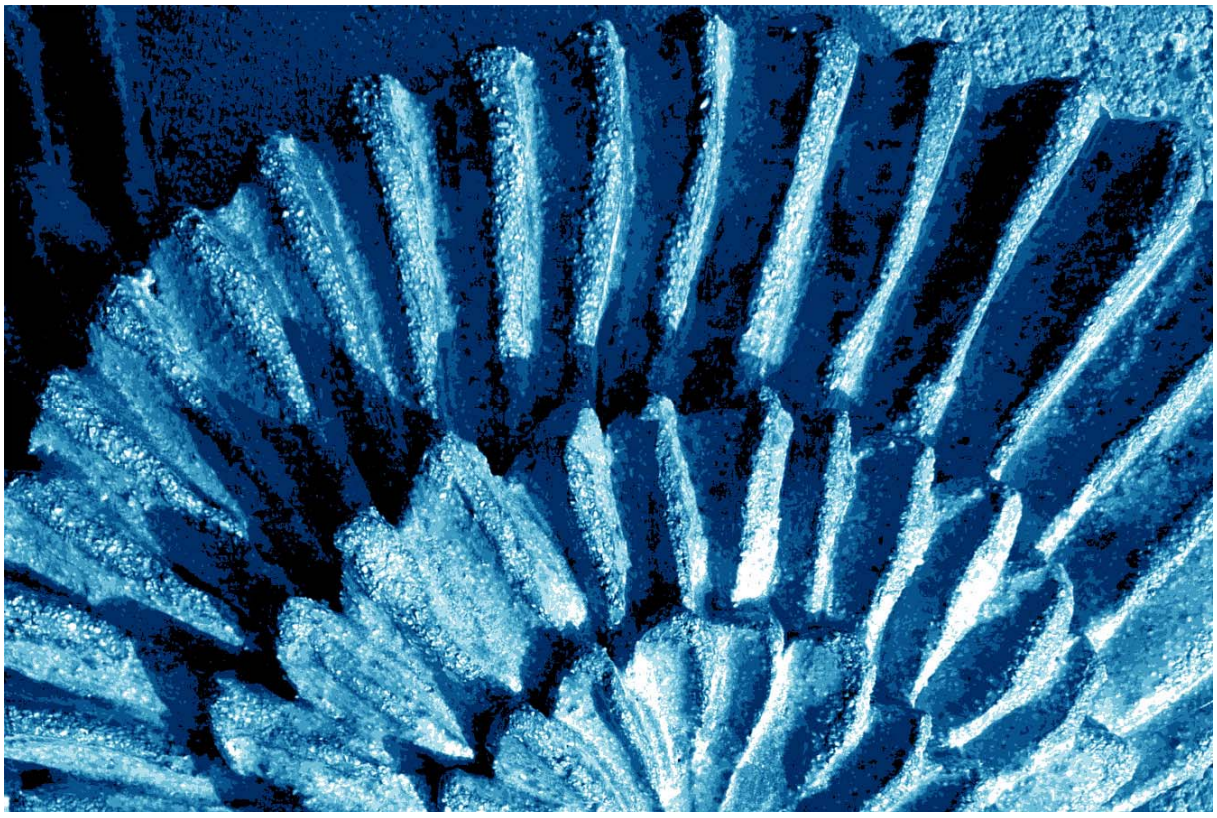
UK National Ecosystem Assessment

Understanding nature's value to society

Living With Environmental Change LWEC

The utility of existing scenario frameworks for the UK NEA Scenarios



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No	Title
1	The Development of Scenarios for the UK National Ecosystem Assessment. Interim Report, May 2010.
2	The utility of existing scenario frameworks for the National Ecosystem Assessment. May 2010.
3	Scenarios for the UK NEA (a sub-global MA): A transparent and flexible methodology. Poster Presentation at Salzau/Germany, June 2010.
4	Assessing User Needs of the UK NEA Scenarios through Focal Questions.
5	UK NEA Scenarios: Narratives. February 2011.
6	UK NEA Scenarios – Final Chapter. February 2011

