# Scenarios explored with Delphi

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# 7 Scenarios explored with Delphi

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## 7.1 Introduction

The purpose of this chapter is to demonstrate the use of mini-Delphi scenario workshops to consider how UK coastal and marine ecosystem services might change during the next half century, taking account of socio-political, as well as climate, change. **Chap. 2** introduced numerical models as tools for predicting the future, and the work of the IPCC has shown how 'General Circulation Models' (GCMs) can be used to simulate climate change. Why not, then, couple a GCM to a model of a coastal social-ecological system?

There are several reasons why not. Firstly, because the discipline of social-ecological modelling is in no way as advanced as that of climate change modelling. Secondly, because complex systems include feedback loops that can amplify initial uncertainties and render prediction extremely imprecise. And finally, because complex numerical models are costly and time-consuming to set up and run.

In this chapter, we report an alternative to modelling, involving a 'Delphi' expert workshop. Our case study explored how ecosystem services might change under five socio-political scenarios, and how they might respond to social or ecological shocks.

## 7.2 Delphi

Unlike numerical computers, conscious human minds have very little algorithmic capacity; we use other ways of assessing evidence to make judgments in complex cases. Experts have in-depth knowledge of a particular domain but may be biased when extrapolating beyond this domain or into the future, and may be over-influenced by current disciplinary paradigms or a dominant personality during discussions. Conversely, group discussions may result in a bland, 'lowest-common denominator' outcome.

In classical times, the oracle at Delphi in Greece provided cryptic guidance for decision-makers. The modern 'Delphi method' was developed c. 1960 by the RAND corporation to improve expert-group judgements. Initially it involved interaction at a distance, by (i) the solicitation of anonymous responses to formal questionnaires, (ii) iteration with controlled feedback to participants, and (iii) an appropriate statistical method for aggregating opinions in the final round (Dalkey 1969, Donohoe 2011). Face-to-face discussion in a 'mini-Delphi' (Green et al. 2007) can shorten the process. Delphi methods have been recommended both for evaluating solutions to current problems when empirical evidence is lacking (e.g. Powell 2003), and for forecasting long-term developments (Cuhls 2001).

Models themselves depend on collective expertise and validation against past events to justify extrapolation to the future. Our contention is that expert workshops, run according to mini-Delphi principles, with opportunities to examine validity claims and re-assess initial assumptions, might provide a rough and ready estimate of future possibilities of equal reliability, but at much lower cost in cash and time, than may be obtained from complex social-ecological models. Of course, experts are not precluded from using model results, where available, as evidence.

## 7.3 Scenarios

The use of scenarios in planning and 'forward-looks' also began in the 1960s, and began to be applied to environmental matters towards the end of the century. The Millennium Ecosystem Assessment (MEA 2003) aimed to:

*'use scenarios to summarize and communicate the diverse trajectories that the world's ecosystems may take in future decades. Scenarios are plausible alternative futures, each an example of what might happen under particular assumptions. They can be used as a systematic method for thinking creatively about complex, uncertain futures.'*

Whereas IPCC (2007, updated 2013) used a set of socio-political scenarios to generate schedules for future emissions of green-house gases and thus for predicting climate change, we took one climate schedule as a given and focussed on the potential consequences of several different socio-political scenarios for the use and sustainability of the UK's marine ecosystem services. The scenarios used in our case study were distinguished by differences in (i) the importance of market forces (versus other methods of resource allocation) and (ii) the dominant level of environmental government (from local through national to supranational).

**[Fig. 7.1 here]**

The horizontal axis in **Fig. 7.1** relates to personal dispositions to behave - at one extreme - as autonomous and competing individuals, interacting with others through bargaining, or - at the other extreme - as beings whose actions are mainly socially determined (Douglas 1970, Wildavsky 1987). In modern societies, in which money provides the main 'steering medium' (Habermas 1987), the first disposition - orientation to 'consumerism' - provides the basis for a society in which the satisfaction of well-being needs (and thus the distribution of resources) is largely dealt with by markets. The second disposition - orientation to 'community' - can underpin either hierarchical societies (in which power is the steering medium) or collectives without a formal power structure.

The second, vertical, axis relates to the large-scale institutions of modern societies, and the way in which these institutions operate across scales. We have called this axis 'governance' with the implication that it concerns institutions that 'steer' societies in relation to their geo-political environment. At the level of the nation state, these institutions include parliaments, central banks, legal systems, and armed forces. At higher levels there are organizations such as the EU, the UN, and the WTO. At lower levels there are local governments and 'civil society'. At the 'interdependence' end of the axis, global institutions control nation states, and - in the ultimate - citizens, through the 'steering media' of power or money. Or perhaps, by means of a global exchange of empathy and information via the world-wide-web. At the 'autonomy' end of the axis, the lower levels fully control operational and collective levels of governance. This might be a world in which states devolve most

powers to localities, retaining mainly the constitutional level of governance: or, alternatively, a world made up of a thousand small polities, like the self-governing cities of ancient Greece.

