



# Preparing a detailed project plan for CQuEL

Work package 2: Which Ecosystem Services?  
Final Report

May 2010

Supported by:



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# Preface

CQuEL, Character and Quality of England's Landscapes, is Natural England's principal integrated monitoring project. CQuEL will provide place-based evidence about the character and function of landscapes and the provision and quality of selected ecosystem services delivered by England's natural environment.

CQuEL will provide an enhanced and up-to-date understanding of Natural England's contribution to enhancing and improving the condition of the natural environment. CQuEL will also provide evidence to key strategic partners, particularly Defra. Defra has been a funding partner of the project planning stage.

The work to prepare the CQuEL project plan has been carried out by a consortium comprising Countryside, Fabis Consulting and Land Use Consultants. The work has been guided by a Project Board at Natural England. The findings have been informed by Expert Panel workshops and the project team gratefully acknowledge the input of stakeholders at the workshops.

## List of reports

Summary Report

Work package 1: Methodological Review

Work package 2: Which Ecosystem Services?

Work package 3: Communications

Work package 4: Sources of Data

Work package 5: Links to Natural England's Land Use Strategy and Vision 2060

Work package 6: Project Plan

## Recommendations

**Key recommendations are shown in bold with a grey highlight.** Each recommendation is referenced with a code to identify the Work Package and recommendation number, for example the second recommendation of Work Package 1 is referenced **[R1.2]**.

## Executive Summary

### Overall scope of the services under CQuEL

- i. The scope of CQuEL will be to provide a framework against which the performance of Natural England can be judged, in terms of the ecosystem services Natural England can enhance through its interventions and its influencing. In terms of the latter, if the scope is cast too wide the ability of CQuEL to successfully monitor outcomes will be diminished and expense will increase significantly. **Therefore, we recommend that the focus of the CQuEL assessment should be on those services over which Natural England has primary leverage and/or influence [R2.1].**

### The geographical scope of services under CQuEL

- ii. It is important to understand patterns of supply and demand for ecosystem services; the links between different places or areas; and the geographical flows of services across space. It is therefore clearly appropriate for CQuEL to extend to the urban and marine but, with a clear focus on those geographical aspects over which Natural England currently has the most influence, and where data is most readily available. **Therefore, we recommend that CQuEL should cover both the urban and marine environments but should focus on those geographical aspects over which Natural England currently has the most influence and where data is most readily available [R2.2].**

### Actual and potential service delivery

- iii. Potential service delivery has many facets. In particular it relates to (a) how natural assets are managed and (b) where natural assets are located relative to the populations they serve. As examples: woodlands will only provide biomass if they are under active management but all woodlands have the 'potential' to provide biomass. Equally woodlands close to centres of population have greater 'potential' to provide the cultural services compared to those that are relatively inaccessible. Therefore, **it is recommended that potential service delivery forms an important part of CQuEL [R2.3].**

### Factors underpinning service delivery

- iv. At the Expert Panel workshop there was a strong call for 'biodiversity for its own sake' to be identified as a specific service. However, **we recommend that CQuEL sees biodiversity, geodiversity and indeed landscape as underpinning and universal [R2.4].** This is not to downplay their role but rather to acknowledge their central importance in the provision of all ecosystem services: To identify biodiversity, geodiversity or landscape only as a specific service is to significantly downplay their overall role in the delivery of all ecosystem services. They form part of the underlying supporting services; they provide many of the natural assets (such as specific habitats) and govern many of the functions that are responsible for the delivery of many services. Equally they may be identified as specific services, such as providing genetic diversity (biodiversity) and sense of place (landscape). They are therefore central to the overall narrative of service delivery.
- v. There remains the question, whether CQuEL should monitor the supporting services such as soil formation and photosynthesis. **We recommend that the supporting services should not be monitored separately by CQuEL [R2.5].** This is because they provide the processes and functions

that underpin many of the other services: they are the fundamental building blocks to all service delivery.

## Scope of the provisioning services

- vi. At the Expert Panel workshop there was a desire that CQuEL should monitor all forms of renewable energy, not just biomass production (where Natural England exerts direct leverage), and that it should also monitor minerals production. These are not aspects over which Natural England exerts direct control or leverage, although some of Natural England's influencing work does address these elements. Instead, **we recommend that electrical power generated by wind and minerals extraction be identified as a force for change that has the potential to affect the delivery of other services [R2.6].**

## Scope of the Cultural Services

- vii. **It is recommended that CQuEL should use the classification of cultural services identified in the study commissioned by Natural England - Capturing the Cultural Services of Landscape (2009) Research Box / LUC [R2.7].** As Natural England is providing the lead in this area, and as the Research Box/LUC study is developing further insight, it is important to use these results, especially as one of its tasks (being developed in the current Phase 2 study) is to consider how these services can be identified. To ensure linkage with the NEA, there is potential to nest these cultural services under the 'final' cultural services identified in the NEA.
- viii. In addition, while it may be difficult for CQuEL to cover more abstract services such as Community Development and Cultural Diversity (which are currently not well understood), aspects of cultural cohesion provided through Green Infrastructure and Accessible Natural Greenspace might be measured through a metric of populations served by accessible greenspace. Nevertheless **it is recommended that CQuEL avoids getting drawn into aspects of cultural service delivery that require considerable new research to justify the method of measurement selected [R2.8].**

## Development of a nested hierarchy of services

- ix. Finally, one of the observations of the Expert Panel was that the identified list of services for consideration under CQuEL, was 'bumpy'. In other words, some services covered a wide range of facets and could do with splitting down while others were 'small' and would benefit from grouping together – a nested hierarchy of services would tackle this. A nested hierarchy would also provide a better illustration of how the identified services in CQuEL link with the NEA final services. It could also help in the identification of relevant datasets. **Therefore, it is recommended that a nested hierarchy of services is used to guide the selection of relevant data within CQuEL [R2.9].**

## Introduction

The purpose of this Work Package is to identify which ecosystem services should be included in CQuEL. CQuEL will focus on those ecosystem services over which Natural England has leverage through its grant schemes, most notably Environmental Stewardship. In this way CQuEL will provide a framework against which the performance of Natural England can be judged; it will assess the quality of the services and benefits that Natural England is helping others to deliver. The scope of CQuEL will also extend to those ecosystem services which Natural England seeks to influence either through working in partnership with others, or through seeking to influence their policies and programmes. However, the assessment of these services will be more limited. This will be restricted by the availability of suitable data and the identification of appropriate indicators. Work Package 4 will provide further recommendations for data and appropriate indicators.

CQuEL will be able to identify the spatial distribution of service delivery across England using the National Character Areas (NCAs), or groupings of NCAs, as the spatial reporting framework. As identified in Work Package 1 (recommendation **[R1.10]**), CQuEL has the potential to directly complement the National Ecosystem Assessment (NEA). Not only will CQuEL establish a strong link between ecosystem services and landscape character, it also has the potential to extend the analysis down to a much finer geographical scale and potentially to report on a more specifically defined suite of ecosystem services.

