in Vivid Economics (2008) *Economic Benefits of Fisheries Management.* A report to Defra.

The World Bank report *Where is the wealth of nations* provides a good starting point to explore measurement of wealth, and forms of capital.[25] It outlines two basic methods to value capital:

1. Capital valued as the sum of additions, minus subtractions made overtime to an initial stock – summing up the value of gross investments and subtracting depreciation of produced capital.
2. Capital valued as the net present value (NPV) of the income it is able to produce over time. Valuing the capital stock as the discounted value of future flow of services coming from Kn.

Calculations involving NPV of a flow of benefits require assumptions about the time horizon and the discount rate. These two factors are important when it comes to determining the significance of certain changes in capital. Given that we are dealing with the management of assets for the benefit of public and future generations, we would argue for the use of a low discount rate.

Most natural resources are valued by taking the present value of resource rents – the economic profit of exploitation – over an assumed lifetime. Some (forests, fish stocks) can yield benefits forever if sustainably managed. If overexploited, we can calculate the effective lifetime of the resource given current harvest rates. Pollution affects the value of the capital.

Change in natural capital (δKn) can be represented in the following formula which incorporates the three elements noted above: renewable natural resources, exhaustible natural resources, and pollution.

$$\delta Kn = (PN_r - CN_r)(H - G) + (PN_e - CN_e)(QN_e) + Pp\,(E\text{-}D)$$

P – Price, C – Cost, H – Harvest, G – Growth, Q – Quantity extracted, E – Emissions, D – Natural decay, N_r – renewable natural resources, N_e – exhaustible natural resources, p – pollution.

Following the ecosystem accounting unit suggested by Boyd,[26] measures of natural capital should not include ecosystem services if these are already captured in the value of the resource, but they should incorporate those that are excluded from them. For example, we could assume that values for cropland and pastureland already incorporate the value of hydrological functions and pollination services, but do not include the value of biodiversity provision or the leisure opportunities provided.

Valuing natural capital is a challenging task. Despite its global scope and national focus, *Where is the wealth of nations* contains some aspects that could be of interest for R-ISEW. [27]These are the approaches taken to estimate the value of different elements of natural capital:

- **Energy and mineral resources** – assign monetary values to stocks of oil, gas and coal and minerals. They are measured as present discount value of economic profits over the life of the resource.
- **Forests** – timber wealth is estimated as NPV of rents from wood production. Data needed on wood production, unit rents, time to exhaustion of forest (if harvested unsustainably).

[25] Hamilton K *et al* (2006) *Where is the wealth of nations?* (Washington DC: The World Bank)
[26] Boyd (2006) *op. cit.*
[27] Hamilton K *et al* (2006) *op. cit.*

- **Non-timber forest products** – returns per hectare in developed countries around $190 (adjusted to 2000 prices).
- **Cropland** – suggests the use of country level data on agricultural land prices. Or present discounted value of land rents (market value of output crops minus production costs).
- **Pastureland** – assumes production costs are 55% of output value. Estimates output value looking at prices of beef, lamb, milk, and wool. Then estimate present value of this flow for 25 years and 4% discount rate.
- **Protected areas** – value is estimated using opportunity cost of conservation (pastureland or cropland – whichever is lower). This is a minimum value as it does not fully capture the full value of protected areas.

Re-visiting R-ISEW

Intuitively, it appears that a straightforward way to capture change in natural capital in a comprehensive way would be to adopt a land-use-value approach as outlined in the previous section: changes in land-use are changes in natural capital. Often, this will involve converting figures for annual ecosystem services into NPV of capital. Pollution costs could be incorporated in this approach as depreciation of the value of different types of habitats.

A land-use-value approach would allow for direct comparisons between UK regions. This would require having detailed information on land-use changes for each region on a regular basis, and developing a set of values for each habitat/land-use type.

At the UK level, the Defra-led National Ecosystem Assessment initiative running from 2008 to 2010 will provide an assessment of the current state of all of the ecosystems in the UK generating – among others – evidence on the value of natural environment and ecosystem services.[28]

At an international level, the Economics of Ecosystems and Biodiversity (TEEB) aims at making a compelling economic case for the conservation of biodiversity and at promoting a better understanding of the true economic value of the benefits we receive from nature.[29] The second phase will involve a large-scale assessment of the costs of losses of the main types of ecosystems worldwide and will compare them with the costs of policies to better protect biodiversity and ecosystems.

There are already a number of studies providing values for a wide range of services and ecosystems including some meta-analysis of existing studies; and 'benefit transfer' functions. The Jacobs study on the value of England's terrestrial and freshwater ecosystems describes some of the issues and possible approaches (i.e., habitat, services, or site based).[30] Initial results for England Terrestrial Ecosystems are[31]:

- Provisioning services £10 billion/year
- Regulating services £2.25 billion/year
- Cultural services £5.38 billion/year

The implementation of the EU Water Framework Directive has generated several studies on the value of water ecosystems. A recent study by Brander *et al*. estimates

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[28] www.lwec.org.uk/content/national-ecosystem-assessment
[29] http://ec.europa.eu/environment/nature/biodiversity/economics/index_en.htm
[30] O'Gorman S, Bann C (2008) *A valuation of England's terrestrial ecosystem services*. Defra Project Code NR0108 (London: Defra) p. 94.
[31] All should be considered lower estimates.

the average value of 1 hectare of wetland in the UK at €2480/year.[32] Work under the Aqua-Money EU-funded project includes the derivation of values for water quality improvements across Europe; including values for recreation.[33]

While these studies are a first step towards better integration of ecosystem services into the ISEW, they are not fit to be integrated directly into national accounting for the following reasons:

- The value incorporates intermediate and final ecosystem services and goods. Using them to measure change in natural capital of a region would lead to double counting.
- The values are site-specific. The value of a hectare of a certain habitat will depend on how many people benefit from it and on the abundance of a resource. Scaling up site-specific values to regional and national scale levels – as the R-ISEW requires – poses huge methodological challenges.

Next steps

There is a case to further explore the development of the ISEW into a new structure that integrates all the environmental elements as outlined in this section. This is an area that will require further research and close follow-up and involvement with some of the ongoing initiatives on ecosystem assessment. One approach to address key gaps would be develop a meta-analysis of ecosystem services values, including a transfer function and applying GIS (Geographic Information System) to estimate ecosystem services for each region.

But given that this approach is currently unfeasible, our suggestions for next steps focus on improving and updating existing elements of the R-ISEW. Our recommendation is to focus on three main components:

1. Costs of loss of natural habitats.
2. Costs of loss of farmlands.
3. Costs of water pollution.

We also suggest considering the introduction of an additional element – *depletion of renewable resources* – to account for overexploitation of renewable resource stocks (i.e., fisheries, forests, etc.), as some ISEW-like approaches do. However, scarcity of data suggests that it might not be cost-effective to incorporate this at a regional level.

Costs of loss of natural habitats

Currently this component only accounts for loss of wetlands. Wetland loss is measured per hectare and valued using a proxy derived from the purchase of wetland sites by a conservation organisation. This component could be further developed by:

- Incorporating additional habitat types (woodland, coastal, etc.).
- Reviewing the valuation methodology.

Data on land cover and habitat types are available from various sources such as the Countryside Survey, and the UK Environmental accounts which incorporate one element from land cover. The Forestry Commission, the UK annual agricultural review, Defra, Natural England, and conservation institutions should be able to provide more detailed information for land-cover change in specific habitat types. There is a case to incorporate the loss of farmland into this component as loss of agricultural habitat.

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[32] Brander *et al* (2009) *The value of wetland ecosystem services in Europe*. Presentation to UKNEE conference, March (www.eftec.co.uk/UKNEE/envecon/2009_documents).
[33] www.aquamoney.ecologic-events.de

Despite all the methodological challenges and caveats we have noted, one might be able to redefine this component along the lines of the natural capital methodology approach followed by *Where is the wealth of nations.*. This would require having average land prices for different habitat types, and regular information on land-cover change to assess how the natural capital of a region changes over time. The implication for this is that adjustments for habitat change might be costs or benefits, depending on the direction of the change. This component would be better re-named as *Natural habitats change*.

In addition, given that to a certain extent most non-urban habitats provide a range of benefits (i.e., landscapes, wildlife, etc.) which are unlikely to be captured by any element of the ISEW, it would be good for this component to incorporate one value for the provision of these services.

One way to value these services would be to derive average values for each habitat type, taking conservation costs as a basis. Given that not all habitats are under conservation management schemes, these average payments could be derived as a fraction of average conservation costs for protected areas. Alternatively, these components could be split between habitat areas which are under conservation or protection scheme, and those which are not; the last ones would not incorporate the 'wildlife services' premium.

Costs for average management costs for Natura 2000 sites – which cover a wide range of habitats – are available. Values for the provision of wildlife-related benefits would vary per habitat type, depending on their quality and on the biodiversity levels.

Costs of loss of farmlands

We recommend incorporating the loss of farmland into the natural habitats component. Soil erosion and productivity could be integrated into the *depletion of renewable resources* component.

The following two reports are of particular relevance to inform the review of farmland related components in ISEW.

1. Jacobs account within Defra (2007) Environmental accounts for agriculture[34]
2. Agricultural landscape valuation (2007)[35]

Costs of water pollution

The implementation of the Water Framework Directive (WFD) – which requires that the quality of all water bodies in EU member states are in good ecological status by 2015 – has generated a huge amount of information and data that could be used to improve this component. Since water bodies include all types of water systems, including inland and coastal waters, this would help expand the scope of this component as it currently only includes inland water bodies.

Monitoring systems and water quality standards have been developed to track progress towards delivering the objective of the WFD. The Environment Agency and Scottish Environmental Protection Agency have developed maps illustrating the water quality of all water bodies in the UK. These are classified into five main categories: bad, poor, medium, good and excellent.

Over the past few years the Defra-led Collaborative Research Programme has carried out several economic studies to inform the implementation of the WFD in the UK,

[34] http://statistics.defra.gov.uk/esg/reports/envacc/default.asp
[35] https://statistics.defra.gov.uk/esg/reports/agrlandval/Mainrep.pdf

including studies on the willingness to pay for water quality improvement in different locations.[36]

There therefore appears to be enough data with which to update the valuation methodology of this component. This would require developing a few scenarios (i.e., 100%, 66% or 33% of water bodies meet WFD requirements by 2015 or lower percentages) and generating value functions for water quality improvements.