Our five scenarios are located in this social-political state-space. One of them is 'Baseline', the forward projection of the current state of affairs. The others are supposed to be plausible, possible, and internally consistent descriptions of alternative states of society.

## 7.4. Case Study - Methods and Background

A pilot study showed that account needed to be taken of geomorphological and socio-economic variability within Britain, leading to the distinguishing of three geo-political regions (**Table 7.1**).

**[Table 7.1 here]**

The case study workshop was convened in 2013 as part of the UK's National Environmental Assessment Follow-On phase (NEA-FO). Twenty-six experts attended, invited on the basis of their knowledge of marine ecosystems and their services, and their willingness to engage in both role-playing and 'communicative action'. Communicative action, aimed at increasing mutual understanding of a topic, involves the making and hearing of 'discursively redeemable validity claims', and may be contrasted with strategic action aimed at achieving a successful outcome e.g. for the institution one represents (Habermas 1984). Role playing was necessary because participants were asked to briefly inhabit imagined worlds in which they act according to values other than their own. The aim was to combine both aspects, so that participants were able to evaluate and document outcomes (and check them for consistency) irrespective of their orientation towards those outcomes.

The participants included academics and stakeholders in environmental governmental organisations and NGOs; some also had expertise in workshop facilitation. The working methods were those of 24-hour, 'mini-Delphi' process. The topic was that of changes in UK marine ecosystem services between 2013 and 2060 under the scenarios shown in **Fig. 7.1**. The scope of the exercise was defined as the UK's coastal and marine area but incorporating any necessary drivers beyond it. The time horizon of 2060 is within the timeframe of the UK Office of Budget Responsibility's Fiscal Sustainability Report projections (OBR 2012) for the next 50 years. A novel aspect of the workshop was consideration of the effect of shocks.

For simplicity, a single scenario for climate change was used, that predicted by IPCC in 2007 from the A1B greenhouse gas emissions schedule. UK coastal seas were expected to warm by 1-2°C by 2060, to become slightly fresher (due to increased rainfall and runoff), and to remain stratified for a few days longer in each year (Jenkins et al., 2009). Mean sea level rise was taken from a high emissions scenario as 3 mm/year (totalling 0.2 m between 1990 and 2060 and with 50% error bars; Lowe et al., 2009). Isostatic changes in land elevation would increase the relative mean rise to 0.3m in the southeast and southwest and keep it at about 0.2m in the north and north-west. To these small changes must be added the greater threat from storm surges. Although rare events, surges could, in the worst (simulated) case, combine with sea-level rise to add 1.5-2m to present-day astronomical high tide in parts of the west coast of Britain, and in East Anglia and the Thames estuary.

The five socio-political scenarios were those shown in **Fig. 7.1** and listed in **Table 7.2**. The details (Cooper et al. 2008) provided to participants are given at the start of each subsection in **Sect. 7.5**.

**[Table 7.2 here]**

Two sorts of data were obtained. Qualitative data took the form of narrative reports from subgroups, together with the comments recorded in the assessment forms. The reports were used to prepare the descriptive accounts for each scenarios. Inevitably, there was discussion concerning the desirability and feasibility of the world-views themselves, as well as their implications for ecosystem services, and this is reflected in **Sect. 7.5**.

Participants were asked to use a Likert-type 5-point scale (Likert 1932, Clason and Dormody 1994) to assess the likely change in each service, in each geophysical region, under given socio-economic scenarios, assuming the pattern of climate change already described. Scores ranged from -2 (strong view of deterioration) to +2 (strong view of improvement). Scores were averaged over participants for each service and region, and expressed as whole numbers between -20 (unanimous strong view that service will worsen) and +20 (unanimous strong view that service will improve). Results are shown in **Fig. 7.2**, colour-coded from red (worsening) through yellow (no change) to green (improving).

# 7.5 Case Study: Outcomes from Scenarios

## 7.5.1 Baseline scenario

This projects current trends in the existing state of UK society and economy. In addition to the socio-economic changes in Tables 7.1 and 7.2, the following were also assumed:

- UK Seas will be spatially planned and that projected activities (e.g. areas licensed for renewables development, Marine Conservation Zones, decommissioning of North Sea oil, expansion of oil and gas extraction in deeper waters, some Carbon Capture Schemes) will continue;
- Existing policies, mostly resulting from EU drivers such as the WFD and the MSFD, will be fully implemented (as a consequence of the UK Marine and Coastal Access Bill and Scottish Marine Act); there will be multiple iterations of the EU CFP, and increasing UK regional devolution.