# Approach to the identification of services relevant to CQuEL

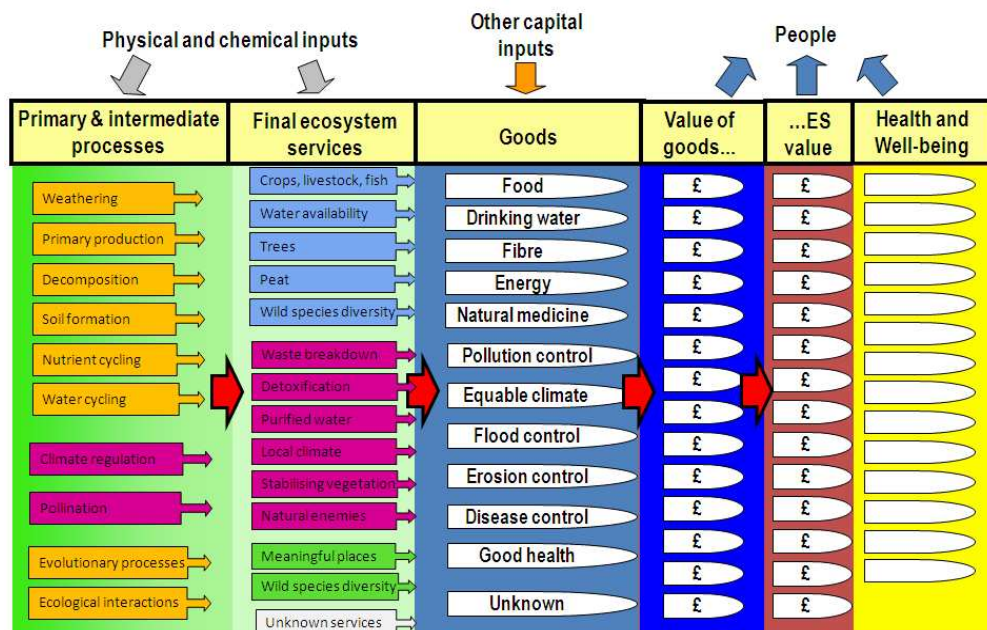
In exploring those ecosystem services that will be most relevant within CQuEL, this Work Package has followed an iterative approach, starting with a long list of potential services and through a series of iterations reducing these down to a final list, which in turn has been developed as a nested hierarchy of services for reasons that will be explained later. Through this, care has been taken to reflect what is being considered in the NEA to ensure that there is complementarity. It is therefore useful to start by summarising the proposals within the NEA which have already been set out in Work Package 1 (page 15).

## The National Ecosystem Assessment

**Figure 1** provides an insight into the analytical approach proposed for the NEA. The methodology is heavily driven by the aim to make an assessment of the value of ecosystem services, either in economic terms, or qualitatively to overall well-being. To make these estimates as robust as possible, the methodology has been constructed to identify a set of ‘final goods and benefits’ that can be valued, thereby avoiding the problem of ‘double counting’.

For the NEA, the agreed set of 10 ‘final’ services, and the goods and benefits that are associated with them, is shown in **Table 1**. They are split between provisioning, regulating and cultural services, although it is recognised that some (water quantity and wild species) may fall into two of these broad groupings. The two cultural services are ‘new’, in the sense that they do not appear in many other ecosystem service typologies; they are ‘meaningful places’ (which includes both ‘green’ and ‘blue’ space), and ‘socially valued landscapes and waterscapes’. In associating goods and benefits with all the final ecosystem services listed in Table 1, it should be noted that there is no one-to-one relationship of particular goods and benefits to particular services. Rather, the assumption is that the goods and benefits (the things that are valued) can be generated by a number of final services, and that part of the work of the NEA would be to disentangle these contributions.

**Figure 1: Methodological framework proposed for the NEA (After Mace et al., October, 2009)**



**Table 1: Revised list of final ecosystem services and corresponding goods proposed for the NEA (October, 2009)**

Final ecosystem service	Goods and benefits
(P) Crops, plants, livestock, fish, etc. (wild and domesticated)	Food, fibre, avoidance of climate stress, energy, genetic resources, industrial inputs, fertiliser, recreation and tourism
(P) Trees, standing vegetation & peat	Timber, avoidance of climate stress, energy, noise regulation, recreation and tourism
(R) Climate regulation	Avoidance of climate stress
(P, R) Water quantity	Potable water, industrial use of water, flood protection, energy, recreation and tourism
(R) Hazard regulation – vegetation & other habitats	Coastal protection, erosion protection, flood protection, avoidance of climate stress
(R) Waste breakdown & detoxification	Pollution control, waste removal, waste degradation
(P,R) Wild species diversity including microbes	Natural medicine, disease and pest control, genetic resources, wild food, bioprospecting, recreation and tourism, citizenship (with liaison with biodiversity)
(R) Purification	Clean air, clean water, clean soils
(C) Meaningful places inc. green & blue space	'CB list' see note below
(C) Socially valued landscapes and waterscapes	'CB list' see note below



**Note:** *In terms of the cultural goods and benefits, physical health, mental health, ecological knowledge will be assessed throughout; spiritual/religious, cultural heritage and mediated natures, aesthetic/inspirational, security and freedom, neighbourhood development, enfranchisement, social and environmental citizenship will be assessed as part of the two cultural services identified (C) in the table above. For other final services, P=Providing; R=Regulating.*

Within CQuEL the aim is to look at the ecosystem services in a more specific way compared to the NEA, identifying the provision of individual ecosystem services and understanding the role that Natural England has in their delivery both directly and indirectly. Nevertheless, as discussed later, the aim is to ensure that these more specific services nest under, or have read across, to the NEA.

## Approach adopted

The specific steps that have been adopted to identify the ecosystem services relevant to CQuEL are as follows:

### Step 1: Identification of a long list of ecosystem services

The first step involved the development of a long list of ecosystem services that reflect those used in other assessments. Sources used included the Millennium Ecosystem Assessment (MA), the National Ecosystem Assessment (NEA) and relevant studies undertaken for, and by, Natural England, including Natural England's Vital Uplands programme and:

- Natural England's Character Area Climate Change Project (Phase 2) (NECCP)
- The primary services delivered through Environmental Stewardship as identified through the Defra study NRO 121: The Provision of Ecosystem Services through the Environmental Stewardship scheme 2009 (ES)
- The description of ecosystem services being included as part of the NCA descriptions in the proposed update of the NCAs.

This long list is summarised in **Appendix 1**, which also includes a definition of each service reflecting definitions that have previously been applied.

### Step 2: Identifying the level of leverage / influence that Natural England potentially has over each service

As noted at the outset, the focus of CQuEL should be on those services over which Natural England has leverage: through its grant schemes, most notably Environmental Stewardship; or where it has influence through working in partnership with others; or through seeking to influence their policies and programmes.

The next step therefore was to identify which of the long list of services Natural England exerts strongest leverage and /or influence over. This assessment was based on an internal review by NE staff backed by a review of those services over which Natural England exerts leverage through Environmental Stewardship (helped by the Defra study NRO 121 mentioned above). A summary of these findings is tabulated in **Appendix 2**. The issue of community cohesion, which is one of the services that had been identified in the NEA, is interesting and is picked up later. Based on this exercise a shorter draft list of services was generated for potential consideration by CQuEL

### Step 3: Taking a shorter draft list of services to the Expert Panel to gather their views

The shorter list of services was then presented to the Expert Panel at a meeting in November to gather their views and comments. These comments are captured in **Appendix 3**. In addition, there were a number of important over-arching issues that were raised by the Expert Panel. These were:

- The geographical scope of the services considered
- The role of biodiversity and the importance of recognising biodiversity for its own sake as a service
- The role of the historic environment both as a provider of many services and as a potential cultural service
- The scope of services that should be covered, particularly the provisioning services especially in relation to renewable energy
- The definition of some of the provisioning services reflecting the more specific role of Natural England
- The nature of the cultural services

These issues are considered later on in this paper as they are worthy of more explanation. The revised list of ecosystem services that arose as a consequence of the comments received from the Expert Panel are set out in **Appendix 4**.

## **Step 4: Identifying the influence of ecosystem function on service delivery**

In parallel to Step 3, a slightly separate exercise was undertaken, both to inform the selection of services, but more particularly to help thinking on how the ecosystem services might be measured. Taking the ecosystem cascade as a starting point (**Figure 2**, page 8) this step identified the ecosystem cascade for each of the main ecosystem services that had been identified. Each cascade starts with the environmental assets (such as woodland) that provide the service, identifies the functions or processes performed by that asset that enable service delivery (such as aiding water infiltration and storage), and then goes on to identify the service and benefits provided. However, a particular aspect that these service cascades were trying to explore was how the location and management of the assets can influence the functions performed and thus the services provided. Clearly, management and location are issues that become of increasing importance in considering how to measure ecosystem service delivery. These cascades were also presented to the Expert Panel to start the process of considering how to measure service provision. These cascades are set out in **Appendix 5** and again are explored further below.