Contents

Introduction

In recent years the development of scenarios for exploring environmental futures has become commonplace (Alcamo, 2001; Carpenter et al., 2006a; O'Neill et al., 2008; Rothman, 2008; Coreau et al., 2009; Mahmoud et al., 2010). This development has brought about a a greater understanding and appreciation of the use of scenarios and consequently they have gained more credence in academic circles (Mahmoud et al., 2010) although there are still questions about their credibility and usefulness in (O'Neill et al., 2008; EEA, 2009).

Their popularity has risen because they have a practical use for society in that they enable policy makers and other stakeholders to identify the optimal environmental strategies under different conditions (Alcamo, 2001) and, perhaps more importantly, they raise awareness of future environmental issues to the wider public (e.g., IPCC).

However, whilst the development of scenarios outlining environmental futures has burgeoned, those with a specific focus on ecosystem services are less abundant. The standout example here is obviously the Millennium Ecosystem Assessment which produced a large 14-chapter report on scenarios (Carpenter et al., 2006b); however, to date, this is the only one to have comprehensively focussed on the future of ecosystem services. Despite this, other scenarios have discussed ecosystem services and some implicitly discuss outcomes for provisioning services.

The aim of this review therefore is to learn what we can from existing environmental scenarios in order to help in the synthesis and creation of scenarios for the National Ecosystem Assessment; more specifically it focuses on examining the range drivers of change explored and the story-lines that have been designed. The scenarios reviewed cover different geographical areas and scales (from national to global) but all have at least some relevance to the UK as well as a focus that is pertinent to the UK's ecosystem services. This section provides an overview of the review and a more detailed analysis of the drivers and story-lines can be found in the morphological analysis section.

What makes a good scenario?

It is useful and necessary to understand the the development of scenarios and the established (but still evolving) factors that make up a 'good' scenario. There is a large body of work that has reviewed and analysed scenario development (De Jouvenel, 2000; Alcamo, 2001; van Notten et al., 2003; Börjeson et al., 2006; Bishop et al., 2007; O'Neill et al., 2008; Wilkinson and Eidinow, 2008) and although not all authors agree on the list of criteria a few commonalities do arise:

- Scenarios can be qualitative or quantitative (or both).
- They ideally should contribute to policy decision-making (Hulme and Dessai, 2008).
- They should be very iterative.
- Inclusive of diverse range of anthropogenic (and/or natural) drivers of change.
- They can be explorative or normative (i.e., setting targets).
- They are also inherently multi-dimensional and contain at least two separate story-lines.
- They do not ascribe high levels of confidence to future outcomes (Wilkinson and Eidinow, 2008) and probability or likelihood is not an essential part of a good scenario (indeed, low-probability wildcard scenarios are sometimes used to highlight the extreme impacts they may have on the environment).
- And, of course, the three desired elements that are most often cited are *credibility*, *legitimacy* and *saliency* (Rounsevell and Metzger, in press; Hulme and Dessai, 2008; Girod et al., 2009; Volkery and Ribeiro, 2009)...
- … which together should result in the development of *plausible* scenarios.

Alcamo (2001) suggests scenarios must consists of five main elements which are common to all the scenarios reviewed here:

- A description of stepwise changes
- A list of the main driving forces
- A base year
- A time horizon and time steps
- The storyline

Review of existing scenarios

Table 1 provides an overview of the twenty-one scenarios reviewed together with some of the main aspects for each one (a more detailed and comprehensive table can be found in the appendix). A more detailed examination of the story-lines and their relationship to the drivers of change within each scenario can be found in the Morphological Analysis section - the following provides a brief review.