Depletion of renewable resources

The management of renewable resources is an area of huge relevance when it comes to green accounting measures. Managing a resource (i.e., forest, fishery, soil, water, etc.) optimally will generate a long-term flow of revenues overtime, without depreciating the stock. Whereas over-exploiting it depreciates the natural capital, and reduces the flow of future benefits.

The R-ISEW currently includes the costs of soil erosion through intensive farming, but it does not adjust for the appreciation or depreciation of stock for other renewable resources. Forest and fish resources have been incorporated in other ISEWs at national level.[37, 38] There is a case to explore their inclusion into the R-ISEW.

There are well-known methods to estimate the depreciation of natural resources.[39] Stocks can be valued as the sum of discounted future rents (i.e., the value today of the sum of all future rents) minus the costs of harvesting. Over-exploitation can be expressed as the NPV of the reduction in benefits from future consumption. So, for example, if £1000 of a region's fishing profits has resulted in the reduction in stocks available for future years, then this gain needs to be set against the NPV of the following years' reductions in potential fishing profits.

A Defra report on the economic benefits of fisheries management refers to an attempt by the Office of National Statistics to construct physical and economic fisheries accounts over the period 1991–2001 for nine fish stocks of commercial interest to the UK.[40] The results indicate that rents are negative for most stock in most years with the exception of sole and North Sea cod; however, they are not 100% conclusive.

In terms of attributing the costs of fish stock depletion to the regions of England, the most promising approaches are to either consider fish consumption by region and/or the size of the fishing industry in each region, rather than assessing the size of fish stocks of the coasts of particular regions. This complies with our conclusions on how to cost environmental costs (see section 4), but also is likely to represent a far more feasible option. Using such approaches is likely evolve generalisations and assumptions regarding the types of fish and the methods used to fish relating to each region's fish consumption / industry, and so some work would be required to identify the most cost-effective assumptions.

No complete review has been conducted to assess the existence of this information for the forestry sector, but given the commercial nature of the activity we argue that there is enough information to incorporate these elements into the ISEW. Any attempt to incorporate change in stock of renewable resources should previously assess the relevance of these components for English regions. If this is insignificant, it will not be cost-effective to pursue this area.

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[36] www.wfdcrp.co.uk
[37] Hamilton C, Saddler H (1997) *The Genuine Progress Indicator: A new index of well-being in Australia.* Discussion paper No. 14 (Canberra: The Australia Institute).
[38] Diefenbacher H (1995) 'The Index of Sustainable Welfare: A case study of the Federal Republic of Germany' In Cobb C, Cobb J, *The Green National Product* (Lanham, MD: University of Americas Press).
[39] FAO (2004), 'Integrated environmental and economic accounting for fisheries', Food and Agriculture Organization of the United Nations. Cited in Defra (2008) *op. cit.*
[40] Defra (2008) *op. cit.*

3. Costing long-term environmental damage

This part of the scoping project set out to explore how recent developments such as the Stern Review could be incorporated into the R-ISEW methodology. Beforehand, however, the issue of which LTED costs to include needs to be resolved.

Past and present emissions

Current practice

The current R-ISEW accounts for greenhouse gas emissions on a cumulative basis. The costs of greenhouse gases emitted in previous years are included in the calculations for each year. This is justified from the perspective of sustainability: The damage from the present and past emissions will predominately take place in the future. In order to maintain levels of economic welfare, the economy will have to be prepared for this damage, including the harm caused by emissions from past years.[41] The index must therefore be adjusted corresponding to the increasing cost of dealing with the accumulating, future problems caused by climate change.

In the present calculations, the cost of past and present emissions are calculated based on a model of a hypothetical endowment fund. A given year's R-ISEW value is adjusted by the amount that would need to be set aside each year from that year onwards so that the endowment fund reaches the required size by 2050 – the hypothetical point at which damages will need to be dealt with, given the simple model we are using. The amount of damage caused by each tonne of emissions is based on an estimate of the social cost of carbon from 2002, setting the cost of a carbon-equivalent tonne at £70.

This approach is consistent with an interpretation of the ISEW as the level of service flow that can be enjoyed indefinitely. It simply subtracts from the current consumption levels an amount which we should be setting aside to prepare for climate change – it is implied that future years will also see the same annual payment into the fund. Without such preparation, the level of service flow enjoyed in a given year cannot be sustained when the damages associated with climate change materialize. Whether or not we are producing any emissions in a given year is not necessarily relevant. Even if we stop emitting today, we will still face substantial environmental damage in the future and the fact that we are not dealing with it implies that our current level of income is not sustainable.

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[41] Obviously only a very small share of the overall damage caused by the emissions will actually be incurred by the emitting regions, in this case England. Climate change is very different from most issues represented in ISEW in that it is truly global in scale. Not differentiating between who will suffer the damage is justified from the perspective of the equality principle: Consequences to people should be treated similarly regardless of where they are or what group they belong to. From this perspective the cost of past emissions could be interpreted as an ecological debt. It is the amount that the people responsible for past emissions should in principle have to pay in compensation for the damage that they have caused.

However, the endowment fund has difficulty fitting the S + ΔK accounting framework. The framework restricts the ISEW to consideration only of productive activity within the given time period – to do otherwise risks leaving the ISEW unbounded, and also risks mixing stocks and flows. The endowment fund is a clever way of getting around the latter of these two problems (by converting the stock of environmental damage accumulated over the years into a regular annual payment), but it very clearly does not get around the former problem. Ultimately, the bulk of the endowment fund payment required for any given year is the result of productive activity in previous years. As well as infringing the time frame, this also means that the endowment fund methodology is very insensitive to changes in annual emissions, be that an increase or a decrease.

On further inspection, it is also clear that this methodology is not actually consistent with an interpretation of the ISEW as the level of service flow that can be enjoyed indefinitely. In determining the amount of money that needs to be set aside for the endowment fund, only current and past emissions are considered. Future emissions are not considered. Of course, it is inevitable that there will be future emissions, and that these will contribute to long-term environmental damage. This increase in the cost means that annual payments to the endowment fund, if they are to be constant over time, would need to be much higher than currently calculated.

Other options in costing LTED

Two other methods for accounting for LTED from greenhouse gases exist in the ISEW literature. The original Daly and Cobb calculations added up the accumulated social costs of carbon emissions for each year. They used the net present discounted cost of all future damages as their basis. This approach has drawn some criticism.[42] It can be interpreted to involve multiple counting. The estimates of the social cost of each year already include future costs for all coming years. If the interpretation of the ISEW adjustment is that, within each year, some amount of funds is set aside to compensate for future periods, then this same saving would seem to take place numerous times over the years.

In 2005, a paper produced by Tim Jackson and Nat McBride for the European Environment Agency reviewed the methodologies used for calculating the ISEW.[43] Despite its flaws, they found that this approach for accumulating LTED was used in most of the ISEW calculations they looked at: in Austria, Chile, Germany, Italy, Thailand and the United States.

The third possible approach to accounting for the cost of LTED is to focus on the cost of emissions within the current accounting period. The adjustments still take into account damage that will take place in the future, using the net discounted value of all future costs.

This approach is simple, and appears to fit the proposed framework – the emission of greenhouse gases annually detracts from our natural capital in terms of climate stability. Alternatively it could be seen as a pending cost which we should be putting aside savings to meet, similar to the endowment fund model. The present value of the savings we need to set aside is determined, not by discounting the future cost, but based on choosing an appropriate interest rate. Our lack of any actual savings being set aside in this way, the fact our endowment fund currently contains no funds, represents an ecological debt. The change in the debt resulting from annual emissions can be seen as a negative ΔK.

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[42] Dietz S, Neumayer E (2006) 'Some constructive criticisms of the Index of Sustainable Economic Welfare' in Lawn P (ed.), *Sustainable Development Indicators in Ecological Economics* (Cheltenham: Edward Elgar) pp. 186–206.

[43] Jackson T, McBride N (2005) 'Measuring progress? A review of 'adjusted' measures of economic welfare in Europe' Prepared for the European Environment Agency.

This approach, however, does not attempt to operationalise Hicksian income – it does not lead to a value of the ISEW which could be continued indefinitely. By ignoring the impending damage that will be caused by past emissions it would, in theory, lead to a huge discontinuity in the ISEW when damages from climate change hit the economy in 2050. It does not consider the adaptation that is already required to meet the challenge of climate change. Jackson and McBride found that this approach was used in Australia, the Netherlands and Sweden. Since then, an ISEW has also been produced for Wales which only accounts for emissions within the accounting period in question.[44]

Two new proposals

One option, so far unexplored in the literature, would be to account for present and past emissions in different manners. This could be done in two ways. One is to include past emissions in the calculations based on a model such as the endowment fund, whereas the current emissions would be included based on their discounted social costs. This would capture some of the benefits of both models: It would remain more sensitive to current emissions, while still incorporating the need for adaptation in order to be sustainable. The obvious downside is an increase in the complexity of the methodology. It would make the interpretation of the figures more opaque, as the same thing, carbon emissions, is accounted for in a different manner depending on whether or not the emissions occurred during the period in question. Also, all the complications in fitting the Hicks/Weitzman accounting framework that are relevant for the endowment fund model would apply.

A second approach is offered by the metaphor of ecological debt. As we have just discussed, LTED from a given year can be seen as a contribution to an ecological debt – an increase in negative stock and therefore compatible with our framework. The key is that past emissions are also included in this negative stock. Whilst our framework does not include stock itself, it does include changes in stock. Assuming an interest rate, the debt from emissions from previous years would increase year-on-year, even if actual emissions halted. With every year, we have less time to save money into our fund, and therefore more money is required. This represents a negative ΔK, and therefore a cost in the ISEW.

Influence of modelling choice on ISEW figures

Adjustments for LTED are one of the largest determinants of ISEW figures. In the current regional estimates, they account for a reduction of 22% of the final numbers. It is worth noting that the absolute size of this adjustment depends largely on the choice of how to model LTED. The choice between accumulated damage, damage from the current accounting period, or one of the author hybrid approaches is likely to matter more than any variance in estimates of actual climate change damage.[45] The accumulated damage approach and the endowment fund approach both lead to significantly larger costs than the approach that only includes current costs. The ecological debt metaphor, incorporating interest from previous years' debts, would result in a cost somewhere in between.