## Analytical issues

There are a range of analytical issues that arise in the choice of ecosystem services and how they are described. These are considered here and include the over-arching issues raised by the Expert Panel. These are:

- The scope of the services that are considered
  - Overall scope
  - Geographical scope
  - Location and management
  - Measurement of actual and potential services
- The choice of services and how they are described
  - Consideration of factors underpinning service delivery
  - The scope of the provisioning services and how they are described
  - The scope of the cultural services
- Development of a hierarchy of services

These are considered in turn below.

### The overall scope of the services

As already identified, the scope of CQuEL will be to provide a framework against which the performance of Natural England can be judged, in terms of the ecosystem services Natural England can enhance through its interventions and its influencing. In terms of the latter, if the scope is cast too wide the ability of CQuEL to successfully monitor outcomes will be diminished and expense will increase significantly. By maintaining a clear focus on what can be successfully and meaningfully measured, CQuEL will deliver an authoritative assessment. CQuEL will therefore provide a powerful and finer-grained illustration of the delivery of ecosystem services, sitting under the umbrella of the NEA. This finer-grain will be both a finer grain of geographical reporting, with the NCAs being one of the main spatial frameworks used in CQuEL, and a finer-grained description of the services. **We recommend that the focus of the CQuEL assessment will be on those services over which Natural England has primary leverage and/or influence.**

### Geographical scope

Discussions at the meeting of the Expert Panel helped in clarifying the geographical scope of CQuEL and the geographical scope of the services to be considered. At the Expert Panel Workshop there was a call for CQuEL to cover both the urban and marine environments, as well as the terrestrial rural environments covered by CQC. In addition, as identified in Work Package 1 (page 14), it is important to understand patterns of supply and demand for ecosystem services, the links between different places or areas, and the geographical flows of services across space. It is therefore clearly appropriate for CQuEL

to extend to the urban and marine but with a clear focus on those geographical aspects over which Natural England currently has the most influence and where data is most readily available. CQuEL therefore, will cover the terrestrial rural environment and:

- Urban areas: urban green space (and the service it provides) and peri-urban areas. Here the vital consideration is the relationship of these areas with the main centres of population, and their actual and potential levels of service delivery to these populations.
- Marine environment: those aspects of the marine environment that are directly or indirectly affected by terrestrial activity, namely: physical coastal processes, biophysical processes influenced by inter-tidal habitats, and water quality issues relating to pollution derived from terrestrial sources.

**We therefore recommend that CQuEL should cover both the urban and marine environments but should focus on those geographical aspects over which Natural England currently has the most influence and where data is most readily available.**

## Location and management

At this point it is useful to reflect on the ecosystem services cascade that was introduced in Work Package 1 (page 11) and is shown in **Figure 2**.

**Figure 2: The cascade from natural assets to human benefits implicit in the concept of ecosystem services (using services from woodland as examples)**

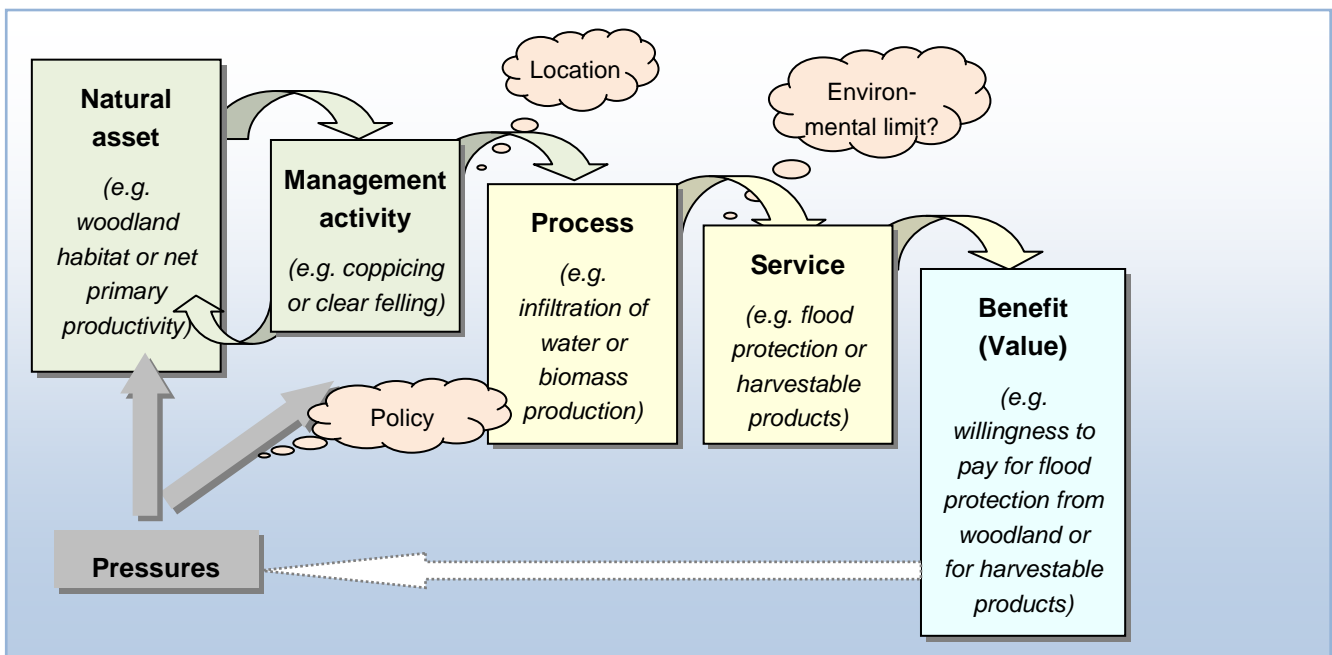


Figure adapted from Haines-Young and Potschin, 2010

As identified in this cascade, there is a distinction between what can be regarded as natural structures; the functions (processes) that they perform; and the eventual services and benefits that they provide to people. Thus, the particular function that a natural asset or structure (such as a habitat) performs only becomes a service if it is valued by people (i.e. it is perceived as providing some form of benefit). So woodland can help slow the passage of surface water, thereby modifying the intensity of flooding, but

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this function will only be regarded as a service if flood control is considered a benefit in that location or provides a benefit downstream within centres of population.

Within this cascade, how an asset is **managed and where it is located** may have a direct effect on the functions that asset is able to perform, and therefore, also the services it provides (see **Appendix 5**). This is of particular importance in the selection of services, in that, through its powers of leverage, Natural England can exert influence over both the management and location of environmental assets. It follows that, where these factors are of particular importance in the provision of services (as in many of the regulating services), these services will be directly relevant to Natural England and therefore to CQuEL. This is considered a bit further below.

The management of an environmental asset can be critical in defining the functions it performs and therefore the services that it provides. The need for management and sometimes the type of management will depend on which service is required. So, for example, unmanaged woodland can help store carbon and will have improved water infiltration capacity compared to grassland, but woodland under coppice management will, in addition, be more productive, will provide a source of renewable energy and will sequester greater levels of CO<sub>2</sub> when compared to unmanaged woodland. On the other hand, badly compacted grassland or moorland (as a result of overgrazing) may exacerbate service failure, encouraging overland flows of water and associated soil erosion in turn leading to increased flooding potential and water pollution.

