Land use planning and the ecosystem approach: An evaluation of case study planning frameworks against the Malawi Principles

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Abstract

Global land use change continues to undermine the capacity of ecosystems to sustain ecosystem service (ES) flows. Much attention in policy and research has therefore been given to concepts, tools and processes for sustainable land use planning, including consideration of ES and the ecosystem approach. However, there are limited empirical cases or evaluations of ecosystem approach based planning from which lessons can be drawn. The aim of this research therefore was to identify and evaluate existing case study planning frameworks that have the potential to operationalise the ecosystem approach. Based on the Malawi Principles, a new suite of evaluation criteria was developed. This was used to assess case study documentary evidence and evaluate the extent to which the 12 Malawi Principles had been considered. The evaluation also assessed the planning methods/approaches used by the case studies and their potential to help translate the Malawi Principles into land use planning outcomes. Finally, a SWOT analysis was used to structure the main findings. Our results show that the Malawi Principles have been considered across the case studies "fully" or "partially" in 64% of instances suggesting, therefore, that the case studies present a reasonable interpretation of the ecosystem approach. However, poor consideration of biodiversity and environmental limits across the cases highlights the risk of land use management decisions continuing to contribute to the degradation of natural capital.

Key words

Land use planning; ecosystem approach; evaluation; Malawi Principles; ecosystem services.

Highlights

- Case study land use planning frameworks were evaluated using the Malawi Principles
- The cases present a reasonable interpretation of the ecosystem approach
- Poor consideration of biodiversity and environmental limits is a key concern
- There is an opportunity for further democratisation of land use planning processes

1. Introduction

Land use planning comprises multiple traditions and processes though it can be defined broadly as the allocation of land to different uses across a defined area in such a way that economic, social and environmental objectives are balanced (FAO, 2016). In the European Union (EU) for example, four major land use planning traditions have been defined (EC, 1997; Farinós Dasi *et al.*, 2007) determined by the complex of historic, cultural and social factors in each territory (Schmitt *et al.*, 2013). The scope and nature of a planning system determines its ability to affect land use change on the ground. In the EU, integrated systems that adopt formal hierarchies of plans linking national to local levels (e.g. Austria and Germany) are highly prescriptive whereas territories operating broad, regional economic planning based systems (e.g. France) pursue wider social and economic objectives in a less top-down fashion (EC, 1997; Farinós Dasi *et al.*, 2007). The integration of multiple objectives in land use planning also requires coordination across sectors and interests (FAO, 2016) necessitating stakeholder and public participation in planning processes (Bourgoin and Castella, 2011; NAFRI, 2012). Furthermore, the use of *ex-ante* assessments in land use planning, such as Strategic Environmental Assessment (SEA), can help planners and stakeholders to evaluate the likely impacts of their plans and provide a platform for participation activities (Geneletti, 2012).

Despite the plethora of land use planning policies and systems in operation globally (and in regions such as the EU), global land use change, whilst enabling humans to utilise the planet's resources as constituents of wellbeing, is undermining the capacity of ecosystems to sustain ecosystem service (ES) flows (Foley *et al.*, 2005; Schröter *et al.*, 2005; MA, 2005). In consequence, much attention has been given in policy and research to concepts, tools and processes for sustainable land use planning, including consideration of ES and the ecosystem approach (CBD SBSTTA, 2000; CBD Secretariat, 1998; Viglizzo *et al.*, 2012; EC, 2013a; von Haaren *et al.*, 2016). The ecosystem approach is cited as the primary framework for action under the Convention on Biological Diversity (CBD), defined as "a strategy for the integrated management of land, water and living resources that promotes sustainable use in an equitable way" (CBD SBSTTA, 2000). It has its origins in pre-existing management concepts such as ecosystem-based management and community-based conservation (Waylen *et al.*,2015a), however, its key innovation is combining the need to manage nature in terms of dynamic ecosystems whilst involving people in decision-making (Waylen *et al.*, 2014; Waylen *et al.*, 2015b). The approach has also been mentioned in various government policies and supporting documents including in the UK where this research took place (section 2); e.g. policies published by the Department for Environment, Food and Rural Affairs (e.g. Defra, 2007; 2011) and the Welsh and Scottish Governments (Welsh Government, 2011; Scottish Government, 2011; 2016).