In addition to the absolute size of adjustment, the choice between modelling accumulated or current damage will also influence the relative weight of increases or reductions of greenhouse gas emissions in the index, i.e., its sensitivity to current carbon emissions. In the endowment fund model, some of the costs created by today's emissions will be carried over to future accounting periods, as hypothetical payments

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[44] Munday M, Roche N, Christie M, Midmore P (2006) *An Index of Sustainable Economic Welfare (ISEW) for Wales (1990-2005) – Draft Report.* ESRC Centre for Business Relationships Accountability Sustainability and Society.
[45] Jackson T, Marks N, Ralls J, Stymne S (1997) *Sustainable economic welfare in the UK 1950-1996'* (London: **nef**)

that will be made to the fund then. Payments into the fund for the future damage will be evenly distributed to all the years in the future before the damage is incurred. This means that the damages created this year will be divided by the number of years (including the current year) before the damage will occur. In contrast, in a model that only accounts for emissions within the current period, all of the damages are included but in a discounted form. When the cost is discounted, it decreases exponentially as the distance in time to its occurrence is increased.

Which of the two accounting methods gives more weight to current emissions depends on both the discount rate and on the delay in time to when the damage takes place. The higher the discount rate and further in the future the damage, the lower weight the discounted cost of current emissions will be relative to changes in the payments to the endowment fund. Even though the time spans associated with climate change are considerable, in most imaginable cases the endowment fund model is still less sensitive to changes in current emissions than calculations based on discounted future costs are.

This can be demonstrated with the figures used in the current calculations. With a model such as the endowment fund, the R-ISEW gain from reducing emissions in a given year will be an order of magnitude lower than the actual social costs associated with those emissions. For instance, in 2006 the discounted social cost of carbon for the whole of the UK, based on the £70 per tonne estimate, was about £14 billion. With the endowment fund model, reducing emissions to zero for that year would increase the R-ISEW by only about £1.4 billion. A cost based only on current emissions would create a ten-fold adjustment.

An indicator that is insensitive to current emissions will give more weight to investment and policies that address other inputs to the R-ISEW calculations than it gives to carbon reductions. If the R-ISEW is used to guide decision-making practice, this might create the undesirable situation where climate change mitigation would start to seem secondary and irrelevant. The two new proposed approaches, accounting separately for past and present emissions would, on the other hand, make the index receptive to both current carbon reduction efforts and the need to invest into adaptation.

Conclusion

The two new approaches reflect a slight tension in the theoretical framework. Taking literally the equation $S + \Delta K$, we would want to choose the second approach, based on ecological debt. Whilst better than an approach that only captures current costs, however, it is not clear whether this satisfies the idea of a Hicksian income as one that can be sustained at a regular level indefinitely. It is true that without further emissions, the ISEW would steadily decline as we approach 2050 when damages are forecast. However, whilst this will provide us with a useful warning of the impending costs of climate change, theoretically, if we were truly capturing Hicksian income (or Hicksian service flow) then, all else being equal, the ISEW should remain steady over time in such a scenario, even beyond the point that damages begin to be felt. The endowment fund approach achieves this by spreading the costs of the damages over all coming years, including the present one. However, for *it* to truly measure the Hicksian income in these terms, it would need to make allowance for future emissions too.

Fundamentally, we must acknowledge that both past and present activity play a role in determining the sustainability of a given year’s activity. By restricting the ISEW to an assessment of only this year’s activity, we would lose some of that information, but we do ensure that it is a more interpretable, cohesive and sensitive policy tool. Other issues, such as the total capital stock, which inherently better capture information about the past, should perhaps be left to other indicators. However, this remains an issue for further discussion, and one which future research may shed light on.

What can be learnt from the Stern Review

New knowledge on extent of damage from climate change

The Stern Review brings together new results from economic modelling of the damage of climate change. The ISEW indices can benefit from updating their estimates based on this new knowledge.

It is worth briefly noting some of the difficulties involved in estimating the damage caused by carbon emissions. First, the analysis is quite sensitive to the discount rates chosen. This issue will be discussed later. Some ethical choices will have to be made concerning how to deal with the unequal distribution of damages. The poorer regions of the world will be disproportionately affected by climate change. Some estimations of the social cost of carbon take this into account by adding a welfare or equity weighting to the calculations to reflect the ethical issues associated with such an outcome. The choice for weighting of distribution can have a significant impact: Richard Tol , for instance, approximates the global cost of climate change to be twice as high for 5 degrees if he uses equity weightings.[46]

The damage caused by emissions at any given moment will also depend on the amount that will be emitted in the future. Any estimate of the costs will therefore have to be done with some assumption about the forthcoming emission path. If, for example, we assume that emissions will very quickly be reduced, the social costs of emissions today would be smaller than with an assumption of growing emissions. This is because the marginal damage of increased emissions increases – the opposite of diminishing returns. Most estimates for the social cost of carbon, including those from the Stern Review, and the £70 estimate used in the current calculations, assume a 'business-as-usual' scenario, where emission levels are assumed to grow based on recent trends. In addition to this, the estimates of damage will naturally have to be based on complex models, including assumptions about variables such as the future growth rates of the economy and industries, innovations of technology, demographic shifts and migration, and so forth.

The assumptions that are behind the damage estimations can be problematic, most obviously if they turn out to be false, but also if they conflict with other assumptions made in the modelling. For instance, in the endowment fund model, the payment to the fund each year reflects the amount that would have to be invested each year, if all future years would have zero emissions. There is clearly logic to this, as the adjustment to the index should be only made based on the damages accrued so far. Still, the estimate of the costs that will be incurred in the future are conditioned on the (global) emissions continuing on an upward trajectory in the future. Picking the cost estimate with the right assumptions is difficult, for the practical reason that most of the costings available are predicated on emissions continuing unabated in the future. There are different classes of damage that can be taken into account. The older climate change models typically only attempted to take into account market impacts, changes on things that are part of formal markets and therefore have a price attached to them. The PAGE2002 model used by Stern also attempted to include non-market goods, such as human health and the environment, that don't have economic prices attached to them. Their value was estimated using separate techniques such as contingent valuation. Stern's model also factored in the risk of systematic changes, where the dynamics of the climate system might severely deteriorate after some tipping point.

The Review estimates the social cost of carbon, given a business-as-usual scenario, at \$85 per tonne of carbon dioxide or £237 pounds per tonne of carbon. This is about 3.4 times larger than the damage estimate used at the moment. The Review also gives estimates of the social cost for future scenarios where carbon concentrations in the atmosphere are stabilised at levels at which climate-related risks are still relatively low.

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[46] Tol R (2002) 'Estimates of the damage costs of climate change, part II: Dynamic estimates' *Environmental and Resource Economics* **21:**135–160.

With a trajectory that ends up with 550ppm carbon dioxide equivalent, the damage caused by a tonne of carbon dioxide is assessed at $30, which translates to £84 per carbon tonne equivalent. The corresponding figures for 450ppm are $25 and £70. Hence the damage estimates used in the current R-ISEW calculations come close to what Stern's modelling expects to happen if climate stabilisation succeeds at keeping greenhouse gas concentrations ambitiously low. The Stern Review does not give any estimates of how the marginal cost of carbon should be raised every year to reflect the increase in damage caused by every additional tonne of emissions.

Since the publication of the Stern Review in 2006, there have been some developments in climate science as well as in economic modelling. In his recent book on the topic, Stern states that recent scientific results have made him more pessimistic about the damages caused by emissions.[47] The Intergovernmental Panel on Climate Change (IPCC) published its Fourth Assessment Report shortly after the Stern Review, outlining the broad scientific consensus about the impacts of climate change. Many scientists have since found its results too conservative[48]. Also Stern, in his new book, advocates a lower emission target, stabilising at 500ppm CO_2-equivalent (or 450ppm of CO_2 alone), instead of the 550ppm that was the basis of the Stern Review.[49]

Some economic models have emerged with more recent estimates of damage. Researchers from the Stockholm Environment Institute (SEI)[50] used the same model as the Stern Review with new information about damages, especially in the USA. They also adjusted some of the model's features which they found unjustified; for example, increasing the costs of adaptation. Stern's original model assumed that a large amount of adaptation could be done essentially free of cost. They also decreased the temperature over which 'catastrophic events', such as the loss of ice-sheets that act as positive feedback, become possible.

Although SEI's model has not received the same extent of scrutiny as Stern's calculations, it indicates the general direction of estimations of damages following from climate change. The report gives damage estimates in terms of annual damage as a proportion of GDP in 2100. Different estimates are given in Table 1.

The authors of SEI's model suggest that focus should be given to the worst-case scenarios instead of the average damages. Most damage estimates are based on the average values derived from a number of model scenarios that is thought to be the most likely value. In this class of scenarios, the difference between the Stern's estimates and those of thee SEI is about three-fold. Given the uncertainties in prediction and immense costs of the least likely cases, the SEI authors claim that we should 'worry less about calibrating the most likely outcomes, and more about insurance against worst-case catastrophes'. When focusing on the less likely scenarios, the differences in the damage estimates become larger.

With the endowment fund model, however, the situation is more complicated. The adjustments are not dependent only on the extent of damage, but also its distribution over time – the damage curve.

Table 1. Estimates of annual global damage in 2100 in different damage categories as a percentage of GDP in a business-as-usual scenario from the Stern Review and the SEI model.

[47] Stern N (2009): A Blueprint for a Safer Planet. (London: Random House).
[48] Cookson C(2009) 'Global warming closing in on "critical threshold"' *The Financial Times* 16/02/09.
[49] Stern (2009) *op. cit.*
[50] Ackerman F, Stanton E, Hope C, Alberth S (2009) 'Did the Stern Review underestimate US and global climate damages?' *Energy Policy* **37:**2717–2721.

	Economic	Non-economic	Catastrophic	Total
Stern mean	0.6	1.4	0.3	2.2
SEI mean	1.6	2.3	2.6	6.4
SEI 83rd percentile	3.2	4.5	6.3	13.5
SEI 95th percentile	4.2	6.1	8	16.8

The temporal distribution of environmental damage

At present, all the damage is modelled to occur in a single point in time in 2050. This choice was made because the literature used did not present an explicit damage function over time. The Stern Review includes some information on when in time the damages are estimated to occur. Based on these results, the calculations for accumulated environmental damage in the ISEW models could be refined.

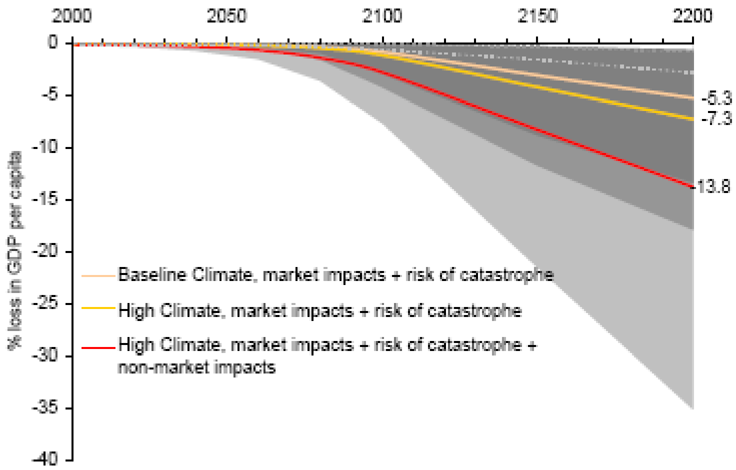

Figure 1. Different scenarios of damage caused by climate change as proportion of GDP. The grey areas point to the distribution of 5–95% impacts range of different scenario runs.