There was mild optimism in the workshop about the sustainability of most services during the first round of scoring, which was tempered during the second round. A key reason for this optimism was the view that national and regional environmental protection would become increasingly effective, supported by a public increasingly ready to accept proper costing of externalities. Differing regional trends were expected, as a result of lower population densities and greater recognition of the value of the environment (in itself and as a provider of services) in the north and west of Britain, in contrast to higher rates of population growth, urbanization, and economic development in the south and east.

## 7.5.2 National Security scenario

This was described to participants as follows:

- **Values & Policy**: Individualistic, highly personal consumption, low taxes, market-based, but strong commitment to national culture and interests. Little concern for social equity or

environmental protection. Sovereignty retained or taken back to national level. Externally, erosion of EU powers, and weakening of WTO links by protectionist measures.

- **Demography**: Little inward migration and relatively low birth rates, although UK age distribution balanced to some degree by diminished longevity. Migration to internal growth 'hot spots' and average household size stable, but with household numbers increasing more slowly than under Baseline.
- **Economy**: Priority of growth undermined by protectionist policies. Focus on meeting internal demand and on security of supply. Nevertheless external trade to obtain food, and export goods or services in exchange, would likely require at least bilateral agreements with trading partners. Considerable variation in regional development.

Workshop participants expected the UK to take a strongly protectionist stance and withdraw from agreements and institutions that were seen as undermining its sovereignty. Thus it would leave the EU and revoke national transposition of the CFP, the MSFD, Birds and Habitats Directive, etc. Membership of OSPAR, ICES and the International Maritime Organisation would continue, and a complex series of bilateral agreements would be negotiated with neighbouring states. Much attention would be paid to self-reliance for energy supply (nuclear, coal and deeper sea and Falkland oil) and there would be increased spending on protecting borders and trade (from immigration and smuggling). Consequently, state support for welfare and environment would decrease. Innovation would be difficult to finance. The marine biotech industry would stagnate or emigrate. There would be strong protection of property rights, including marine property for which the Crown Estate would become the de-facto regulator. With increased domestic tourism, landscape values would be paramount (albeit threatened by weakened control of pollution). The renewables industry would shrink. Environmental protection and planning would be more reactive than proactive. Heritage and conservation charities and public bodies would likely have greater influence than environmental-protection agencies.

It was thought likely that fisheries management would go through cycles of boom and bust as bilateral agreements with neighbours proved ineffective and effort controls crumbled. The difficult financial situation might, however, eventually led to the removal of all subsidies and this, combined with fuel price hikes, would lead to bankruptcies and reduced fishing effort. Subsequent franchising of rights to fishing companies might then lead to improved stock management, with the franchisees reaching voluntary agreements with neighbours, even if effort exceeded the optimum for maximum sustainable yield. Aquaculture would only be further developed for the ‘luxury goods and exports’ market (mainly salmon) but warmer temperatures might cause the spread of Pacific oysters which could become popular with local prospectors.

Because sea defences would become increasingly expensive as sea level rose, only valuable assets (such as London’s commercial district) would be properly protected; other coastal areas might be lost during locally catastrophic ‘un-managed’ realignments’. Pollution control laws were expected to remain at about the same level as 2013, but with declining compliance because of lack of enforcement. There would be increasing problems with cumulative impacts. Feedback from recreational users through strong local councils and landowner associations might maintain protection for beaches and bathing waters.

Group participants were generally pessimistic in their scoring of ecosystem services, expecting most to decline. The exceptions were fisheries, as discussed above, and socially valued landscapes, reflecting a greater pride in the national countryside and the increase in domestic tourism.

### 7.5.3 World Markets scenario

This was described as follows:

- **Values & Policy**: Libertarian, techno-centric, materialist consumerism. Presumption in favour of market provision. Growth more important than social equity, with environmental policy limited to correction and support of the market. Increased global interdependence and governance, through WTO and multinational corporations. Corporate governance starts to displace national government. Policy determined at regional trading bloc and international level. Rapid enlargement of EU.
- **Demography**: UK population growth slows overall but migration increases to meet demand for labour and reduces proportion of older people. Growth uneven across regions. Smaller and more numerous households.
- **Economy**: Rapid UK and global growth, with dismantling of trade barriers increasing intra- and extra- EU trade. Service sector dominates others, with decline of agriculture and manufacturing. Benefits of growth spread to some extent through 'spill over' effects.

Participants concluded that outcomes depended on the ability of governing bodies to correct for externalities. It might be that an international body would successfully impose strong environmental regulation/certification, on the grounds that continued growth requires functioning ecosystems. Significant environmental degradation might take place before the wider community – including financiers and investors – realised that this degradation impacted on profit potential, and consequently put the business world behind greater regulation. A fundamental element of such regulation would be a working market for carbon. It was thought likely that most natural assets would be privatised and managed on the basis of property rights. Fish stocks, for example, might be managed by a global system of tradable quotas, very likely leading to greater consolidation of fleets and enhancement of profitability. The owners of these (now private) assets would have a direct incentive to use them and their supporting ecosystems sustainably.