Providing a structure for the approach, twelve principles were proposed and subsequently adopted as part of a workshop on the ecosystem approach held in Lilongwe, Malawi in 1998 (CBD Secretariat, 1998). The Malawi Principles (as they became known) are the tenets of the ecosystem approach, providing a framework for ecosystem managers and stakeholders (Table 3). Their generalised nature is such that they are relevant in a wide variety of planning and decision contexts where ecosystems may be impacted (Korn *et al.*, 2003). This holds true for land use planning where decisions can affect ecosystems and ES flows in various ways and at multiple scales (Foley *et al.*, 2005; Schröter *et al.*, 2005; Geneletti, 2012). There may also be key areas of complementarity between good-practice land use planning and the Malawi Principles; e.g. promoting participatory processes, encouraging integrated approaches and using *ex-post* monitoring and evaluation to inform adaptive management (Waylen *et al.*, 2014; Waylen *et al.*, 2015b).

We suggest, therefore, that there is a clear rationale for adopting the ecosystem approach in land use planning and, specifically, using the Malawi Principles as a framework to guide planning and decision-making processes. Indeed, this is a requirement of policy in devolved nations in the UK: (1) the Scottish Land Use Strategy (LUS) embodies ecosystem approach principles (Scottish Government, 2011; 2016) and plays a formalised role in statutory planning (Phillips *et al.*, 2014); and (2) the Environment (Wales) Act 2016 has a delivery framework for sustainable management of natural resources requiring joined-up policy making, including for land use, in line with the principles of the ecosystem approach (Welsh Government, 2016a; 2016b). There is a less explicit requirement to adopt the ecosystem approach in English planning via the National Planning Policy Framework (DCLG, 2012). Further, land use planning has been identified by UK stakeholders as an area where the approach could be used to great benefit (Howard *et al.*, 2013). However, there are limited empirical cases or evaluations of ecosystem approach based land use planning from which lessons can be drawn (Korn *et al.*, 2003; Howard *et al.*, 2013; Waylen *et al.*, 2013; Phillips *et al.*, 2014). For example, von Haaren *et al.* (2016) discuss the role of ES in spatial and landscape planning though from a primarily theoretical perspective and with a focus on ES values and public participation (but limited consideration of impacts on natural systems). Brody (2003) evaluated local land use plans in Florida against ecosystem management principles, missing out the 'involving people' aspects of the ecosystem approach. Also, whilst Korn *et al.* (2003) and Waylen *et al.* (2013) describe several ecosystem approach case studies, cases tend to be ecosystem specific (e.g. upland, wetland), conservation focussed and/or address relatively small areas (e.g. discrete catchments).

The limited availability of empirical cases is unsurprising as adopting the ecosystem approach is likely to be a challenging undertaking (Waylen *et al.*, 2013; 2014) and existing research efforts to help operationalise the approach have focussed on specific aspects only; e.g. using the ES concept to help embed nature explicitly into planning processes and outcomes (Scott *et al.*, 2014), which could be at the expense of other aspects, such as scale issues and public participation. Also, in agreement with Howard *et al.* (2013), we see integrated land use management planning at scale (i.e. regions encompassing multiple discrete ecosystems/landscapes) as a key opportunity area for the ecosystem approach. In this research, therefore, we were interested in critically evaluating the degree to which example regional level land use planning frameworks have the potential to adopt all aspects of the approach, as per the twelve Malawi Principles. Accordingly, the overall objectives of this case study research were to: (1) identify existing regional land use planning frameworks that could have potential to operationalise the ecosystem approach and evaluate their utility in this regard; and (2) identify the main strengths and weaknesses of the frameworks reviewed to inform wider practice. We have used the Malawi Principles as our evaluation framework.