In Figure 1, the ‘high-climate’ scenarios include possibilities of amplifying natural feedback processes, such as weakening carbon sinks or methane release from wetlands. These would increase the severity of climate change after certain threshold levels would be reached. The third scenario includes non-market impacts, such as human health and natural habitats.

As Figure 1 shows, the Stern model suggests relatively minor damage before the end of the century, with substantial amounts only really setting in during the twenty-second century. The damages are reported in percentages of GDP. In the baseline climate scenario, the loss to GDP by 2060 is 0.2%, rising to 0.9% by 2100 and 5.3% by 2200. The non-market impacts are estimated at 0.5% of GDP at 2050. The damage costs for each year are not given explicitly in numerical form in the Stern Review.

If Stern’s model is accurate, then the timeframe adopted by the present ISEW model is likely to be unduly pessimistic. The damages caused by climate change, if it is to continue unabated as in the Stern scenarios, will mostly be incurred later than 2050, and mostly in 2100. The distribution of damage is also estimated to be quite extreme: Most of the damage is associated with developing countries, and little costs are expected to be incurred by developed countries before 2100. This is partly a consequence of the assumptions concerning adaptation mentioned earlier.

Stern's results about the distribution of damage in time have, however, drawn some criticism from scientists and economists. Ackerman *et al.* question the results that 'are concentrated in near-term impact on developing countries, in worsening worldwide conditions after 2100. ... It appears inconsistent with the growing evidence that climate impacts are already being felt in the global North'.[51] More recent results from climate science show that high increases in temperature in this century are possible and likely if trends in greenhouse gases are not reversed.[52] In light of such views, the current assumption about costs becoming material in 2050 is not impossible. At the same time, the simplification of having all damages take place at one place in time is obviously not realistic. It is likely that a significant amount of the damages will take place later.

When the endowment fund methodology is used, a damage curve in which the harm takes place later has the potential to reduce the adjustment that is done to annual figures to account for long-term environmental damage. This can be based on two sides of the calculation. First, the necessary investments into the fund will be distributed over a longer period, meaning annual investment can be reduced. Secondly, if the fund were modelled as yielding interest, it would have a longer period in which to do so. At present, however, the ISEW calculations use a zero interest rate for the fund. More detailed data that would show the damage to occur later would hence tend to decrease the adjustment based on the endowment fund. This effect is, however, likely to be outweighed by the general increase in the size of the damage, described earlier.

Similarly, using the ecological debt methodology, later damages would imply that the current size of the required fund is lower, as it would have more time for interest to accrue. This does not necessarily mean that the annual change in the size of the debt is bigger, however, as it appears that this depends on several factors, including the interest rate being used.

Next steps

Future work on this component needs to focus on two areas. First, a decision needs to be made with regard to how the costs of past and present emissions are incorporated in the ISEW. This decision must inevitably be made in conjunction with the RDAs, who have been using a particular methodology until now. Practical considerations, such as the need for sensitivity to changes in emissions will be crucial in deciding on the accounting method. The overall question (introduced earlier) of the importance of having a consistent theoretical framework will also be relevant. If we decide that a framework is desirable, then the methodology we use will need to be consistent with it – for example, it would appear that the last methodology discussed is the only one wholly consistent with the $S + \Delta K$ framework. However, if other considerations outweigh the importance of having a consistent framework, then we have the flexibility to choose whichever methodology is preferable on other grounds.

The R-ISEW modelling would also greatly benefit from updating the damage estimates from more recent research. Relying on the Stern Review would have the benefit of being widely acknowledged and having some authority. It would require little work to have access to the data on the damage curve and implement it in our LTED calculations.

However, its conclusions regarding the distribution of damage over time have come under criticism. Climate science has moved very rapidly over the last three years, and even Stern himself has suggested that the Review was probably overly optimistic. It may be prudent to make a thorough review of other models of climate damage that have

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[51] Ibid. p. 2719.
[52] Adam D (2009) 'World will not meet 2C warming target climate change experts agree' *The Guardian* 14/04/09.

been carried out since 2006, and perhaps opt for one of those rather than the Stern Review. A model would have to be chosen that would make use of the state-of-the-art knowledge from climate science. The review should also cover current developments in economic modelling of climate change and make sure the used model sufficiently accounts for things such as uncertainty and the possibility of catastrophic events. The chosen model should also preferably create the types of outputs that are required to make the R-ISEW calculations more exact, such as time-series data with an explicit damage curve.

The next necessary step would be to work together with some of the economists involved in climate modelling to make such data accessible. With the appropriate data at hand, the calculation methods in the spreadsheets would have to be developed to incorporate it. The ideas of how to do such calculations are already clear, so this last step would not require much investment.

4. Consumption or production?

Where do environmental costs fall? The simplest approach is to cost them where they take place – the point of emission or depletion. As we have seen, however, this is not consistent with the inclusion of LTED and resource depletion, both of which are global costs. As such, we have demarcated the ISEW to cover productive activity within a given region, or the benefits of productive activity in that region. The fact that the productive activity within a given region may not lead to any depletion of resources from within that region, or cause LTED within that region, therefore is irrelevant. Instead, we have opted for a theoretical framework which leads us to consider where the responsibility for those costs falls, not where the actual costs fall. This introduces an ethical dimension to the ISEW.

Who is responsible for environmental costs? In an interdependent society, there is no easy answer. Consider a fork – its manufacture and distribution entail the depletion of mineral resources, and the emission of CO_2, SO_2, and other gases associated with metal production. Who should count the costs? The company who manufactured the fork from crude steel? The company who produced the steel itself? The company who mined the ores or pumped the oil used to produce the energy required in the process? The company who sold the finished fork to the consumer? Or the consumer? Furthermore, what if the fork was purchased by a restaurant rather than an individual for use at home? Is it now the restaurant's responsibility? Even within companies there are questions as to who bears the cost – the managers, the employees, the shareholders? This complex web has led some to throw up their hands and describe environmental costs as 'shared'. This may well be true, but unless we can specify how they are shared, quantitative approaches such as the R-ISEW will not be possible. This is becoming particularly important as international negotiations regarding emission quotas develop. For example, China has recently made it clear that it believes that Western consumers are responsible for the CO_2 emissions produced in the manufacture in China of goods exported to the West.[53] Meanwhile, Western governments have made it clear that they will not accept such a position. If negotiations are to succeed, some compromise will be necessary.

In this portion of the scoping work we shall do three things. First, we will briefly consider the theoretical possibilities for apportioning responsibility. These are, namely, attributing environmental costs exclusively to final-consumers, attributing them exclusively to their producers, or some attempt at 'shared responsibility'. All these approaches are consistent with our theoretical framework; the choice is therefore one that should be guided by ethical and pragmatic considerations.

Secondly, we will briefly run through the various components of the R-ISEW in its current form and identify the theoretical approach that is being embodied. Lastly, we will

[53] Watts J (2009) 'Consuming nations should pay for carbon dioxide emissions, not manufacturing countries, says China' *The Guardian* 17/03/09.

consider the practical feasibility of calculating the components of the R-ISEW according to our favoured approach, and the required next steps.

Theoretical possibilities

The simplest method for apportioning environmental costs is to allocate them to the direct producer of those costs (*producer responsibility*). So the costs of air pollution are allocated to those entities responsible for the emission of air pollutants, and likewise with water pollutants and greenhouse gases. The IPCC, for example, adopts this approach for allocating responsibility for greenhouse gases. It is a little less clear cut who should bear the costs of resource depletion. Is it the entity which extracts the resource from the lithosphere (i.e., the drilling company)? Or is it the entity which, by burning that resource, thereby uses it, to the exclusion of others (i.e., the power generator)?

More importantly, it is immediately clear that an approach apportioning costs to producers misses a substantial part of the story. Energy is not produced and air pollution is not emitted in a vacuum – they are connected to economic activity made viable by the existence of willing consumers of produced goods. Surely these customers are partly responsible for the environmental costs accrued in the manufacture of goods for their benefit? Indeed, one could argue that they bear all of the responsibility – after all, if consumers did not want environmentally costly goods, producers would not be producing them. Such *consumer responsibility* is the approach adopted by the popular National Footprint Accounts.[54] In this approach, consumers of goods and services are allocated the entire weight of the environmental costs associated with those goods and services. This approach is also consistent with how the free market deals with costs. When the costs associated with the production of goods are internalised (e.g., the manufacturer paying for raw materials, or for guards to protect their warehouses from being burgled), these costs are reflected in the price of the goods sold. In this way the consumer ultimately pays. Similarly, one would expect that, were environmental costs internalised in the same way, through carbon taxes or some such policy, they would also be reflected in increased prices. In other words, the market's tendency is to transfer costs to consumers ultimately.

Supporters of consumer responsibility argue that it better reflects the truth of how individual's lifestyles affect the environment. Clarke criticises producer responsibility approaches for allowing countries to 'export' their environmental costs:

> *It is assumed that the moral claim for [a consumer responsibility] approach is self-evident as increasing one's own well-being at the direct expense of some-one else is counter to all belief systems and legislated against in international declarations on human rights.*[55]

For example, it is true that most pollutant emissions have declined in the UK, including carbon monoxide, nitrous oxides, pollutants affecting water quality, and even the ubiquitous carbon dioxide. These declines are reflected in dropping costs of air pollution in the R-ISEW over the last 12 years. However, these falls are neither the result of a decline in the consumption of the goods associated with these pollutants, nor are they fully explained by improved efficiency in production processes. Rather, they reflect a growing pattern of dependence on goods produced outside of the UK. For example, a recent report compiled by SEI and the University of Sydney on behalf of Defra, found that the UK's balance of trade resulted in a net import of 131.8 Mt of CO_2 in 2004,

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[54] www.footprintnetwork.org

[55] Clarke M (2007) 'Is the GPI really genuine? Considering well-being impacts of exports and imports' *International Journal of Environment, Workplace and Employment* **3:**91–102.

embedded in imported goods.[56] Taking account of these imported CO_2 emissions would, in that year, have resulted in a marginal social cost of CO_2 emissions some 20% higher. In other words, consumption in the UK continues to rely on high environmental costs, simply that they are exported.[57]

Rodrigues *et al*. suggest that this is an important characteristic of a measure of environmental costs.