Equally the location of environmental assets can be critical in influencing whether they deliver particular services with different services potentially requiring different locations for the same asset. So woodland for biomass planting is better located close to vehicular access, whilst that needed to regulate cross land flows and soil erosion is best located across slopes. Location can be considered at three levels:

- Field-scale: Is the asset, for example woodland, in a location where it is able to deliver the desired service? For example, a woodland running down a slope will not regulate overland water flows whereas a woodland running across a slope will.
- Landscape-scale: Following the above example, is the woodland in a catchment susceptible to flooding? For example, chalk catchments tend to be less susceptible to flooding than clay catchments
- Regional-scale: Will the flooding adversely affect property or high grade agricultural land downstream?

## **Actual and potential service delivery**

The above cascade also raises the issue of whether CQuEL should be measuring potential, as well as actual, service delivery. Potential service delivery has many facets: in particular it relates to (a) how natural assets are managed (as discussed above); and (b) where natural assets are located relative to the populations they serve. As examples: woodlands will only provide biomass if they are under active management but all woodlands have the 'potential' to provide biomass. Equally, woodlands close to centres of population have greater 'potential' to provide the cultural services compared to those that are relatively inaccessible.

**It is therefore recommended that potential service delivery forms an important part of CQuEL.**

Without dealing with potential it is difficult to look at trade-offs and change. Exploration of potential will also be important in the use of scenarios within CQuEL and in considering the relationship between

service supply and demand. The notion of a limit or threshold presumes that we are looking at the gap between supply and demand.

## The choice of services and how they are described

The choice of services is core to this Work Package. The selected ecosystem services are set out in **Appendix 4**. These, as in most other classifications of ecosystem services are divided into:

*Supporting Services:* The fundamental services that underpin all other ecosystem services, such as soil formation and nutrient cycling.

*Provisioning services:* Covering products obtained from ecosystems and landscapes including food, fibre, fuel and fresh water.

*Regulating services:* The benefits obtained from the regulation of ecosystem processes including carbon capture, air quality regulation, and water regulation. Many of these services are of particular importance in the face of climate change.

*Cultural services:* The non-material benefits that people attain through spiritual enrichment, reflection, relaxation and aesthetic experiences.

Issues relating to the selection of services for CQuEL are outlined below.

## Factors underpinning service delivery

**Biodiversity:** As already noted at the Expert Panel workshop, there was a strong call for ‘biodiversity for its own sake’ to be identified as a specific service. However, **we recommend that CQuEL should see biodiversity, geodiversity, and indeed landscape, as underpinning and universal**. This is not to downplay their role but rather to acknowledge their central importance in the provision of all ecosystem services. To identify biodiversity, geodiversity or landscape only as a specific service is to significantly downplay their overall role in the delivery of all ecosystem services. They form part of the underlying supporting services; they provide many of the natural assets (such as specific habitats); and govern many of the functions (such as carbon sequestration) that are responsible for the delivery of many services. Equally, they may be identified as specific services, such as providing genetic diversity (biodiversity), and sense of place (landscape). They are, therefore, central to the overall narrative of service delivery.

In this context, geodiversity is interpreted in its broadest sense – geology, geomorphology, topography, associated natural processes, and the interaction of biotic and abiotic processes, as in saltmarsh development.

**The historic environment:** Through the Expert Panel workshop there was also a strong call for the historic environment and cultural influences to be treated in the same way, i.e. as integral to the narrative of service provision. This recognises that in the English context, humans are an integral part of ecosystems and their management, and that history and past processes are integral to the assets that we have today. Indeed, all key elements of ecosystems – assets, processes, services and benefits – have developed over time, usually over long periods, and usually back into pre-modern periods. It is realised that the historic environment sector is well-placed to contribute to the ecosystem service approach to managing the environment, through an appreciation of the long term trajectories of change

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and an understanding of how environmental ‘assets’ came to be where they are (normally meaning how they came to be so confined), and in what form they are. Therefore, understanding the historic environment forms part of the feedback loop identified in Figure 2, with all parts of the cascade potentially influenced by an historic perspective. This understanding equally needs to be seen as part of the cycle identified in the individual service cascades set out **Appendix 5**.

These are important concepts to build into the thinking on ecosystem services and it is something that CQuEL will try to do as it is developed.

**The supporting services:** There remains the question, whether CQuEL, should monitor the supporting services such as soil formation and photosynthesis?

**We recommend that the supporting services should not be monitored separately by CQuEL.** This is because they provide the processes and functions that underpin many of the other services – they are the fundamental building blocks to all service delivery (incorporating soil formation, primary production, photosynthesis and nutrient cycling). There is also the issue that finding appropriate datasets could prove tricky and the importance of these supporting services will be picked up through the measurement of the other services that they support.

## The choice and scope of the provisioning services

**Sustainable production systems:** The provisioning services are potentially more problematic in the context of Natural England’s remit than either the regulating or the cultural services because they may be seen as a force that diminishes the delivery of at least some other ecosystem services and the environmental capital on which these services depend. It was for this reason that the Expert Panel called for CQuEL to focus on the monitoring of sustainable production systems rather than all production systems. It is this wording which has been adopted in the selected list of services set out in Appendix 4. This raises two issues: First, what CQuEL measures is dependent on how ‘sustainable production’ is defined. Is it, for example, identified in terms of:

- Those farms that meet the basic regulatory standard; or
- Those farms entered into a Farm Assurance Scheme or Environmental Assurance Scheme and if so which ones or
- Those farms with Environmental Stewardship agreements; or
- Organic farms?

None of which in isolation measure ‘sustainable production’

Secondly, by only looking at parts of total production, it is more difficult to understand the trade offs that may be being made between different types of ecosystem service, for example, between food production and genetic diversity, and the regulating services.

In consequence, while the list of selected ecosystem services maintains the definition of sustainable production, and while appropriate data sets have been explored in Work Package 4, there may be a case for CQuEL measuring:

- Total agricultural production to provide a better understanding of trade offs in service delivery



- An agreed indicator of sustainable production where data is readily available, such as organic farming and farms in Environmental Stewardship (accepting that these are not an exact fit with sustainable production) and making it very clear from where the data has been drawn.

**Biomass provision:** At the Expert Panel workshop a slightly different issue was raised in relation to **Renewable Energy**. In this case, there was a desire that CQuEL should monitor all forms of renewable energy, not just biomass production (where Natural England exerts direct leverage), and that it should also monitor minerals production. Current thinking is that electrical power generated by wind and minerals extraction should not be monitored as ecosystem services under CQuEL because they are not aspects over which Natural England exerts direct control or leverage, although some of Natural England's influencing work does address these elements. Instead **we recommend that electrical powers generated by wind and minerals extraction be identified as forces for change that have the potential to affect the delivery of other services.**

This also reflects the overall scope of CQuEL as defined in Work Package 1 (recommendation **[R1.13]**), namely that CQuEL be restricted to ecosystem outputs that are renewable and which depend on a combination of biotic and abiotic factors. Thus, aspects, such as the potential of a landscape or seascape for wind energy, would be excluded from the analysis, as would mineral production.

## **Selection of the regulating services**

By comparison, there was general support from the Expert Panel for the selected list of the regulating services, albeit there were suggestions on precise wording and comments on the clear inter-linkages between services which, in part have been picked up in the hierarchy of services suggested at the end of this Paper.

## **The scope of the cultural services**

This was the other main area that excited comment at the Expert Panel Workshop. Overall, the cultural services caused the most confusion amongst the Expert Panel, because:

- they largely derive from how we perceive and use the natural and cultural environment, as opposed to being related to clear physical and biological functions, and processes (this is why the service cascades in Appendix 5 take on a different form when describing the Cultural Services);
- for this reason there was scepticism about how they could be measured; and
- within the NEA they have been reduced to just two final services – 'Meaningful Local Places' and 'Socially Valued Landscapes'.