Should UK and global society, however, prove too myopic to take this path, a failure to manage externalities could lead to ‘mega-death’. The key driver of this would likely be climate change beyond that of the IPCC (2007) A1B case. Should this happen, large global shifts in population might occur as lands became regularly flooded or drought-stricken. The resulting pressures on remaining natural resources would lead to an increasing downward spiral in the most impacted countries and to international conflicts over scarce resources such as oil. The only brake on such a course of events would be the insurance market via increasing charges as risk increased. Within the UK, the south-east would likely be most detrimentally impacted.

### 7.5.4 Global Community scenario

This was described as follows:

- **Values & Policy**: Communitarian, with internationalist values and increasing globalization of governance systems to deal with large-scale, interconnected, problems. Balancing of economic, social and environmental welfare, with preference for latter and acceptance of high tax levels.

Policy co-ordinated at EU and international level, but implemented at local level. EU more centralised, with less regional autonomy, and slower expansion. Environmental policy expands across policy sectors and is prioritised. Powerful, green, WTO favours environmental protection in trade disputes.

- **Demography**: Low birth rates offset by migration to meet demand for labour, with some increase in average age but relatively static distribution. Household size declining slowly, and numbers grow at historic rates.
- **Economy**: Growth constrained by tax levels and social and environmental objectives. Shift to services is slower than in Baseline. Growth in intra- and extra-EU trade, but with some inhibition by 'footprint' concerns. Development evenly distributed across regions and classes, though with some transitional variations.

In this world the goals are ‘strong’ sustainability based on a ‘slow’ growth philosophy and practice. Workshop participants foresaw emphasis on maintaining and/or improving overall wellbeing and the stock of wealth (i.e. discounted present value of a future consumption stream anchored to all four forms of capital – physical, human, natural and social). Population growth would be stabilised. The global economic system and network of interdependencies would be radically reformed. Remits of some international institutions would be re-orientated towards the ‘slow’ growth strategy. For example, the WTO could have its 'fair trade' brief expanded to include environmental sustainability concerns. Banks would have their retail and investment activities completely separated. A ‘Tobin’ tax would be in force internationally, constraining international speculation and its destabilisation of financial, energy, property and commodity markets. The World Bank and IMF would be assigned a stronger regulatory role in environmental as well as financial management. Natural capital and its contribution to ‘wealth’ would become part of the national/international income/wealth accounting practice.

Overall, a more extensive and interventionist regulatory regime would be in place, and a stricter and ‘smarter’ set of policy measures operating at the international and national scales. International environmental agreements would be negotiated and rigorously enforced; green-house gas emissions would be limited to meet a 2-3° warming target; and the Law of the Sea Convention would be given strong legal ‘teeth’, alongside integrated coastal management (ICM) and other marine related governance. There would be a preference for fish over meat as a protein source, which, given limits on wild fisheries yield, would need the development of sustainable, probably multitrophic, aquaculture and the resolution of siting conflicts.

The UK would be following a ‘green’ growth strategy with an emphasis on innovation and investment in resource saving and recycling technologies, covering, energy, water, waste and other raw materials. Public transport would be favoured over private transport. Supply chains would be made short. Product differentiation and persuasive advertising would be discouraged. Resource exploitation would be constrained by the precautionary and 'polluter pays' principles, and risk minimisation rules would have precluded exploitation of ‘fragile’ areas such as the Arctic. Such areas would be zoned and kept clear of all activities except scientific research. There would be more 'soft engineering' of coastlines, generating more salty wetlands for coastal defence, wildlife, and carbon storage, less interference with sand dunes, and reduced cost for maintenance of 'hard' defences. All this would take place in the context of ICM, and with reduction in waste generation and discharge, would have led to improvements in water quality.

The state would intervene to try to redistribute income and wealth to reduce the gap between the top and the bottom of the income distribution, through progressive taxation and other fiscal means. Attitudinal and behavioural change would be evident across both civil society and the business communities. Social networks would be encouraging new social norms focused on reflexive citizenship and corporate responsibility and ethics, including greater appreciation of cultural and environmental assets. Thus, a global and national culture involving the maximisation of short term desires and profits would be replaced by a culture favouring longer term needs and 'average' rates of return. Fair compensation and equity would be adopted as principles to be applied in any significant resource conflict/trade–off contexts.

Although this is an attractive vision, a society that tried to move in this direction would likely encounter resistance, and there could be an initial flight of capital and service industries eschewing the new tax regimes. This would only be resolved if other countries joined the common institutions described in the text. However, the scenario itself is a possible and consistent configuration for a global or continental society, even if its state-space location would be hard to reach from present co-ordinates.