> *When faced with indicators that show an increase in the environmental performance of rich countries, some ask whether there was real progress or simply passing the buck to poorer countries … A good indicator of environmental pressure should not allow such suspicions.*[58]

And yet, there are reasons not to adopt this opposite extreme of attributing *all* the environmental costs to consumers. First, whilst it is true that producers would not produce environmentally costly goods if consumers did not want them, the opposite also holds – i.e., consumers would not be able to consume environmentally costly if producers did not produce them. As the expression goes, 'it takes two to Tango'. Producers are not necessarily helpless pawns at the hands of greedy consumers. They are also able to make choices as to what they produce and how they produce it. It is important to recognise this element of choice. Allocating full responsibility to consumers, and then somehow encouraging or forcing consumers to reduce their environmental impact will reduce overall environmental impact, but the pressure on producers would only be indirect – as they strive to ensure that consumers purchase their products despite the environmental costs connected with them. Pressure could be applied directly on the producers themselves by encouraging or forcing them to reduce their environmental impacts. Indeed there is an argument to be made that this would be more effective as they are more likely to have more information available to them as to how to do so.

Shared responsibility approaches

Several approaches to sharing responsibility between consumers and producers have emerged, many motivated by the need to ensure that shared environmental costs, when aggregated add up to the total environmental cost, and not more, leading to double-counting. Perhaps the most straightforward is that of Bastianoni, Pulselli and Tiezzi.[59] In a supply chain consisting of three participants A, B and C, A emits 50 units of carbon emissions, B 20 and C 20 units. The Life-Cycle Assessment (LCA) approach they take as their starting point sums all 'upstream' emissions – i.e., those preceding in the supply chain.

Were each participant to conduct their own LCA, and the results totalled, they would reach 230 units, which is obviously more than the total environmental damage caused – i.e., there would be double-counting. To deal with this, Bastianoni *et al*. suggest normalising the three LCA analyses, such that their totals add up to 230 (i.e., divide by 230 and multiply by 100). Doing so produces the figures 22 for A, 35 for B and 43 for C in this example. In all examples it will attribute increasing costs as one moves down the supply chain towards the consumer. This approach suffers from not being invariant to the number of participants in the chain. If a fourth participant (D) were to be involved a

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[56] Wiedmann T, Wood R, Lenzen M, Minx J, Guan D and Barrett J (2008) *Development of an Embedded Carbon Emissions Indicator – Producing a Time Series of Input-Output Tables and Embedded Carbon Dioxide Emissions for the UK by Using a MRIO Data Optimisation System* (London: Defra).
[57] Ferng J (2003) 'Allocating the responsibility of CO_2 over-emissions from the perspectives of benefit principle and ecological deficit' *Ecological Economics* 46:121-141.
[58] Rodrigues J, Domnigos T, Giljum S and Schneider F (2006) 'Designing an indicator of environmental responsibility' *Ecological Economics* 59:256-266, p. 257.
[59] Bastianoni S, Pulselli F, Tiezze E (2004) 'The problem of assigning responsibility for greenhouse gas emissions' *Ecological Economics* **49:**253–257.

the end of the chain, they would automatically receive the highest proportion of the environmental cost and dramatically reduce the costs attributed to the other participants – even if D does not produce any environmental costs directly.

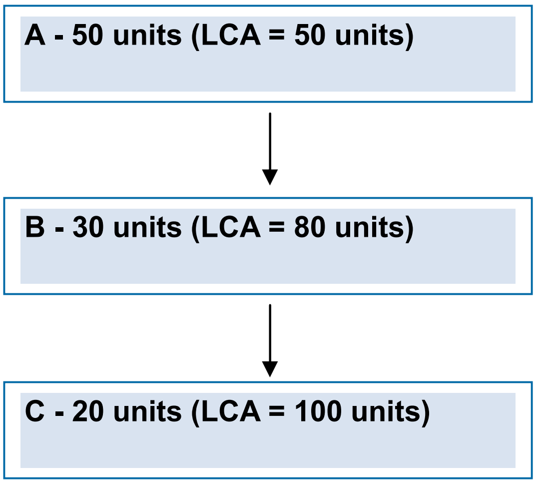

Figure 2. Bastianoni *et al.* approach.

Lenzen, Murray, Sack and Wiedmann report an approach which tends to lean in the opposite direction in proportioning environmental costs.[60] They step away from LCA, and divide environmental costs between the producer and their direct consumer. Costs then trickle down the production chain with those closest to high impact activities, being attributed the highest costs. Those further away are generally insulated. They propose trickling costs down on the basis of the Value Added by their operations. Companies adding a lot of 'value added', retain a high proportion of the costs, passing on a smaller proportion to their customers. In effect, adding more value to the product as it goes through the supply chain exposes one to a higher share of the environmental cost. How this works is shown Figure 3, showing the shared environmental cost of a jar of pickles.

For example, the pickle producers add the largest value added to the product and so retain a high proportion of the costs at their level. If they only added a low amount of value, they would retain less cost and more would be passed on to the final consumer.

It makes sense to link environmental costs to economic factors. After all, damage to the environment is almost always done in modern society as a byproduct of some economically motivated activity. Indeed, it is for this reason that the ISEW exists as a means to capture the environmental impact of our economies. Proportioning greater responsibility to those making the greater economic gain from a process seems appropriate. Unfortunately, this approach does not really achieve that objective. As the previous approach inevitably apportions more costs downstream towards the consumer, this approach inevitably apportions more upstream towards the producer of the environmental damage.

EF = 8ha, VA = \$0.8m, NO = \$1.6m | Sand mine: 8ha x 0.8/1.6 = **4 ha**

[60] Lenzen M, Murray J, Sack F, Wiedmann T (2007) 'Shared producer and consumer responsibility – Theory and practice' *Ecological Economics* **61:**27–42.

		8ha - 4ha = 4ha passed on
EF = 0.4ha, VA = $1.6m, NO = $3.2m	Glass manufacturer: (4ha + 0.4ha) x 1.6/3.2 = **2.2 ha**	
		4.4ha – 2.2ha = 2.2ha passed on
EF = 0.2ha, VA = $4.8m, NO = $8.0m	Jar maker: (2.2ha + 0.2ha) x 4.8/8.0 = **1.44ha**	
		2.4ha -1.44ha = 0.96ha passed on
EF = 0.2ha, VA = $10m, NO = $18m	Pickle maker: (0.96ha + 0.2ha) x 10/18 = **0.64ha**	
		1.16ha – 0.64ha = 0.52ha passed on
EF = 0ha, VA = $4.0m, NO = $22m	Food retailer: (0.52ha + 0ha) x 4/22 = **0.09ha**	
		0.52ha – 0.09ha = 0.42ha passed on
	Final consumer: **0.42ha**	

Figure 3: Lenzen *et al.* approach.

Being further away from the producer in the economic chain automatically cushions one from the environmental costs. For example, were the consumer in Figure 3 to cut out the middle men, purchase the glass directly themselves, and produce the jar and the pickle to fill it with, they would immediately find their responsibility had increased more than six-fold. That seems rather arbitrary if, at the end of the day, they are still getting the same pickle. Also arbitrary is the assumption that the sand mine adds half of the value of the sand in its operations. How is that determined? If, for example, it is deemed that they indeed add more than half (let's say 75%) then the entire set of calculations is thrown off, and the responsibility of all the other participants in the chain is almost halved.

A variant of this approach suggested by stakeholders involved in the same paper is to use operating surplus (or profit) rather than value added to determine what proportion of the environmental cost is retained and what is passed on. The argument behind this is that the operating surplus is a proxy for the flexibility a participant has in altering its production methods. It also avoids the incoherent situation produced by the value added approach that processes which are more labour intensive and therefore add more value but do not contribute to environmental costs, are likely to penalised.

A better approach may be to simply use the operating surplus described earlier to distribute responsibility regardless of where an agent is in the production chain, as shown in the hypothetical example in Table 2.

Table 2: Surplus added approach.

	Value added	Net value	Operating surplus	Proportion of environmental cost
Sand mine	1.6	1.6	0.2	5%
Glass manufacturer	1.6	3.2	0.2	5%
Jar maker	4.8	8	0.4	10%
Pickle maker	10	18	1.2	30%
Food retailer	4	22	2	50%

As we can see in Table 2, it is the food retailer that bears the greatest cost now, as they also enjoy the greatest benefit from the entire production chain. But what about the consumer? They do not gain an operating surplus – once the pickle jar has been purchased by a consumer, who won't sell it on, it is out of the economic market. It may well be necessary to simply, arbitrarily split the cost equally between the consumer and the production chain. No other option presents itself. Whilst Lenzen *et al.* suggest that often the consumer has more choice than the producer and so should bear more of the cost, their actual solution, if anything, achieves the opposite effect, and furthermore, the consumer's share is determined rather arbitrarily by how much value is added in the final stage of the process.

It should be noted that the benefit principal demonstrates that the point of 'production' can have two meanings. It could mean the point at which pollutants are actually emitted, the point of emission. Or it could mean the location where the company benefiting economically from the pollution is located – what we will call the *point of economic benefit*.

Preferred approach

Indicators serve a signalling role. The ISEW should be a part of the process of applying pressure on different actors to change behaviour. As the R-ISEW is currently being utilised by RDAs (the public sector) there is a case to be made for it to support the application of pressure on both consumers and producers – a shared responsibility approach.

The benefit principal seems the most just for partitioning costs along the supply chain. However, this is clearly the most challenging approach to operationalise. Not only would we need to fully assess where products are being consumed, but we would also have to fully understand the supply chains and gather data on profit margins for each sector.

An appropriate compromise may be to simply split environmental costs 50/50 between producers and consumers – an approach that has been put forward by Stern for dealing with goods produced in China and consumed in the UK.[61] As such environmental costs of producers within a given region would be divided by two before including them in the accounts. Then, we would need to estimate the environmental costs of consumers within a region. Before considering our options further, we shall turn to assess what approaches the R-ISEW currently adopts.

Current R-ISEW

The following vocabulary will be used in defining the current methodology:

- Point of emission (where the pollution actually takes place).

[61] Monbiot G (2009) 'Stern breaks the east-west deadlock on who's responsible for CO_2' *Guardian Online* 27/5/09.