**The definitions of the NEA Cultural Services** *taken from Chapter 5 Cultural Ecosystem Services Zero Order Draft 8<sup>th</sup> January 2009*

**Meaningful local places.** These are ‘centres of meaning constructed through experience’. The most meaningful place of all is the home, the site within which the most intimate, personal and profound aspects of human life and social interaction occur. Homes are located within neighbourhoods, geographical territories which become symbolically meaningful through repeated, everyday interactions between people and the physical settings which provide the contexts for those interactions. As substantial work in environmental social sciences, built environment, allied health disciplines, and the humanities demonstrate, the kinds of relationships afforded by local spaces (parks, woods, rivers, street trees, etc) are vitally important in helping individuals achieve quality of life and well-being.

**Socially valued landscapes.** This recognises that landscape is a cultural term, first coined in the C16th Landscape is a way of seeing, a way of organizing visual experience by taking a perspective that encompasses and organizes a view. The European Landscape Convention describes landscape as “an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors.” The experience and appreciation of landscapes is acquired, it reflects the historical depth of particular cultural interpretations. Until the early C18th, European sensibilities turned in horror from mountainous landscapes, finding them hideous to behold. By the end of that long century, a different set of shared meanings were in place as the distinction between the ‘picturesque’, well farmed and domestic landscapes of southern England and the ‘sublime’ awe-filled landscapes of Snowdonia, the Lake District and the Highlands of Western Scotland became sedimented into the Romantic sensibility

Work has been commissioned by Natural England on the cultural services over the last two years specifically ‘Capturing the Cultural Services and Experiential Qualities of Landscape’ (undertaken by Research Box with LUC). Through this research, eight cultural services have been identified strongly associated with landscape and the natural and cultural environment, partly reflecting those cultural services identified in the MA. These are illustrated in Table 2 with definitions drawn from the response of participants.

**Table 2: Cultural Services identified through the Research Box study**

Service	The definitions of participants
Sense of place	Feeling connected to a place because of a combination of characteristics; a sense of belonging built on association; seeing a landscape’s distinctiveness
Cultural heritage / sense of history	Feeling a sense of antiquity; seeing the history and vintage of the landscape; feeling one amongst many through history, seeing yourself in the landscape amongst past and future generations
Education	Learning about nature and the landscape and how it has evolved; learning about oneself; learning to lead life differently – more simply;

	discovering new experiences
Aesthetic qualities	Valuing a landscapes and wildlife for their own particular aesthetic
Recreation	Being able to undertake a wide range of recreational pursuits from watching wildlife to specialist active recreation pursuits.
Inspiration / Spiritual	Being inspired by one's surroundings because of its character or quality, feeling an emotional response to one's surroundings; recognising the 'otherness' of nature
Tranquillity / Calm	Feeling calm/ relaxed / comforted by the nature of one's surroundings
Escapism	A sense of freedom that offers release; switching off from daily pressures; getting away from it all

Reflecting on this research, it is **recommended that CQuEL should use the classification of cultural services identified in the study commissioned by Natural England - *Capturing the Cultural Services of Landscape (2009) Research Box / LUC***. Because Natural England is providing the lead in this area, and as the Research Box/LUC study is developing further insight, it is important to use these results, especially as one of its tasks (being developed in the current Phase 2 study) is to consider how these services can be identified. To ensure linkage with the NEA, there is potential to nest these cultural services under the 'final' cultural services identified in the NEA Ecosystem Assessment (as illustrated in the services hierarchy illustrated over the page).

In addition, while it may be difficult for CQuEL to cover more abstract services such as Community Development and Cultural Diversity (which are currently not well understood), aspects of cultural cohesion provided through Green Infrastructure and Accessible Natural Greenspace might be measured through a metric of populations served by accessible greenspace. Nevertheless, **it is recommended that CQuEL avoids getting drawn into aspects of cultural service delivery that require considerable new research to justify the method of measurement selected.**

## Development of a hierarchy of services

Finally, one of the observations of the Expert Panel was that the identified list of services for consideration under CQuEL, which in part reflects the MA, was ‘bumpy’. In other words, some services covered a wide range of facets and could do with splitting down, while others were ‘small’ and would benefit from grouping together – a nested hierarchy of services would tackle this. A nested hierarchy might also provide a better illustration of how the identified services in CQuEL link with the NEA final services – this might particularly be the case for the cultural services, as noted above.

In addition, for Work Package 4, concerned with identifying the type of data available to use for measuring the ecosystem services under CQuEL, there is a very strong case for breaking some of the services down in order to bring greater clarity to what needs to be measured. **It is therefore recommended that a nested hierarchy of services is used to guide the selection of relevant data within CQuEL**

Reflecting this, a proposed hierarchy of services is set out in **Table 3** and expanded in **Appendix 6** with definitions. This hierarchy draws on the NEA, the work of the European Environment Agency on CICES (Common International Classification of Ecosystem Services), and a suggested hierarchy that was considered in Defra NRO110 *Multi-functional wetlands in agricultural landscapes* Wildfowl and Wetland Trust (2008) – in reality this latter hierarchy was more concerned with working backwards to the potential functions and from these, back to the assets and processes that help provide these functions. Nevertheless, the combination of these sources provided a good basis for developing the nested hierarchy.

The cells highlighted in green in **Table 3** are those aspects of service delivery which it has been considered to date might be measured under CQuEL (data permitting). This has taken account of points raised at the Expert Panel Workshop in November and reflects the agreed scope of CQuEL.

The aspects of cultural services have been discussed with Research Box on ascribing their identification of cultural services to the ‘Final Cultural Services’ identified by the NEA – ‘Meaningful Local Places’ and ‘Socially Valued Landscapes’. **Table 3** suggests the current best fit.

**Table 3: A potential hierarchy of services**

SERVICE CLASS	SERVICE GROUP	SERVICE TYPE
<b>Provisioning services</b>		
Nutrition	Terrestrial agricultural products	Commercial cropping
		Sustainable cropping
		Commercial animal husbandry
		Sustainable animal husbandry
	Freshwater food production	Commercial aquaculture
		Sustainable freshwater production

	Coastal food production	Commercial aquaculture
		Commercial fisheries
		Sustainable fisheries
	Harvesting from the wild	Non commercial collection
Fibre materials /	Production of biotic materials	Timber
		Wools and hides
		Natural building materials (thatch/straw)
	<i>Production of abiotic materials</i>	<i>Minerals</i>
Energy	Renewable biotic sources	Biomass/ plant and animal wastes
	<i>Renewable abiotic sources</i>	<i>Wind</i>
		<i>Solar</i>
		<i>Water (hydro)</i>
		<i>Air/ground source</i>
Water	Provision of potable water	Provision of stored water (aquifers/ peats/ reservoirs)
		Provision of river waters
<b>Regulating services</b>		
Regulation of flows	Regulation of erosion	Soil erosion control
		Coastal erosion control
	Regulation of terrestrial water flows	River flood generation control (wider catchment)
		River flood propagation control (within river valleys)
		Aquifer recharge
Regulation of coastal waters	Coastal flood control	
Regulation of physical environment	Climate regulation	Reduction in GHG outputs
		Carbon sequestration
		Carbon storage
		Climate amelioration (modification of local micro-climates)
	Regulation of freshwater quality	Purification of ground water
		Purification of surface water (chemical and ecological quality)

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	Regulation of coastal water quality	Purification of estuarine waters
		Purification of coastal waters
	Regulation of air quality	Filtering aerial particulates
	Regulation of soil quality	Build up of soil organic content
Regulation of biotic environment	Pest and disease control	Biological controls
	Maintaining natural lifecycles	Pollination
	Gene pool conservation	Conservation of wild genetic resources
		Conservation of domesticated genetic resources (rare breeds / species)
<b>Cultural services</b>		
Meaningful local places	Sense of place	
	Cultural heritage	
	Education	
	Recreation	
Socially valued landscapes	Aesthetic qualities	
	Inspiration / spiritualism	
	Tranquillity / calm	
	Escapism	