### 7.5.5 Local Stewardship scenario

This was described as follows:

- **Values & Policy**: Communitarian, co-operative self-reliance. High levels of public services funded by high local taxation. Strong emphasis on social equity and environmental protection at the local level. Local government replaces national and supra-national governance. EU becomes more diverse with regional autonomy and fragmented policy.
- **Demography**: Population size stable, but relatively low birth rates and increased public health provision increases average age. General migration away from cities, with household size increases and household number reductions.
- **Economy**: Slow growth, exacerbated by tax levels, with increases in smaller scale production. Trade greatly diminished, but with some preference for intra-EU over external trade. Growth more even across communities.

Participants thought that local stewardship would prove to be effective in promoting improved conservation of coastal and near-shore marine ecosystems and sustainable use of the resources they generate. However, Local Stewardship approaches are vulnerable to strong external forces beyond their control. For example, local community management of fisheries might encounter difficulties offshore, where communities do not have the resources to implement fisheries management measures and impose them on out-of-area exploiters. Thus, increased devolution and subsidiarity would be a need for an enabling and back-up framework provided by UK federal and EU legislation. For example, problems arising from decoupling of terrestrial, coastal and marine systems management could be overcome by the application of integrated EU Directives, as pioneered by River Basin Management in the Water Framework Directive of 2000.

There would likely be regional differences in the capacity and effectiveness of local stewardship for resolving regional and national ecosystem management issues. Regions such as Scotland may have increased capacity to expand coastal and nearshore production of marine based protein to help feed the more densely populated areas of England. Likewise, parts of England have the climate and soils

that can produce enhanced yields of carbohydrates to help meet the needs of people in Scotland. However, given the differences in population pressures and differing economic foci of the human resources between regions, there would likely be differing interests in and ability to foster local stewardship. For example, Financial Services in London and the southeast of England currently dominate the UK economy. The Global Markets outlooks involved in these activities may counteract the effectiveness of local stewardship in improving the management of ecosystems and maintaining the quality and quantity of renewable resource flows.

The effect of these reservations (about the tension between local stewardship and the need for national, continental or global scale regulation) was reflected in a wide range of individual scoring. Nevertheless, the majority of participants were optimistic about outcomes under this scenario.

### 7.5.6 Quantitative analysis

Two general points emerged clearly from the quantitative analysis in **Fig. 7.2**: first, there was consistency between the first and second assessments of the 'Baseline' scenario; and, second, some scenarios were thought to hold better prospects for services than others.

**[insert Fig. 7.2 here]**

## 7.6 Case Study: Effect of Shocks

A shock is a short-term disturbance. In ecological terms, it corresponds to a pulse perturbation (Bender et al. 1984), and contrasts with a sustained or press perturbation. In scoping potential shocks, Pinnegar et al. (2006) remarked that not all change is gradual; it may happen suddenly as a result of what we call shocks in this chapter, or it may happen slowly as a result of a build-up of change within an ecosystem or an accumulation of pressures on the system. A shock might act as the 'final straw' that tips an ecosystem from one regime into another. In our analysis we treat slow disturbances in terms of scenarios (including the single scenario of global climate change), and shocks as temporary increases in the pressures on the marine ecosystems from outside their boundaries.

Several sorts of physical and ecological shocks were considered: a storm surge sufficient to overtop the Thames barrier with consequent pollution of the south-eastern North Sea; a six months period of reduced light and sea-surface heating resulting from a volcanic eruption on Iceland; blooms of an invasive species comparable to the ctenophore *Mnemiopsis* in the Black Sea; an extreme summer resulting in sub-thermocline de-oxygenation over large areas of coastal sea. In the group's view, most marine and coastal ecosystems would recover from such pulse disturbances within a few years. This resilience arises partly from the biological community and partly from the open and well-flushed nature of the seas around the UK.

It is possible that a shock might cause an ecosystem to shift from one regime to another, but it is sustained, press, disturbances that are thought more likely to bring about such change. Certain sorts of shock, such as flooding with salt-water, might have long-term consequences for the integrity of coastal freshwater wetlands and the services they provide. Other shocks might impact directly on certain services, for example on aquaculture, but their long-term impact would depend on their effect on the socio-economic rather than the ecological system: if for example the owners of fish-farms afflicted by jellyfish blooms decided to redeploy their capital elsewhere. Finally, such shocks, it

was thought, might have ecologically beneficial effects if they changed human perceptions of the environment and thus drivers of change. For example it might be decided to accept flooded areas as part of managed realignment of the coast, so diminishing the 'coastal squeeze' which greatly weakens the ability of littoral and supra-littoral communities to move and adapt to sea level change.