- Point of effect (where the pollution reduces service flow or reduces natural capital).
- Point of final consumption (where the final consumer of the pollutant-producing good or service lives).
- Points of economic benefit (where economic benefit from the production of pollutant-producing goods or services is made).

Recall that for our purpose we would like the ISEW to capture the latter two points (consumption and economic benefit).

Currently, all three local pollution components are costed at point of effect (air pollution, noise pollution and water pollution), where in two cases this is also point of emission (air pollution and noise pollution). Generally, it can be assumed that these coincide with the point of economic benefit. Pollution abatement is explicitly costed at the point of economic benefit.

Loss of farmland and habitat is also costed at the point of effect (i.e., the farmland or habitat being lost). Again, one can assume that this is also the point of at least some of the economic benefit (development sites built on the lost land).

With regard to LTED, CO_2 emissions and N_2O emissions are mostly costed at point of emission. Mostly, this is synonymous with at least one point of economic benefit. A major exception is CO_2 emissions from personal transport, where the point of emission is clearly the point of final consumption.

Other emissions are dealt with in a more complex way. Methane emissions from waste are distributed according to regional population size. If we assume per capita waste creation is invariant across regions, by using population means we imply a point of final consumption approach here.

Other proxies used in distributing greenhouse gas emissions are consistent with the point of economic benefit approach, including the use of sectoral regional GVAs (gross value added), regional livestock herd sizes and farmland acreage, and regional airport traffic levels. Of these, the latter comes closer to also approximating point of final consumption, as people using an airport are likely to live reasonably close to it – if not in the same region, than at least within the UK.

The last environmental component is somewhat more challenging to categorise. Nationally, the UK's costs of resource depletion are based on energy consumed within the country. This, for example, would theoretically include energy consumed here but produced abroad. However, this does not imply we are already adopting consumer responsibility. Much energy is consumed by industry, services and to some extent transport. The current methodology does not take into account the energy used in producing goods and services abroad that are consumed here in the UK. As such, national resource depletion currently costs at the point of energy consumption which is an intermediate point sometimes closer to point of final consumption, but often is actually a point of economic benefit.

Domestic energy consumption at regional level is obviously consistent with a point of final consumption approach.

Energy consumption from road traffic is distributed according to regional traffic figures. This should approximately map onto point of final consumption for personal transport, assuming that most travel occurs within region of residence. However, this is not the case for the transport of goods and work-related transport, where the traffic only helps identify a point of economic benefit (and even then, not necessarily, as the transport of goods will often cross several regions that do not have anything to do with either their production or consumption).

Energy consumption from air travel follows a similar logic to road traffic, but here the assumption that the region in which the travelling occurs (i.e., the airport) is the region of residence is more tenuous. Rather, this represents a closer approximation to a point of economic benefit (i.e., of the airport)

Energy consumption associated with industry, services and agriculture is distributed according to the regional GVA – as such this is consistent with a point of economic benefit approach.

In summary, the ISEW currently involves a mix of attribution according to points of emission, effect, economic benefit and final consumption. Often, the methodology actually uses point of emission, which approximates to point of economic benefit, though in some cases, particularly around resource depletion, point of final consumption is used.

Next steps

As we have said, it will prove very challenging to source data to develop a fully theoretically and ethically sound partition of environmental costs. Shortcuts may well be the best approach in the short to mid-term. Whilst pragmatism in terms of data availability is important, however, a few minimal requirements should be stipulated.

Taken from the perspective of final use, environmental costs counted in the ISEW predominantly stem from four main sectors – transport, domestic energy use, the production and disposal of goods and services, and infrastructure. It is much easier to find data on transport and domestic energy at the point of final consumption than on the environmental costs of goods, services and infrastructure there. To achieve an approximate 50/50 mix, we might be tempted to cost the former two at the point of consumption and the latter two at the point of economic benefit. However, to do so would risk incentivising regions to reduce the costs of domestic energy use and transport, but ignore the environmental costs of goods and services consumed in their area, and local infrastructure. Conversely, it would incentivise reducing the environmental costs of goods and services *produced* in the area, whilst ignoring businesses in the area that draw economic benefit from providing energy and electricity to consumers outside of it. As such, we suggest it is important to ensure that all four sources of pollution are divided between consumers and producers equally.

Bearing in mind that the largest environmental costs are those from LTED, resource depletion and, to a lesser extent, air pollution, the following presents a possible set of solutions, broken down by final use sector:

- **Domestic energy use.** At the moment, energy used in homes results in three main costs: resource depletion costed at the point of final consumption, the emission of CO_2 costed at point of emission, and the emission of other air pollutants, also costed at the point of emission and, therefore, a principal point of economic benefit. We would need to carry out some analysis to verify this, but assuming this represents a roughly 50/50 split between consumer and economic benefit, it would seem that we could continue with this approach.
- **Personal transport.** Currently the environmental costs of personal land transport (i.e., road and rail), including noise, closely approximate point of final consumption, assuming that people tend to travel within their own regions. In doing so, they neglect the responsibility of entities drawing economic benefit from personal transport – principally the oil sector and the public transport sector. To resolve this, we would have to map out where these sectors produce economic benefit and attribute some of the costs from these components to them. With regard to air transport, the opposite difficulty presents itself. Data are typically available based on where airports are located – point of economic benefit.

However, it should not be hard to estimate the regional distribution of passengers, either using data from the National Transport Survey (which asks people how often they fly), or the Family Expenditure Survey (which asks people how much they spend on different forms of transport, including flights).

- **Goods and services.** Here we have a much better measure of environmental costs by point of economic benefit – in terms of emission data for air pollution and LTED, and industrial energy use in the resource depletion component. On the other hand, we clearly struggle to accurately assess consumer responsibility. Estimates do exist of total resource consumption and CO_2 emissions associated with products consumed within a given country such as the UK. Some work would be required to identify the best of these estimates, and to ensure they cover the key environmental cost components, such as air pollution. The challenge is to distribute this macro-figure amongst regions. The most precise approach would be to use micro-level figures product-by-product and map them onto consumer expenditure categories. To do this we would need figures for pollution- intensity for each product category for each key pollutant. This is a tall order, and full life-cycle assessments of the environmental impacts of individual products has only been carried out in a few cases. Rather, we would suggest using sector-level input-output assessments. The EU is funding a large project (EXIOPOL) to assess the inputs and outputs of different industrial sectors. The project is due to be completed in 2010. We would suggest that after this date, work could be done in collaboration with some of the partners in this project (we have links with the Sustainable Europe Research Institute in Vienna, and the Wuppertal Institute for Climate, Environment and Energy in Germany) to transfer the learning from it to the ISEW. In this way we could estimate pollutant-intensity for key areas of consumer expenditure. These figures need not be precise as they may only be needed as indices with which to distribute total UK figures.
- **Infrastructure.** Our starting point here is similar to that for goods and services. Rather than using consumer expenditure to proportion the consumption share of the cost, however, we would need to use some elements of public expenditure data – for example how much is spent within each region on roads, schools, etc. The environmental costs associated with the construction of these public goods could then be partitioned between regions.

In summary, the following tasks would need to be carried out:

- Confirm the distribution of the costs of domestic energy use.
- Map regionally the economic benefits from personal transport.
- Identify suitable data to proportion some of the environmental costs of air transport between regions by region of residence of passengers.
- Estimate total embedded costs of all imported goods
- Identify data on public expenditure on infrastructure and link to environmental costs

Reasonable answers to these questions should be attainable with 20 days' work.

We would recommend revisiting the question of determining the pollution-intensity of specific sectors of consumer expenditure in 2011, after the EXIOPOL project has been completed. However, if we wanted to have rough estimates beforehand, it would be possible to work with external partners to do so.

5. Other developments

Consumer durables

We had considered improvements that could be made to the component on consumer durables (see interim report). However, should we adopt the theoretical framework being proposed, then inclusion of this component would not be consistent.

It is worth considering how the concept we are attempting to capture with this component may be incorporated better into the ISEW. From a sustainability indicator perspective, the intention of this component is to penalise economic systems which lead to goods that do not last as long and therefore provide smaller service flows. This, however, is not an easy task. If we are to accept the assumptions of market economics, a rational consumer is fully aware that a poor quality good might last fewer years than a better quality good, and expects to pay a lower amount to make up for this. Similarly, a consumer who spends £50 on a meal rather than on a new pair of shoes is assumed to have estimated the overall utility of the meal and found it to be higher than the overall utility of the shoes discounted over the time it is expected to last.

One solution would be to incorporate evidence that the discount rates used by consumers are from those assumed in economics textbooks.[62,63] Let us take an example. Let's say that the consumer's subjective discount rate is 10% per year (actually the studies noted earlier found implied discount rates of between 20% and 300%), whereas that found in economics textbooks is 3%. For a consumer to purchase a product costing £100, assuming it will last five years with no depreciation, they must assume that it will provide £24.5 of utility for each of those five years. The total is of course over £100 but that is what is to be expected when discounting. However, the interesting point for the ISEW is that the total utility (at £24.5 per year) discounted at the lower rate of 3% per annum, is £115 – 15% more than the real expenditure. In other words, a good that lasted five years, assuming no depreciation should be valued 15% more than the actual expenditure. One that lasted ten years should be valued at 34% above actual expenditure.

There are two theoretical problems with this methodology. First, it implies that the discount rate of 3% is somehow 'correct' and that 10% is wrong – a strong basis would be required to make such a claim. Secondly, there is no clear way to know where to set the 'true' spending level. Should we adjust expenditure on durables upwards? Or should we adjust expenditure on short-term goods *downwards*? One option would be to take a

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[62] Hausman J (1979) 'Individual discount rates and the purchase and utilization of energy-using durables' *Bell Journal of Economics* 10:33-54.
[63] O'Donoghue T, Rabin M (2000) 'The economics of immediate gratification' *Journal of Behavioural Decision Making* 13:233-250

baseline year, decide that spending in that year accurately reflected the sum of utility and discounted utility, and adjust later years based on that data.

The bigger challenge is the practical one – where are we to find data on the durability of different goods over time? We have not had the opportunity to fully scope out this possibility and so are unfortunately still not in a position to say whether there is existing research in this area.

In summary, the following work would be required to capture shifting expenditure patterns and changes in the durability of goods:

- Review of empirical evidence of consumer discount rates.
- Review of theoretical arguments for different discount rates.
- Collection of data on durability of different goods over time.

Public expenditure

The public expenditure category presently only counts health and education. It would benefit from also considering other categories of expenditure, such as around public transport. Some scoping would be required. This would involve an audit of public expenditure to analyse what should constitute part of the ISEW and analyse its relationship to the capital growth element and any defensive expenditure that would need to be subtracted elsewhere. We estimate that five days would be required to formulate recommendations for adjusting the public expenditure category.