## Appendix 1: Long list of potential services

Service	Comments on use to-date in service assessments (definitions)
<b>Supporting services</b>	
<b>Soil formation</b>	The formation of soils is a potentially ubiquitous service and strongly overlaps with the laying down of soil organic matter and nutrient cycling. But in some assessments emphasis is placed on the potential loss (and gain) of grades 1 & 2 agricultural soils.
<b>Photosynthesis</b>	Ubiquitous and therefore not included in most assessments.
<b>Primary production</b>	The accumulation of energy and nutrients is relatively ubiquitous and closely links to the laying down of soil organic matter and nutrient cycling. It is recognised that Environmental Stewardship can contribute to this service.
<b>Nutrient cycling</b>	As above.
<b>Water cycling</b>	Not usually considered as it strongly overlaps with the provisioning and regulating water services.
<b>Biodiversity</b>	Biodiversity is not usually identified as a supporting service (although it is in one or two cases), more commonly being considered in terms of the variety of services that it provides, such as genetic diversity.
<b>Provisioning services</b>	
<b>Food</b>	The provision of food products derived <i>directly</i> or <i>indirectly</i> from UK ecosystems, through agriculture or collection from the wild.
<b>Fibre</b>	This service may include provision of timber and wood, coppice products, hemp, animal skins, wool, roofing thatch and reed.
<b>Fuel</b>	The NEA has considered the use of biomass as fuel and <i>indirectly</i> through conversion of biomass products to biofuels. Other studies use the title renewable energy and consider both actual and potential sources.
<b>Genetic resources</b>	The NEA focuses on the genetics involved in animal and plant breeding whereas the focus of Environmental Stewardship (ES) is on vulnerable domesticated breeds and species, such as old apple varieties.
<b>Biochemicals</b>	The provision of biochemicals, natural medicines, and

<b>Service</b>	<b>Comments on use to-date in service assessments (definitions)</b>
	pharmaceuticals from landscapes and ecosystems.
<b>Ornamentals</b>	Animal and plant products, such as skins, shells and flowers used as ornaments.
<b>Fresh water</b>	Freshwater generated and found in ecosystems including rivers, although the NEA is also considering sea water for aquaculture. Under ES the focus is on the storage role of upland peat.
<b>Regulating services</b>	
<b>Air quality</b>	The regulation of air quality by ecosystems and landscapes through the generation of chemicals and particles to the atmosphere and the interception of natural and human origin chemicals and particles.
<b>Climate regulation</b>	The release and absorption of greenhouse gases by ecosystems (the global implications). The NEA also consider the regional and local implications, with regional climates (temperature and precipitation) affected by the distribution of different ecosystems and local / site-specific climates affected by the structure and location of habitats and other landscape features – affecting wind and sunshine / shade / temperature.
<b>Water regulation</b>	The NEA identifies this service as covering all forms of water infiltration and flood alleviation – river and coastal. The other assessments separate river and coastal flooding, while the ES assessment makes a further distinction between water infiltration in the wider catchment and flood regulation within floodplains.
<b>Erosion regulation</b>	The NEA is concerned with both soil erosion and coastal erosion whilst ES assessment is only addressing soil erosion on farmland.
<b>Soil quality regulation</b>	The NEA defines this service as the regulation of soil quality (current and potential) by UK ecosystems.
<b>Water quality regulation</b>	All the identified assessments define this service as the regulation of water quality by ecosystems through the origin and amelioration of chemicals and particles affecting water quality. In the case of the NEA consideration is also given to seawater quality.
<b>Toxic hazard regulation</b>	The NEA identifies this service as the decomposition, modification, removal, fixation or burial of toxic substances.
<b>Noise regulation</b>	The NEA defines this service as regulation of noise pollution levels by UK ecosystems (and landscape features).



Service	Comments on use to-date in service assessments (definitions)
<b>Disease regulation</b>	Defined by how the changes in ecosystems can directly change the abundance of <b>human pathogens</b> .
<b>Pest regulation</b>	Defined by how changes in ecosystems can affect the regulation of pest outbreaks in crops and livestock.
<b>Pollination</b>	All assessments associate this service with the distribution, abundance and effectiveness of pollinators, as affected by changes in ecosystems.
<b>Natural hazard regulation</b>	Concerned with the control of natural hazards especially coastal flooding. In the NEA coastal flooding is covered under <b>Flood hazard regulation</b> which considers both river and coastal flooding. In all the other assessments regulation of coastal flooding is considered as a separate service
<b>Cultural services</b>	
<b>Cultural diversity</b>	Defined as the influence of different ecosystems on the diversity of cultures.
<b>Community development</b>	This is not a service identified in the MA, but in the NEA has been defined as the contribution of ecosystems / landscapes to community development through increased social cohesion, job opportunities and local pride.
<b>Religious values</b>	In the NEA religious and spiritual values are being considered separately although they are combined in the MA.
<b>Spiritual values</b>	Deals with the spiritual experiences provided by landscapes and ecosystems.
<b>Tranquillity / calm<sup>1</sup></b>	A strong perceptual quality of landscape that is also an important service in a modern 'stressed' environment. Clearly identified as a separate service in the Research Box study.
<b>Escapism<sup>2</sup></b>	Deals with the sense of escape provided by nature and natural landscapes in an increasingly pressured world – a specific service recognised in the Research Box study.

<sup>1</sup> This is an additional service identified through the Research Box study – Research Box with LUC and Rick Minter (2009) *Capturing the Cultural Services and Experiential Qualities of Landscape*

<sup>2</sup> Ibid

<b>Service</b>	<b>Comments on use to-date in service assessments (definitions)</b>
<b>Knowledge systems</b>	In the MA, this service reflects the influence of ecosystems and landscapes on the knowledge systems (traditional and formal) developed by different cultures.
<b>Educational values</b>	This is the education opportunities offered by ecosystems and landscapes both directly through fieldwork activities and indirectly through contribution to the wider body of knowledge.
<b>Inspiration</b>	This service reflects that ecosystems and landscapes provide a rich source of inspiration for art, folklore, national symbols, architecture and advertising.
<b>Aesthetic values</b>	This service acknowledges that many people find beauty or aesthetic value in various aspects of the landscape.
<b>Sense of place</b>	This service acknowledges that landscapes and ecosystems are central to defining sense of place, contributing to the recognisable, characteristic and unique identity of a locality.
<b>Cultural heritage values</b>	The cultural heritage service reflects that landscapes and ecosystems contribute to the creation, expression, preservation, and public understanding of past and present cultural heritage.
<b>Recreation service</b>	These recognise that landscapes provide varying recreational opportunities.
<b>Tourism service</b>	

## Appendix 2: Long list of potential services – relevance to Natural England

**Leverage:** applied through Natural England grant schemes most notably Environmental Stewardship (ES)

**Influence:** achieved through the work of Natural England often working in partnership with others

Service	Leverage and influence of Natural England	
	Leverage	Influence
<b>Supporting services</b>		
Soil formation		
Photosynthesis		
Primary production		
Nutrient cycling		
Water cycling		
<i>Biodiversity / geodiversity</i>		
<b>Provisioning services</b>		
Food		
Fibre		
Fuel <sup>3</sup>		
Genetic resources		
Biochemicals		
Ornamentals		

<sup>3</sup> NE grants only available for biomass crops

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Service	Leverage and influence of Natural England	
	Leverage	Influence
Fresh water		
<b>Regulating services</b>		
Air quality		
Climate regulation		
Water regulation		
Erosion regulation		
<i>Soil quality regulation<sup>4</sup></i>		
<i>Water quality regulation</i>		
<i>Toxic hazard regulation</i>		
<i>Noise regulation</i>		
Disease regulation		
Pest regulation		
Pollination		
Natural hazard regulation		