Amongst the examples of political and economic shocks considered by Pinnegar et al. (2006) was the break-up of the Soviet Union, and in particular its effects on its Baltic states, which gained independence but at high economic cost. Our workshop discussed the possibility of a break-up of the European Union. However, complete dissolution seemed unlikely; more realistic possibilities included failure of some EU member states with greater centralisation. The break-up of the UK was another possible shock. In either case it was thought that there would be minimal long-term disturbance of ecosystem services from those expected under the Baseline scenario. The main threat was from weakened governmental oversight of environmental quality and the use of ecosystem services.

The economic shock considered was that of a recession more severe than that experienced by the UK since 2008, perhaps accompanied by collapse of state revenues, and lasting for a decade or more. The likelihood would be that an impoverished government could not afford to enforce statutory protections of the marine environment, and thus that there would be increasing press disturbances of marine ecosystems through over-exploitation of services, as envisaged under the 'National Security' scenario. On the other hand, such an economic shock might lead to a significant change in society, and perhaps to one of the two 'green' scenarios and a stable zero growth economy.

## 7.7 Discussion

The oracle at Delphi is remembered for its ambiguous pronouncements. In 560 BCE it told Croesus of Lydia that, if he made war on the Persians, he would destroy a mighty empire. According to Herotodus, in his 'Histories', Croesus went to war, but the outcome was defeat for the Lydian empire. It would have been better for Croesus to see the oracular response not as a conditional prediction but as a reminder to think about the consequences of war. Perhaps it is best to see our own Delphi exercise as much as an exploration of the intersection of three sets of issues as an attempt at conditional predictions of the future. The issues are: climate change; changes in governance and social values; the effects of these on marine ecosystems and on the services we take from them.

As Charles Dickens implied, when he wrote (in 'A Tale of two Cities') that 'it was the best of times; it was the worst of times', there is no state of society that is not a mixture of good and bad. Eleanor Ostrom and colleagues have argued that there are no panaceas for environmental problems, no single recipes for ways in which society should be organised so as to move towards sustainability (Ostrom 2007, 2009). Discussions of scenarios may be creative ways to identify particular solutions to environmental challenges, and some of these solutions might emerge in responses to scenarios that at first glance promise little for environmental sustainability. That is to say, it may be better to see the benefits of a scenario exercise as resulting as much from the process of debating the options as from any predictive outcome (Haines-Young et al. 2011). Debate not only clarifies issues; as a process of 'communicative action' (Habermas 1984) it can help motivate deeper engagement with the issues. In this respect, Pahl et al. (2014) emphasises the importance of the narrative component of scenarios.

Despite individual differences in scoring change in particular ecosystem services under a given scenario, there was a clear outcome from the workshop, shown in **Fig. 7.2**. Opinion was that the World Markets and, to a lesser extent, the National Security scenarios would likely lead to strong impairments in most marine and coastal ecosystem services, whereas the Global Community and Local Stewardship scenarios would lead to improvements. Explanations involved the priority given to environmental sustainability in the last two scenarios, the primacy of the market in World Markets, and the reactive and partial nature of governance in National Security. There was fair consistency amongst the two scorings of the Baseline scenario, and the median opinion was slightly optimistic for most services. The key explanatory factor in this case was the view that current environmental legislation, mostly transpositions of EU directives, would be fully implemented and enforced. A minority opinion expected economic drivers to prove stronger than the will to protect the environment. Regional differences were expected under all scenarios, typically the result of a gradient from the southeast of England (where population and consequent pressures are highest) to Scotland (with mostly lower pressures and an environment suitable for aquaculture).

The workshop outcomes suggest ways in which present and near-future management practices could be modified to improve sustainability of ecosystem services. Thus the 'Global Community' scenario points to the benefits of 'soft engineering' of coastlines and of multi-trophic aquaculture. Such technologies might be of immediate value as well as providing resilience against climate change, and managed re-alignment of coasts might increase carbon sinks through creating or restoring wetlands. As discussed in **Chap. 2**, purpose-specific models could be used to explore the costs and benefits of such solutions.

Both discussions concerning shocks to the Baseline scenario led to the conclusion (paraphrased from Nietzsche) that 'what does not destroy us, makes us strong'. Marine ecosystems were seen as resilient against pulsed physical or ecological disturbance, and the UK socio-economic system was seen as similarly resilient against foreseeable political or economic shocks. As already noted, our focus was mainly on the response of marine ecosystems to these shocks. An event such as Thames Barrier overtopping would be catastrophic for many citizens, and although the socio-economic system would recover, the costs might fall unequally across social groups, as occurred when New Orleans was flooded by hurricane Katrina in 2005 (Vigdor 2008). Our optimism about the resilience of the UK socio-economic system is based on a view of effective multi-tier governance (at local, regional and national levels). The market economy might be less resilient, due to 'just-in-time' supply chains and the possibility of bank collapse.