Family breakdown

The costs of family breakdown are currently estimated using divorce rates, the defensive costs of divorce and its impacts in terms of reduced longevity. This is imperfect given that changes in divorce are often as much a reflection of changing societal norms as they are of changes in the health of family relationships. Furthermore, given that family breakdown often has psychological impacts and divorce is only one outcome, we suspect that we are currently substantially underestimating total costs. We suggest augmenting the defensive costs of divorce with further indicators, for example:

- The defensive and psychological costs of domestic violence (rates of domestic violence are available from the British Crime Survey).
- The number of children on the Child Protection Register. To determine the cost per child would require some work. We could not use government spending on social work, as this is not included in the ISEW in the first place. However, we could perhaps determine the psychological costs to children, or the loss of future earnings to children who are on the register, or perhaps an estimate of how much extra it *would* cost if we were able to eliminate the negative impacts on children as a result of family breakdown. **nef** is currently carrying out work for Action for Children which would provide some clues as to what these costs may be, but a further five days work would probably be required to adapt this information the ISEW.

Other ISEWs

Our survey of other ISEWs and related indicators to date has come up with the following:

- It is imperative for us to develop a new valuation of the replacement costs for oil.[64] Currently, we use the average of two figures: i) the price of a barrel of oil and ii) an estimate of the cost of generating the same energy using renewable

[64] Dietz and Neumayer E (2005) *op. cit.*

sources. The estimate used is from the original ISEW[65] and is no doubt out of date. Furthermore, the decision to take an average of these two figures has some degree of arbitrariness to it. It would be a good idea for future development work to identify a more coherent single value to be used.

- Leisure time is often valued (e.g., Redefining Prosperity's GPI). This can be done by measuring change in leisure time from an agreed base, therefore meaning the component could either be positive or negative. This is coherent with the S +ΔK framework, as productive activity that reduces or increases our leisure time compared to a previous baseline directly affects the annual service flow from leisure time. Data on time use is available from the sporadic time-use surveys conducted in the UK. To convert this data into changes in leisure time, we would need to determine which categories of time use count as leisure time, and decide on a unit value of this time. This would likely require no more than a few days to carry out.
- Confirmation that our new approach to commuting time (counting the actual costs and the opportunity costs of time wasted) is used elsewhere (including in New Zealand[66] and Wales[67]).

GPI Atlantic

In March, we met with Ron Colman of GPI Atlantic to discuss ISEW methodologies. GPI Atlantic has adopted a very different approach to indices, whereby it has opted to forego the aggregation process that is central to the ISEW and other GPIs. However, it will potentially be a very useful resource in that it has explored many social, economic and environmental costs and benefits in depth. When we are able to study its methodologies in detail, there is the potential to learn and incorporate improvements to certain components in the R-ISEW. It has also calculated values for components that we have not included in the R-ISEW to date, such as debt, health outcomes and education outcomes. If these are compatible with our chosen theoretical framework, it may be worth exploring how they could be incorporated in the R-ISEW

Stiglitz Commission

We had anticipated the publication of a report by the Stiglitz Commission in France in April 2009. However, the Commission has chosen to delay publication and is not expected to produce a final recommendation until this autumn.

[65] Daly and Cobb (1989) *op. cit.*
[66] Forgie V (2007) 'The need for "convention" in environmental valuation' *International Journal of Environment, Workplace and Employment* **3:**72–90.
[67] Munday *et al.* (2006) *op. cit.*

6. Scenario model tool

Discussions between **nef** and the RDAs had highlighted the potential value of a scenario-modelling tool that would be able to forecast the effect of different policies or projects on the R-ISEW. It was thought that, insofar as the R-ISEW provides a measure of progress for a region, the scenario-modelling tool could assess the extent to which a policy or project, if pursued, would contribute or detract from improvements in the R-ISEW.

For the scoping project, **nef** was commissioned to explore the possibilities for such a tool through a worked example. The RDAs put forward scenarios and our first choice was the Birmingham Airport runway extension. However, a number of problems were encountered when trying to use the R-ISEW to model the effect of this project. These suggested that the R-ISEW may generally not be an appropriate tool for modelling the impact of infrastructure projects.

A second scenario – a 30% shift to homeworking – was selected from the list put forward by the RDAs to explore whether the R-ISEW could usefully model other types of scenarios. This suggested that where a scenario involves a more general shift in the economic or social circumstances and behaviour, rather than an infrastructure investment, the ISEW could provide some useful insights. Findings are discussed below and an accompanying spreadsheet is also available.

Scenario 1: Birmingham Airport

The expansion of Birmingham Airport was initially chosen to develop and test the scenario modelling tool. It was chosen for the following reasons:

- It would stretch the ability of the R-ISEW to pick up the negative environmental and social consequences of airport expansion.
- The economic benefits of airports are contested and this would possibly present an alternative means of accounting for them.
- Environmental and economic studies were already in existence, which was important as the budget for the scoping phase was predicated on using pre-existing data.

However, the analysis had to be abandoned before completion for various reasons. Nonetheless, many interesting lessons emerged from this for the use of the R-ISEW but also for regional policy decision-making more broadly.

Our conclusion was that the R-ISEW may be less useful for modelling the effects of infrastructural projects such as airport expansion. The three main problems were:

1. The structure of the model.
2. The timescale over which it appraises.

3. Displacement effects.

Structure

The model is too rigid for this type of calculation, depending as it does on already-determined categories and adjustments. The rigid structure is problematic in three respects:

1. First, it means that project-specific variants of some of the headline outcomes in the R-ISEW cannot be captured because they are in a different format. For example, the principle underlying the R-ISEW is that consumer expenditure is adjusted for defensive expenditure. In the Birmingham Airport planning application, a number of defensive measures, such as investment in a sound insulation barrier and translocation of marshy grassland, are discussed. Following the *principles* of the ISEW, these should be deducted from the effect on consumer expenditure. However, the components of the R-ISEW as they stand do not provide any opportunity for this to be done. Similarly, the environmental impact assessment conducted for the planning application was very comprehensive, listing impacts on a range of habitats and wildlife but much of this could not be captured within the existing R-ISEW framework. One way around this would be to use the headline outcomes of the ISEW but allow more flexibility in terms of how they are quantified and costed. While this is a potential solution, it would prevent the scenario modeller from being used in a predictive manner, as future calculations of the R-ISEW using the rigid categories would not match the predictions made using more flexible ones.
2. Secondly, the rigidity is problematic because whilst many of the impacts of large-scale infrastructural projects are known, others may be more difficult to determine. It may, therefore, be necessary to set outcomes in consultation with stakeholders to ensure that the analysis picks up all material impacts (positive and negative). The rigidity of the R-ISEW prohibits this and could lead to decisions being taken without due consideration of things that matter to stakeholders, where these stakeholders might be individuals, the local community, businesses and other actors.
3. Finally, the rigidity is problematic because it prevents the analysts from using their judgement, which would benefit an analysis of this kind. Even where there was scope to use personal judgement there is no provision for recording the decision-making process so that the reader can follow this. If it were to be adopted, guidance for how to use the model should be produced and this would need to include provision for an audit trail of decision-making.

Timescale

The ISEW is calculated annually but for infrastructure projects the impacts are usually over a considerably longer time-frame. It would be more appropriate therefore to do whole-life costing rather than an annual calculation when deciding whether an investment is worth making. It may be possible to use it to measure the effects of the construction phase but even so the costs and benefits in the early years when the decision is being taken will not account for long-term externalities. In the case of the airport expansion, the large upfront investment would most likely increase the R-ISEW because many of the negative consequences (e.g., air pollution) that offset the positive effects of job creation are not experienced until much later. In other words, a one-year snapshot for an infrastructure project can give a very distorted picture of its whole-of-life impact and so would potentially lead to poor decision-making. One way around this would be to use the R-ISEW but conduct the analysis over a longer time-frame.

However, to do so would be to stretch the scenario-modelling methodology. This would make the scenario model more akin to a cost-benefit analysis.

CBA vs ISEW: A comparison

Cost-benefit analysis (CBA) has a long history of informing decision-making in both public and private sector contexts. CBA practice varies considerably, but at its core it is a comparison of the 'cost' of a given investment to the 'benefits' that the investment is predicted to yield over its lifespan. Some CBAs are very narrow, considering just financial values, while more recently there has been an emphasis on capturing a more comprehensive range of outcomes and, specifically, on capturing social and environmental impacts that are not traded in the marketplace and so do not have a financial value attached from the outset. Techniques of economic valuation, such as contingent valuation and hedonic pricing, are used to identify financial proxies for such outcomes in order to bring them into the decision-making frame . Social Return on Investment (SROI) is an adjusted form of CBA that has been developed by **nef** to make the capture of social and environmental outcomes more robust (For more information on SROI, see http://www.neweconomics.org/gen/newways_socialreturn.aspx) When using SROI, the first step is stakeholder engagement to map out all the material outcomes that are likely to result from the investment over its life-course. This ensures that the resulting CBA provides a holistic assessment, capturing those outcomes that matter most to stakeholders.

The ISEW-derived scenario model, on the other hand, differs in two primary ways from CBA. First, as opposed to identifying project-specific outcomes and valuing these, the assessment is based on the pre-existing categories and operationalisations of the R-ISEW (e.g., 'habitat', 'air pollution'). As already noted, sometimes this leaves out material outcomes, which in turn can adversely affect decision-making. Secondly, given that the R-ISEW is an annual measure of adjusted economic output, the primary objective of the scenario model was initially to determine what the effect on the R-ISEW would be in a given year. For infrastructure projects, such annual snapshots are less useful because by their very nature infrastructure projects usually involve significant upfront investments that then lead to (positive and negative) outcomes over the life of the infrastructure. As such, whole-of-life analysis is key to good decision-making around such projects.

Displacement

In using the R-ISEW it is only possible to look at costs and benefits to the region without taking account of the effects on other regions. Whilst the airport might create jobs and markets for the West Midlands, it may be simply displacing these from elsewhere leading to no overall net gains. A similar critique can be made of the GVA but it is not one that the R-ISEW can correct. This is more acute in relation to something such as the airport project where the displacement effects are likely to be high. So while the airport expansion may benefit the West Midlands, this may be at the expense of another region. There may be reasons why West Midlands should obtain this benefit at the expense of the other region and one may still want to go ahead with the project, but if such a decision is taken it should be in the full knowledge of its impact on other regions. A scenario model based on an R-ISEW for the West Midlands alone would not consider this displacement effect.