The first aspect to note is that the main focus of each scenario varies considerably - some are quite wide in their scope (e.g., environment) while others are more refined (e.g., agriculture or water use); this reflects the geographic scope (see appendix) with the European and global scenarios generally having broader foci although some of the smaller-scale scenarios also have a broader focus (e.g., the Natural England 2060). Secondly, the geographic scope of the scenarios (see table 2 in appendix) varies considerably but also affects the style of the story-line narrative and the timescale - generally global scenarios are longer-term visions (2100) whilst the more regional focus (most UK-based scenarios aim for 2050 give or take a decade).

Construction

Most of the scenarios were constructed in a similar vein and drew heavily on the involvement of multiple stakeholders (through interviews, workshops and questionnaires), expert advice, peer-reviewed sources as well as the extrapolation of trend data (exploratory). Where differences do arise are in the ratio of qualitative to quantitative scenario output: the vast majority utilised both (and nearly always with a stronger emphasis on the qualitative aspect) but 25% used qualitative descriptions only.
A second aspect of construction is whether the scenario should be explorative (using trend data to explore uncertain future outcomes) or normative (i.e., where a goal is set and the scenario describes how to get there): the ALARM SEDG scenario was the only example here (Sustainable European Development *Goal)* .

Table 1 - Key aspects of the scenarios reviewed

Scenario (see reference list for details)	Main focus	Timeline	Data	Uses five[1] main indirect drivers?	Outlines habitat impacts	Ecosystem Services
SRES[1]	Climate change, economic development	2100	Ql, Qn	y	o	n
MA[2]	Ecosystem Services		Ql, Qn	y	8	y
Foresight Futures[3]	Environment	2020	Ql, Qn	2	8	y
Foresight Futures Land Use[4]	Land use change	2060	Ql	y	6	y
UKCIP socio-economic[5]	Climate change	2050	Ql, Qn	y	6	n
UKCIP Climate change[6]	Climate change	2050	Ql, Qn	4	0	n
AFMEC Marine[7]	Marine	2040	Ql, Qn	y	1	brief discussion
Net Benefits[8]	Fisheries	2025	Ql, Qn	4	1	brief discussion
Natural England 2060[9]	Environment	2060	Ql	4	7	brief discussion
EA Water Resources[10]	Water	2050	Ql	y	0	brief discussion
UNEP 3rd GEO[11]	Environment	2040	Ql, Qn	y	6	n
WCS Futures of the Wild[12]	Biodiversity	2030	Ql, Qn	4	6	n
ELME[13]	Marine	2040	Ql, Qn	4	1	n
EEA Prelude[14]	Environment	2035	Ql, Qn	y	4	n
PSI BESEECH[15]	Urban, climate change	2050	Ql, Qn	4	1	n
Global Scenarios Group[16]	Environment	2050	Ql	y	4	n
ACCELERATES[17]	Agriculture	2050	Ql, Qn	4	1	n
ATEAM[18]	Climate change	2080	Qn	4	4	y
EURURALIS[19]	Land use, environment	2030	Ql, Qn	y	5	y

[1] The five* main indirect drivers of change are categorised: Demographic; Economic; Socio-political; Science and Technology; and, Cultural and Religious. These indirect drivers are the most commonly listed drivers for environmental change.

Scenario (see reference list for details)	Main focus	Timeline	Data	Uses five[1] main indirect drivers?	Outlines habitat impacts	Ecosystem Services
ALARM[20]	Biodiversity	2050	QI, Qn	4	4	y
ESPON[21]	Geopolitics & planning	2030	QI, Qn	y	4	n

Drivers of change

For nearly all the scenarios a strong emphasis was placed on utilising the five main indirect drivers identified by the NEA *Drivers* chapter (Winn, 2010): socio-political; economic; science and technological; cultural and religious; and, demographic. Of these, cultural and religious drivers are the least used but are still adopted by 70% of the scenarios (see table 3 in the appendix). The other indirect drivers are developed by most of these scenarios quite extensively and are often broken down into subgroups delineating the different aspects. A differentiation in emphasis placed on each driver is not always made explicit but in some case it is a major theme of the scenario development (e.g., Natural England's 2060 scenarios emphasise the importance of values).