Green policies have generally had low priority for UK governments, and have typically been developed and implemented as a response to external circumstances. EU membership and the transposition of EU directives into UK law have brought about considerable improvements in nature conservation and environmental quality (Burns 2013). It was the shocks of the storm-surge flooding in 1953 that led to developments such as the Thames Barrier, and workshop participants took the optimistic view that the hypothetical overtopping of this barrier might in the long run lead to the development of greater ecological and societal resilience through more widespread and managed coastal re-alignment. Of course, this assumes that a flooding shock to the social system would lead to rational choices about the most effective means of coastal defence.

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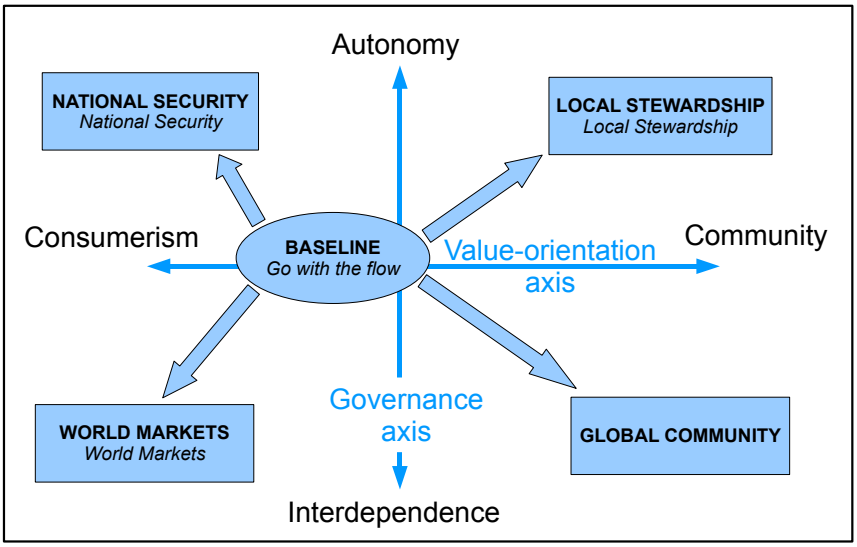


**Figure 7.1. A psycho-socio-economic state space** described by two variables (relating to societal governance and individual dispositions towards consumerism or community) and containing the scenarios used in the case study**.** Based on UKCIP (2000), Pinnegar et al. (2006) and Cooper et al. (2008). Additional text (e.g. 'Go with the Flow') refers to the scenarios of Haines-Young et al (2011) used in the first UK NEA.

| Final Ecosystem Service | scenario | BASELINE (1) | | | BASELINE (2) | | | NATIONAL SECURITY | | | WORLD MARKETS | | | GLOBAL COMMUNITY | | | LOCAL STEWARDSHIP | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | region | SEE | N&W &W | SC | SEE | N&W &W | SC | SEE | N&W &W | SC | SEE | N&W &W | SC | SEE | N&W &W | SC | SEE | N&W &W | SC |
| Wild fish/shellfish/seaweed | | -1 | 1 | 5 | -5 | 1 | 6 | 1 | 1 | 1 | -18 | -18 | -13 | 20 | 20 | 20 | 12 | 13 | 13 |
| Cultured fish/shellfish/seaweed | | 7 | 9 | 16 | 2 | 5 | 13 | -2 | 2 | 5 | 1 | 16 | 18 | 3 | 10 | 10 | 10 | 9 | 14 |
| Genetic resources | | 1 | 4 | 4 | -1 | 0 | 2 | -6 | -8 | -8 | -14 | -14 | -14 | 0 | 0 | 0 | 6 | 8 | 8 |
| Climate regulation | | 1 | 4 | 3 | 1 | 2 | 4 | -5 | -6 | -8 | -16 | -18 | -18 | 18 | 10 | 10 | -3 | -3 | -2 |
| Natural hazard protection | | 5 | 6 | 3 | 2 | 3 | 4 | -9 | -6 | -4 | -10 | -2 | -2 | 18 | 10 | 10 | 5 | 7 | 7 |
| Waste breakdown/ detoxification | | 2 | 4 | 4 | 3 | 4 | 4 | -9 | -7 | -5 | -12 | -4 | -4 | 1 | 10 | 10 | 5 | 8 | 5 |
| Meaningful places – Socially valued seascapes | | 3 | 8 | 7 | 2 | 6 | 9 | 8 | 5 | 7 | -18 | -7 | -9 | 1 | 10 | 10 | 8 | 8 | 8 |

score = sum*10/N
where -- = -2, - = -1, + = +1 and ++ = +2

--------- N = 19-21 ---------
single colour-scale applied across all scenarios:

---------- N = 5 - 7 ----------
red = deterioration (towards lowest value of -20, when all estimates are --)
green = increase (towards maximum +20, when all estimates are ++)

**Figure 7.2. Synthesis of scores for all scenarios.** The values show the average scores for each option, scaled to the number of participants registering an opinion in each case, so that +20 (colour-coded green) implies a consensus about a strong opinion that all components of the service will increase, and -20 (colour-coded red) implies a consensus about a strong opinion that all will worsen. SEE: South-East England, N&W&W: North-west and south-west England and Wales; SC: Scotland.