We recognise that displacement is a challenge for regional bodies, such as RDAs, that are tasked with improving economic, social and environmental outcomes in a single region. Meeting targets for growing the prosperity of their region can be in conflict with ensuring that value is truly additional, as opposed to displaced from another region. It is important that appraisal tools become better at identifying genuinely additional value, so that targets can be set around the creation of additional value as opposed to displaced value. This will encourage a different form of accountability, thereby discouraging a ‘beggar thy neighbour’ approach to regional development. The ISEW scenario model is not helpful to such an approach because in its present form it does not deal effectively with displacement effects.

Additional findings

In addition to general issues around the use of the R-ISEW for assessing infrastructure scenarios, there were some challenges to conducting this analysis that applied specifically to this project and stemmed from the quality of the existing data. An analysis such as this will only be as good as the data that feeds into it. The following problems were identified with the data provided in the economic assessment and these should be borne in mind for any future scenario modelling, whether based on the R-ISEW or another tool:

- The economic study that was used did not make any assessment of deadweight effects and was therefore most likely over-estimating the economic benefits. For example, there was no analysis of whether the trade benefits were new, or whether this was trade that was already happening through London.
- The analysis assumed continuous growth in aviation between now and 2052, projecting an 863% increase over this period. There was no sensitivity analysis conducted on the possible effects of exogenous impacts, such as the effect of a prolonged economic downturn or of regulatory changes (e.g., fuel taxes, flying restrictions) in response to the threat of climate change.

Recommendation on use of ISEW to model infrastructure projects

The usefulness of a scenario model can be judged by the extent to which it improves decision-making. Our experience testing the R-ISEW for scenario modelling for the Birmingham Airport runway extension suggests that alone it is not likely to be a useful tool for modelling the social, environmental and economic effects of infrastructure projects and, therefore, for making decisions around such projects. Although we have looked in depth at just one infrastructure project, we have tried to consider whether the difficulties we encountered were specific to the Birmingham Airport example or would be shared by other infrastructure projects. We have struggled to find infrastructure projects where these problems would not occur and so would suggest that other approaches to appraising infrastructure project should be given more weight.

However, calculating a predicted R-ISEW change could serve a minor role supplementary to a fuller assessment, in the way that one should calculate the predicted change in GVA as *one* element of an impact assessment.

For a holistic analysis of the effects of an infrastructure project, we recommend an adjusted CBA approach such as SROI that:

- Measures over the longer term, making visible the whole-of-life costs.
- Measures across a triple bottom line of social, environmental and economic outcomes and uses economic valuation to make visible the trade-offs between different outcomes.
- Engages stakeholders when identifying outcomes to make sure that the things that matter get measured.

Scenario 2: Working from home

Given the difficulties with using the R-ISEW to model infrastructure projects, the second example explored the effect of a change in the structure of working arrangements in the economy. Specifically, the effect of an additional 30% of the workforce in the West Midlands working from home two days per week was modelled. The outcomes of this modelling are discussed here. They should be read alongside the accompanying Excel workbook for the scenario model. Please bear in mind when reading this section that the objective of this exercise was not to assess the merits from a policy perspective of a move to greater home-working, but instead to test the scenario modelling potential of the R-ISEW. For this reason, the learning from the process, rather than the numbers *per se*, is the primary focus.

Methodology

Starting with the 2006 R-ISEW data and results for the West Midlands, adjustments were made to each component based on the likely effect of increased home-working. Wherever possible, projections were based on research evidence but in several instances, due to a lack of data availability and time constraints, it was not possible to base estimates on research evidence. Full details of the sources and assumptions can be found in the 'scenario assumptions' sheet of the workbook.

Once each component had been adjusted, the new R-ISEW and R-ISEW per capita were calculated in the usual way. These were compared to the West Midlands R-ISEW for 2006 and indexed to the England 1994 value. The percentage change in the R-ISEW for the West Midlands as a result of the move to home-working was also calculated.

Findings

Using the R-ISEW framework enabled the effects of home-working to be modelled across a fairly comprehensive range of outcomes in an efficient way. The existing categorisations acted as a useful prompt to consider outcomes across a triple bottom-line, while the existing data and costings in the processing sheets made the process much quicker and easier than if starting a similar analysis from scratch. Additionally, there was a baseline (R-ISEW 2006) against which the new model could be compared.

The results of the model lend themselves to easy and quick communication. The main findings are summarised in Table 3. It is easy to see the areas in which the greatest difference is made – for example, industrial accidents (includes illness and is due to the reduction in stress that home-workers experience) and commuting – when compared to the baseline 2006 R-ISEW for the West Midlands, and whether that effect is positive or negative.

Alongside these strengths, there were also some weaknesses. These relate in part to issues identified in other parts of the scoping report. The calculation of environmental effects on primarily a producer basis means that some effects were not adequately captured in our model. For example, it is possible that the extra requirement for resources to maintain home workstations in a model that apportions some of the costs to consumers would have seen a smaller change in the R-ISEW. Furthermore, as we said earlier, the model is only as good as the data put in and sometimes we were limited in the data that were available to make projections. This can in part be offset by using sensitivity analysis to vary assumptions and projections once the model has been set up.

It is also important to point out that, while the modelling was relatively easy and quick to do, there are limitations in the extent to which the model can be automated in the absence of significant further investment. The process we undertook to arrive at the new R-ISEW for the home-working scenario involved manually adjusting each of the 2006 components. Unless software development is undertaken to build a model that can pick up the interactions between components and the specificities of each scenario that is to be modelled, this will continue to be the case. As a consequence, those intending to use the existing R-ISEW data and processing sheets will need to be sufficiently numerate and skilled in performing the manipulations of each component.

Table 3: Scenario Calculation: 30% additional homeworking, 2 days per week

Calculated for 2006, West Midlands

Component	SCENARIO TOTAL	Total 2006	SCENARIO PER CAPITA	Per capita 2006	Percentage difference
GVA	90598.95	88997.00	16880.74	16582.26	1.80
Consumer expenditure	64972.79	63823.96	12105.98	11891.92	1.80
Income Distribution					
Adj consumer expenditure	57933.97	56909.59	10794.48	10603.61	1.80
Domestic labour	19883.44	19503.13	3704.76	3633.90	1.95
Public expenditure	14831.00	14831.00	2763.37	2763.37	0.00
Consumer Durables	-1339.32	-1339.32	-249.55	-249.55	0.00
Commute	2478.50	2816.48	461.80	524.78	-12.00
Crime	1069.99	1079.27	199.36	201.09	-0.86
Divorce	748.19	748.19	139.41	139.41	0.00
Car accidents	1066.89	1093.13	198.79	203.68	-2.40
Industrial accidents	933.30	1093.13	173.90	203.68	-14.62
Pollution control	438.76	438.76	81.75	81.75	0.00
Water pollution	47.23	47.23	8.80	8.80	0.00
Air pollution	2081.76	2088.63	387.88	389.16	-0.33
Noise	438.28	448.62	81.66	83.59	-2.31
Habitat	187.87	187.87	35.00	35.00	0.00
Farmland	71.45	71.45	13.31	13.31	0.00
Resource depletion	9866.01	9919.95	1838.27	1848.32	-0.54
Long term environmental damage (LTED)	10112.99	10113.29	1884.29	1884.35	-0.0030
Capital growth	1061.16	1061.16	197.72	197.72	0.00
International position	-3773.20	-3773.20	-703.04	-703.04	0.00
R-ISEW	**£59,055.81**	**£57,180.45**	**£11,003.51**	**£10,654.08**	**3.28**
Indexed to England 1994			**134**	**130**	

% effect on R-ISEW **3.28**

Recommendation on the use of R-ISEW to model non-infrastructure projects

We recommend that RDAs consider using the R-ISEW data and processing sheets as a tool for modelling non-infrastructure projects. It provides a relatively quick way of modelling effects in a more comprehensive way than many conventional economic analyses.

Several reasons why the R-ISEW may be more suitable for modelling non-infrastructure projects than infrastructure projects emerged:

- Non-infrastructure projects are less likely to involve displacement of costs and benefits from other regions.
- Non-infrastructure projects typically involve less initial investment, and are likely to have more constant effects over time, meaning that full lifecycle analyses are not quite as essential.
- The reversibility of non-infrastructure projects (it would be feasible to simply cancel the 30% home-working policy, but it is not so feasible to remove an airport expansion) has implications in terms of the resources that should be invested in making an impact assessment before enacting a decision.

Whilst the R-ISEW did seem to capture many of the impacts of the home-working project, it should be noted that it did not capture all of them, and it may be the case that the R-ISEW may not be a suitable decision-making tool for other non-infrastructure projects. Like with infrastructure projects, where a decision might have substantial effects on people or the environment, results from a more holistic, individually tailored approach such as the SROI should be given more weight than those from the R-ISEW.

If it is intended that the model be used beyond those with expertise in economic analysis, the RDAs should consider investing in the development of an automated software tool.

Next steps

Based on the scoping project, the following appear to be fruitful/necessary avenues for development of the R-ISEW (costs include usual day rates plus 10% expenses, but not project management costs):

- Further thought on theoretical framework, in consultation with RDAs, and with further literature review (Section 1; £4,500 - £6,500).
- Identify unit values for natural habitats other than wetlands (Section 2; £12,000 - £16,000).
- Re-evaluate the water pollution component (Section 2; £3,000).
- Develop components for the depletion of renewable resources, specifically fisheries, but possibly also forests (Section 2; £8,000 - £18,000 per resource).
- Decide on LTED costing model (Section 3; £1,300).
- Review updates of the costs of LTED since the Stern Review, and implement in our chosen costing model (Section 3; £9,000 - £13,000).
- Implement rationalisations to the split of environmental costs between consumers and producers (Section 4; £12,000 initially with further work after 2011).
- Assess the possibility of adjusting consumer expenditure to account for real discount rates and changes in product durability (Section 5; £9,000 - £15,000).
- Assess the possibility of including other elements of public expenditure (Section 5; £1,800).
- Assess the possibility of augmenting divorce as a measure of family breakdown (Section 5; £3,000 - £5,000).
- Incorporate leisure time (Section 5; £2,500).
- Continue to follow Stiglitz Commission's work (Section 5; £1,800).
- Explore the potential of the scenario-modelling tools with other non-infrastructure projects (Section 6; £12,000).
- Develop software to automate scenario modelling (Section 6; £4,000 - £15,000, depending on the sophistication of the software).

nef would be happy to provide more detail on each of these elements of work, including estimated costings.