Not surprisingly, the direct drivers of change show more variation between the scenarios and are and heavily influenced upon the focus (e.g., the Foresight Futures scenario which focusses on floods has fluvial and coastal processes listed as drivers). The two dominant *direct* drivers are climate change (in 100% of scenarios), resource consumption (95%) and land use change (80%). Surprisingly, biotic drivers like invasive species occur in only 40% of the scenarios.

There is one driver that occurs in the scenarios (solidarity and equity) that is not listed in the NEA review although this could possibly be included under the cultural and religious grouping. Additionally, one socio-political driver which is not mentioned anywhere (or in the NEA) is land ownership rights which has clear implications for a range of ecosystem services now (e.g., with the development of the CRoW Act (2000) but also will be a major issue in the future.

Story-lines

Nearly all the scenarios followed a fairly generic pattern of differentiation with four basic story-lines: a free market model (corresponding to the SRES A1 scenario); a national security model (A2); a sustainable or green vision model (B1); and, a local stewardship model (B2). Table 2 highlights the approximate correspondence between the scenario story-lines. The story-lines do not always correspond exactly and there are

aspects of many that are shared across the different themes - the corresponding SRES B scenarios are more closely related as are the A-type scenarios.

Perhaps the most striking deviation from the correspondence to the SRES scenario types is from the Natural England 2060 scenarios (although I have attempted to fit them into the correspondence table); for example the 'Succeed through Science' story-line shares many of the aspect of the free-market type story-lines however it places a strong utilitarian emphasis on ecosystem services that is at odds with most of the SRES A scenarios.

Use of the wildcard scenario

The use of 'low-probability high-impact events' (Alcamo et al., 2006b) in scenarios are occasionally used to highlight the extreme outcomes of such events (e.g., droughts, pest outbreaks, disease pandemics, large-scale floods). They are by their nature rare and have therefore not had much time devoted to them; however, they are very useful for developing emergency contingency plans (perhaps if MAFF/DEFRA had developed shock scenarios for events like BSE and Foot & Mouth the overall consequences to the agricultural industry may have been far more benign) and as such have a valid presence in scenarios despite their rarity.

Surprisingly, only 25% of the scenarios reviewed mentioned a wildcard event and of these only one scenario had properly incorporated shock events into the story-lines (in ALARM - each of the three story-lines had sub-story-lines highlighting unlikely but large impact *social*, *environmental* and *economic* shocks). The marine AFMEC scenario did not incorporate shock events into the scenarios but it did assemble a comprehensive inventory of the major types of event possible (covering geological and astronomical, extreme climatic, biological/ecological, and human shock events).

Discussion

The utility of existing scenarios for developing scenarios for Ecosystem Services

Some ecosystem services are covered well in many of the scenarios (even if they are not explicitly stated); for example, crop yield models have been used to provide some quantification in agricultural land-use change scenarios (Ewert et al., 2005; Rounsevell et al., 2005). However, explicit mention of ecosystem services (or more importantly the *effects* on ecosystem services) in most of the scenarios reviewed is either non-existent or crops up briefly in the conclusion. Occasionally, ecosystem services are mentioned as an objective for land management in a scenario story-line (e.g., *Succeed through Science* for the NE 2060) but otherwise they are not emphasised at all.

There are two exceptions though: the Foresight Futures Land Use discusses ecosystem services throughout the 320-page document and highlights the role ES can have in future land management systems. It also suggests in one of the scenario story-lines how ecosystem services are to be incorporated into land-management (in collaboration with the EU). But whilst ecosystem services have clearly been an important aspect of the FFLU project, the MA scenarios - not surprisingly - offer a far greater analysis of ecosystem services futures (Alcamo et al., 2006a). These perhaps deserve special attention elsewhere due to the comprehensive coverage and detailed examination they provide (the Scenario chapters extend to nearly 600 pages).