<sup>4</sup> All regulating services in italics are those that have been introduced through the deliberations on the NEA

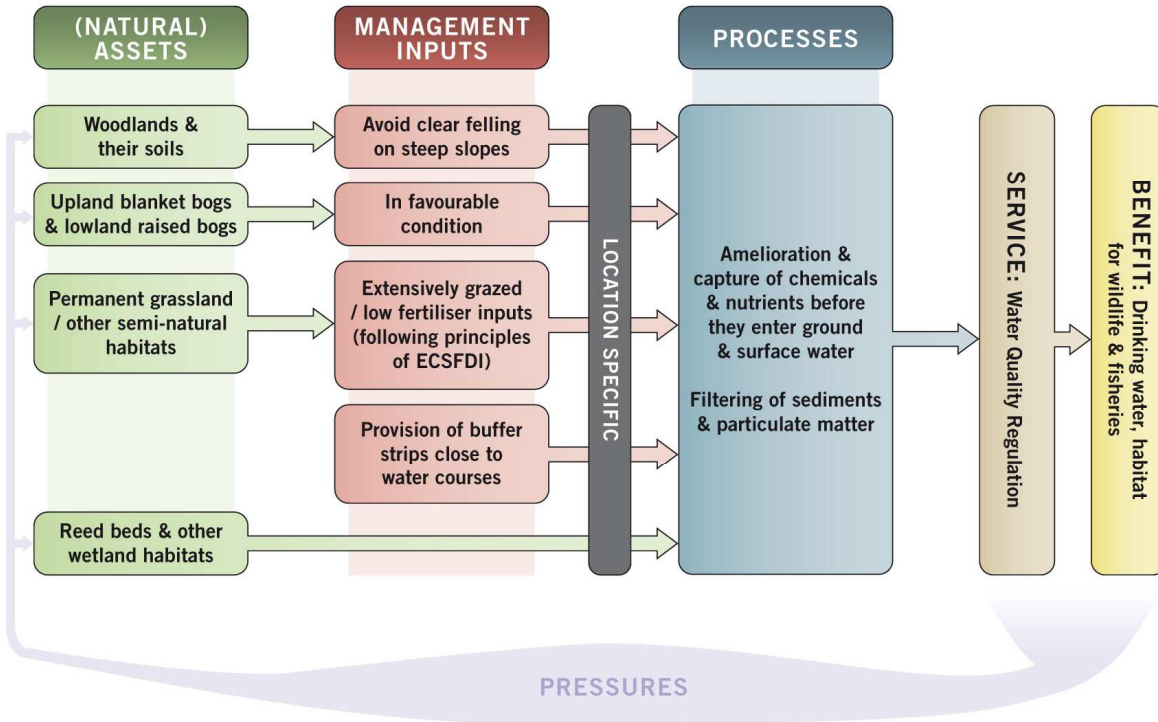
Service	Leverage and influence of NE	
	Leverage	Influence
<b>Cultural services</b>		
Cultural diversity		
Community development`		
Religious associations		
Spiritual associations		
<i>Tranquillity / calm</i> <sup>5</sup>		
<i>Escapism</i> <sup>6</sup>		
Knowledge systems		
Educational service		
Inspiration		
Aesthetic qualities		
Sense of place		
Cultural heritage associations		
Recreation service		
Tourism service		

<sup>5</sup> This is an additional service identified through the Research Box study – Research Box with LUC and Rick Minter (2009) *Capturing the Cultural Services and Experiential Qualities of Landscape*

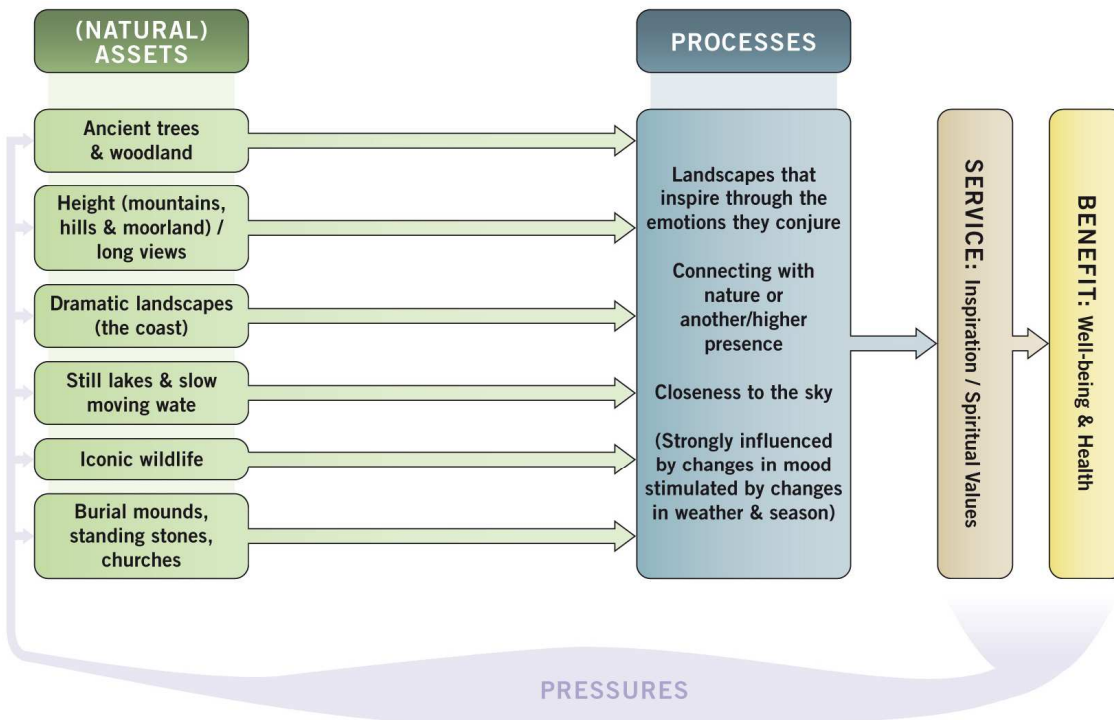
<sup>6</sup> Ibid

# Appendix 5: Examples of the Ecosystem Service Cascade

## Regulating Service: Water Quality Regulation (see also erosion regulation)



## Cultural Service: Inspiration / Spiritual Values



## Appendix 3: Service / Benefit Themes that could be the primary focus of CQuEL: Workshop results

Service / benefit themes	Workshop Comments
<b>Supporting services</b>	
Soil formation Primary production Nutrient cycling Water cycling	<ul style="list-style-type: none"> <li>• Biodiversity and geodiversity should be referred to directly, especially as the links between landscape and other suggested services are not always direct.</li> <li>• The service or benefit theme should be called ‘Soil formation / conservation’.</li> </ul>
<b>Provisioning services</b>	
Food	<ul style="list-style-type: none"> <li>• It should be confirmed if this service refers to all agricultural production or “sustainable” food production.</li> <li>• Need to explain if “collection from the wild” includes fishing? Fishing is also linked to cultural services.</li> <li>• It is noted that this service is fundamental to the delivery of other services.</li> <li>• Minerals should also be included here.</li> <li>• Marine resources should also be included here.</li> <li>• There are significant future pressures on food production and limitations on where food can be produced.</li> <li>• There is a need for trade-offs and interactions with other services.</li> <li>• Food production should be sustainable.</li> <li>• It was suggested that food, fibre and renewable energy be joined together.</li> </ul>
Fibre	<ul style="list-style-type: none"> <li>• “Commercial timber” will mainly involve the use of non-native species. This will also involve trade-offs with other services.</li> <li>• This service will require a different approach as to energy.</li> <li>• This service is linked to air quality and other regulating services.</li> <li>• Other ‘natural’ materials such as stone or minerals should be included within this service.</li> <li>• The term ‘commercial’ suggests that there is potential value for that service.</li> </ul>