**Table 7.1** Geo-political subdivisions of Britain. Non-arable farming includes: sheep and dairy; use of moorlands for sports hunting; extensive conifer plantations. Isostatic changes (part of recovery from loading by ice-caps) are several mm/year (Bradley et al. 2009)

| Region | Socio-economic characteristics (2013) | Maritime characteristics | Major trends, 2013-2060 (in Baseline) |
|---|---|---|---|
| South-East England: lowlands overlying young (Mesozoic and Cenozoic) sedimentary rocks; dry warm climate; isostatically sinking | Highest population densities and wealth (albeit not uniformly distributed); arable farming and greatest use of fertilizers; the UK's largest international trading ports; | Eroding sinking coastlines, shallow agriculturally polluted (nutrient-enriched) estuaries, mainly shallow, mixed, turbid coastal seas | largest increase in population, real GDP and city development; decrease in agricultural production; increased household consumption (goods, energy) and demand for recreation; large increase in tourism and increase in services GVA |
| Wales and the North and West of England: hill country and valleys, overlying older (Palaeozoic) sedimentary and metamorphic rocks; cooler, wetter climate | Moderate population densities, with most clustered into impoverished post-industrial towns and cities; declining ports; non-arable farming; Welsh government has some marine environmental responsibilities | Mostly stable and scenically attractive coast (cliffs and beaches); some historically polluted and presently nutrient enriched estuaries and coastal waters; offshore seasonal thermal stratification | moderate growth in population, real GDP and cities; increased energy production as well as consumption; increased recreational demands; some increase in tourism; increase in industrial GVA |
| Scotland : mountainous Highlands of old (preCambrian) granitic rocks, north of older sedimentary rocks; cooler wetter climate; isostatically rising except outer islands | Low population densities except in the central belt (Glasgow-Edinburgh); non-arable farming; devolved Scottish government with environment protection agencies and responsibility for many aspects of 61% of the UK's EEZ | Many islands, firths and sea-lochs, with alternating exposed and sheltered waters; high runoff leading to frequent haline stratification; offshore waters with seasonal thermal stratification; the largest part of the UK's fishery and marine energy resources | moderate growth in population, real GDP and cities; increased energy production as well as consumption; increased recreational demands; large increase in tourism; increase in services GVA; increased aquacultural production |

**Table 7.2** Comparison of several sets of scenarios: NEA-FO: scenarios used in this chapter; AFMEC (Alternative Future Scenarios for Marine Ecosystems): Pinnegar et al. (2006), ELME (European Lifestyles and Marine Ecosystems): Cooper et al. (2008), NEA 2011 (National Ecosystem Assessment): Haines-Young et al. (2011), MEA (Millennium Ecosystem Assessment): MEA (2005), UKCIP (UK Climate Impacts Project): UKCIP (2000)

| | **Scenario in outline** | **NEA 2011 name** | **WP3b name** | **names in other work** |
|---|---|---|---|---|
| 1 | Projection of present conditions and trends, including growth in population, real GDP, debt, energy consumption, service industries, tourism, transport, international trade, city and coastal development, decrease in fisheries catch/effort (see also table 7.1) | Go with the Flow | Baseline | Business as Usual Baseline (ELME) Conventional Development (AFMEC, UKCIP) |
| 2 | National conservation funded from global markets | Green and Pleasant Land | | |
| 3 | Global free-market and environmental standards reconciled through valuing and nationally managing ecosystem services | Nature@Work | | TechnoGarden (MEA) |
| 4 | Strong subsidiarity, emphasis on environment and equity: 'green cantons' | Local Stewardship | Local Stewardship | Local Stewardship (AFMEC) Local Responsibility (ELME) Adapting Mosaic (MEA) |
| 5 | Strong state and protection of national market economy: 'patriotic individualism' | National Security | National Security | Fortress Britain (AFMEC) National Enterprise (ELME & UKCIP) Order from Strength (MEA) |
| 6 | global growth and free markets: 'competitive libertarian individualism and big companies' | World Markets | World Markets | World Markets (AFMEC, ELME, UKCIP) |
| 7 | globalization for equity and environment as well as markets : 'the Nordic social democratic model' | | Global Community | Global Commons (AFMEC) Global Community (ELME) Global Orchestration (MEA) Global Sustainability (UKCIP) |