Despite the overall paucity of ecosystem services in the scenarios, there are clear advantages in reviewing existing scenarios before embarking on creating your own: they help distill the connections between drivers of change and the consequences for the environment (which could be expressed as species or habitat loss or gain, changes in productivity, recreational patterns, water quality, etc) and hence one can extrapolate consequences for ecosystem services. They also provide an extremely useful experience of understanding the styles and extremes of the different story-lines; although there are remarkable similarities between many of them one could speculate this is due to the logical conclusions drawn from iterative processes undertaken by the many 'scenario builders' from different teams rather than by chance, laziness or a general lack of imagination in the human psyche (one hopes at least!).

Problems developing Ecosystem Services scenarios

It is worth pointing out that the development of scenarios to better understand the futures consequences of the biodiversity is fraught with difficulties from an ecological perspective too. Despite the wealth of ecological change models examining the effects of climate change (and other drivers) which have provided us with a much better idea of how species will be affected, they are all based on a number of ecological assumptions that may not necessarily hold true. These assumptions may also have considerable consequences for ecosystem services and are worth investigating.

Coreau et al. (2009) highlight a number of challenges for understanding how future ecosystems (and their services) may change. Firstly, there are difficulties in envisioning the future of ecosystems for ecologists because of the paucity of long-term data pertinent to important ecological functioning processes (Coreau et al., 2009). Secondly, it is often assumed that current ecological relationships and processes will stay the same over time although this is not necessarily true (Carpenter, 2002). For example, this may be particularly pertinent in the face of climate change which may affect species differently (e.g., through migration rates and even genetic or phenotypic responses); this could have serious implications for habitats based on long-standing community

structures (Thuiller et al., 2008). Indeed, non-analogue biotic communities (Jackson and Williams, 2004; Williams and Jackson, 2007; Keith et al., 2009) may arise that could have significant consequences for ecosystem function and hence ecosystem services. Finally, future human drivers of change may be completely different from the current drivers and despite the explorative nature of most of the scenarios they are all based on known and current drivers of change.

Conclusion

The twenty-one scenarios reviewed here all fulfil Alcamo's (2001) criteria for the main elements of scenarios (a description of stepwise changes; a list of the main driving forces; a base year; a time horizon and time steps; and, a storyline) and in doing so provide us with useful sources to draw upon, particularly for the development of drivers of change and for the highlighting common story-line styles. Where they do not all succeed is in our more specific demand for a useful guide to developing scenarios for understanding the effects on future ecosystem services although there are enough implicit mentions of goods and services as well as a number of scenarios that outline consequences for habitats that we may find some comfort.

The shelf-life of many of the existing scenarios will also affect the usefulness of the developing new scenarios and can be assessed by a number of criteria including quality of the input data (for example, some of the scenarios using climate change data are out of date); quality of the construction process - this addresses the holy trinity of 'credibility, legitimacy and saliency' (and most of the scenarios reviewed scored highly in these respects but some were perhaps less 'legitimate'); and, usefulness to policy-makers and stakeholders (which is a major objective of the NEA but I cannot comment on the effectiveness of the scenarios reviewed here). This last point has been raised elsewhere: the EEA report (EEA, 2009), although not wholly negative, is slightly more skeptical of the end-use of scenarios and suggested that many of the recent environmental scenarios did not presented relevant information, identified threats which had no viable policy response, had been poorly supported from the range of stakeholders and ultimately did not get fully utilised by the main policy institutions. The process of reviewing existing scenarios should in part help to ensure that these concerns are negated and certainly the NEA's strengths are that it draws upon the knowledge and skills of geographers, economists, sociologists and ecologists as well as policy-makers and stakeholders from a range of backgrounds.

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