Renewable energy	<ul style="list-style-type: none"> <li>• This could be titled 'alternative energy'.</li> <li>• Is it appropriate to consider biomass as a valid renewable energy source?</li> <li>• If CQuEL is monitoring service provision and not "Natural England acceptable" services then wind and tidal also need to be considered within renewable energy.</li> <li>• This service does not just include biomass.</li> <li>• Wind energy (including on and off shore), tidal, solar power and hydro-electric power should also be included within this service.</li> <li>• Does this heading consider the potential for renewable energy or the actual renewable energy generated?</li> <li>• Trade-offs should be considered along with the use of the renewable energy. It should also be considered how the energy is required and what is possible to produce.</li> <li>• The potential for renewable energy will vary across landscape types.</li> <li>• Some renewable energy generation is controversial but location specific.</li> </ul>
Genetic resources	<i>No comments</i>
Fresh water	<ul style="list-style-type: none"> <li>• This service should also include desalination, river systems and other landscape features.</li> <li>• This service heading should be named 'Fresh water supply'.</li> </ul>
<b>Regulating services</b>	
Air quality regulation	<ul style="list-style-type: none"> <li>• Need to consider whether this can be differentiated in a meaningful way.</li> </ul>
Climate regulation	<ul style="list-style-type: none"> <li>• Climate regulation should also include soils (for example peat) and biomass.</li> <li>• This heading could be separated to provide 2 separate sections titled mitigation and adaptation.</li> </ul>
Water regulation	<ul style="list-style-type: none"> <li>• This heading should be renamed 'flood regulation'.</li> </ul>
Erosion regulation	<ul style="list-style-type: none"> <li>• This is also linked to water regulation.</li> <li>• This service is linked to soil quality regulation.</li> <li>• The heading should be renamed 'soil' or 'terrestrial'.</li> </ul>



	<ul style="list-style-type: none"> <li>• This service should also include coastal flooding and erosion.</li> <li>• This service is linked to regulation of coastal flooding.</li> </ul>
Soil quality regulation	<ul style="list-style-type: none"> <li>• It was questioned if this is measurable.</li> <li>• This service is closely associated with cultivation and soil management.</li> </ul>
Water quality regulation	<i>No comments</i>
Disease regulation	<ul style="list-style-type: none"> <li>• It was questioned whether disease regulation is linked to pollination and natural pest control.</li> <li>• It was questioned whether this service is relevant to England or the UK as a whole.</li> <li>• Animal, crop and tree diseases could be included under this service.</li> <li>• Plant and animal pathogens could be included.</li> </ul>
Pollination and natural pest control	<ul style="list-style-type: none"> <li>• It was questioned whether disease regulation is linked to pollination and natural pest control.</li> <li>• This service is no more relevant to CQuEL than many other biodiversity or regulating services that have been flagged as amber or red.</li> <li>• It was questioned if pollination is a provisioning service.</li> </ul>
Regulation of coastal flooding	<ul style="list-style-type: none"> <li>• This should involve monitoring existing coastal erosion and planning for new coastal erosion.</li> <li>• Regulation of coastal flooding and soil quality regulation are linked.</li> </ul>
<b>Cultural services</b>	
Sense of place	<ul style="list-style-type: none"> <li>• All headings under cultural services should be combined and titled 'well-being'. The benefits of the service should be the focus.</li> <li>• It was questioned how this could be measured, suggesting that it may be difficult to produce a base line in order to monitor change.</li> <li>• Sense of place, inspiration/spiritual values, tranquillity/calm, escapism, and cultural heritage values should be combined because they are all contingent and therefore qualitative.</li> </ul>
Inspiration / Spiritual values	<ul style="list-style-type: none"> <li>• It was questioned how this could be measured, suggesting that it may be difficult to produce a base line in order to monitor change.</li> </ul>

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Tranquillity /calm	<ul style="list-style-type: none"> <li>• Tranquillity mapping should be referred to.</li> </ul>
Escapism	<ul style="list-style-type: none"> <li>• Activities that take place through escapism stimulate a range of emotions. This service is therefore strongly perceptual and should either be kept separate, or should be a sub-heading under recreation.</li> </ul>
Cultural heritage values	<ul style="list-style-type: none"> <li>• This should be a provisioning service because it is a framing concept that underpins the provisioning of services and frames perception.</li> </ul>
Recreation services	<ul style="list-style-type: none"> <li>• This links with the comment under 'food' regarding 'collection from the wild'. Fishing is a form of recreation also.</li> <li>• This service is quantitative.</li> </ul>
Tourism services	<ul style="list-style-type: none"> <li>• This service is quantitative.</li> </ul>

## Appendix 4: Draft of Ecosystem Services to be considered under CQuEL

This list has been produced following the Expert Panel workshop.

Service / benefit themes	NE Leverage	NE Influence	Definition of the service / benefit theme from the perspective of CQuEL
<b>Provisioning services</b>			
Food			Sustainable food production and collection from the wild, <i>potentially including freshwater fish.</i>
Fibre			The provision of timber, reed and wheat straw thatch and speciality wools.
Biomass			The provision of biomass as a renewable energy source. <i>There remains a question whether this should be expanded to cover all alternative energy sources but the difference between potential and actual provision would require detailed study - more the responsibility of DECC.</i>
Genetic resources			The genetic resources associated with semi-natural habitats and wild species and with vulnerable domestic breeds and species (e.g, old apple varieties) covered by the CBD. <sup>7</sup>
Fresh water supply			Fresh waters stored in upland blanket bogs and natural aquifers and in river systems.
<b>Regulating services</b>			
Air quality regulation			The filtering of particulate matter by trees and other woody vegetation.
Climate regulation			The release of greenhouses gases by land management activities (-) and the sequestration and storage (+) of greenhouse gases by soils and vegetation and the modification of local micro-climates by vegetation (especially important to counter the heat island effect in urban areas).
Regulation of water flows			The regulation of fresh waters through improved water infiltration to aid aquifer recharge and reduce the frequency and severity of flooding combined with the natural storage of water in the upper

<sup>7</sup> the Convention on Biological Diversity

Service / benefit themes	NE Leverage	NE Influence	Definition of the service / benefit theme from the perspective of CQuEL
			catchments and across floodplains to reduce the severity of flooding downstream.
Regulation of soil erosion and quality			The regulation of soil erosion (both by wind and water) and soil quality through the build up of soil organic matter.
Water quality regulation			The regulation of water quality through the origin and amelioration of chemicals, nutrients and particles that affect water quality.
Disease regulation			The changing abundance of human pathogens in response to changes in landcover and land management.
Pollination and natural pest control			The distribution, abundance and effectiveness of pollinators and of natural pest predators in controlling animal, crop and tree diseases.
Regulation of coastal flooding and erosion			The regulation of coastal flooding and erosion through the presence of coastal ecosystems.
<b>Cultural services</b>			
Sense of place			The sense of place of different localities.
Aesthetic qualities			The aesthetic qualities of landscape and nature reflected in part in landscape designations and 'beauty spots'
Inspiration / Spiritual associations			The inspiration and spiritual fulfilment provided by landscapes, their cultural services and the natural world.
Tranquillity /calm			A sense of calm / tranquillity imbued by the landscape.
Escapism			A sense of escapism engendered by landscape and the natural environment – escaping from the stresses of modern living.
Cultural heritage associations			The contribution of landscapes to the creation, expression, preservation and public understanding of past and present cultural heritage.
Educational service			The opportunities for education provided by the natural environment and cultural heritage.
Recreation service			The recreational experiences provided by landscapes and the natural environment.

## Appendix 6: Example of a Nested Hierarchy