The following section describes the methodology including a summary of the case study selection process and the cases themselves. Section 3 then outlines the results of the evaluation structured by the research questions addressed. Section 4 discusses the results and considers the implications of the findings for land use planning practice elsewhere. Finally, section 5 draws some conclusions.

2. Methodology

2.1 A case study approach

This research evaluated three UK case study land use planning frameworks for their potential to operationalise the ecosystem approach and deliver sustainable land use outcomes. As far as possible, cases were selected to be representative of other related planning frameworks. All cases exemplify broader categories of which they are members (Yin, 2009) hence the evaluation of each case study will have *some* wider relevance to other planning frameworks within its category (section 2.2). The case study approach also allowed land use planning (a process) to be explored in-depth, facilitating a full investigation of the nature and complexity of each case (Cresswell, 2009). A detailed analysis of each case study's potential to translate the 12 Malawi Principles into land use planning decision-making was undertaken along with an assessment of the methods used within the planning process.

The evaluation was inherently focussed on process aspects in that the document review method (section 2.4.1) targeted plan documents and planning related evidence reports; i.e. 'outputs' in evaluation terms (HM Treasury, 2011). Accordingly, the results only provide an indication of the case study's *potential* to deliver sustainable land use outcomes. Outcome (summative) evaluation is therefore a key area for future research (section 4.4).

2.2 Case study selection

Four criteria were used to select the case studies. This ensured that all cases consistently exhibited several key characteristics in line with the overall research objectives (section 1). Each case study was required to demonstrate the following:

1. *Ecosystem approach:* clearly exhibit consideration of some aspect(s) of the ecosystem approach, either explicitly or implicitly[1]. This ensured that the cases were relevant to the research objectives and therefore that useful data could be collected;
2. *UK based:* the case study research described in this paper was undertaken as part of a wider UK (Scotland) based research project that developed a new methodological framework for demand-led urban land use planning using ES 'coldspot' mapping (Phillips, 2014). The UK context was therefore critical to ensure that findings from the case study review (e.g. strengths and weaknesses) could usefully inform this new framework;
3. *Good availability of documentary evidence*: data collection focussed on document review (section 2.4) so access to adequate sources (in terms of number and quality) was vital; and
4. *Exhibiting a degree of representativeness:* cases were selected where it was clear that they fit within a broader category of land use planning frameworks, the intention being that the research would have a degree of generalisability, informing wider planning practice.

Using the criteria above, three case study land use planning frameworks were selected: (1) THESAURUS – Thames Gateway Ecosystem Services Assessment Using Green Grids and Decision Support Tools for Sustainability; (2) EERA – East of England Regional Assembly Environmental Limits Mapping Project; and (3) GNOM – Glasgow and Clyde Valley Green Network Opportunities Mapping. Table 1 provides summary information on each of the case studies. Appendix 1 provides more detail.

[1] Readers should note that none of the cases assessed explicitly adopted an ecosystem approach. Certain aspects were adopted explicitly (e.g. ecosystem assessment). Implicit aspects were teased out and evaluated using criteria (Table 3).

155 **Table 1: Introduction to the case studies**

Case study	Location	Aims and remit	Representativeness	Further reading
THESAURUS	Thames Valley, South-east England (Kent).	Identify ES provided by existing green infrastructure; integrate ES with existing planning frameworks (Local Plan, Green Grid Strategy).	Indicative of how an ecosystem approach could be adopted to Local Plans and green infrastructure strategy in England within the overall context of the Town and Country Planning Act 1990.	Kent Thameside Green Grid Strategy Defra THESAURUS project reports
EERA	Haven Gateway, South-east England (Essex).	Assist spatial planning in the East of England Region by taking account of environmental capacity issues; ensure that the proposed scale and location of growth in the Regional Spatial Strategy (RSS) does not exceed environmental capacity in the Region.	Indicative of how an ecosystem approach could be adopted to Regional Spatial Strategies (now abolished) within the overall context of the Town and Country Planning Act 1990 and the Planning and Compulsory Purchase Act 2004.	East of England Regional Spatial Strategy (archived) Environmental Capacity in the East of England: Applying an environmental limits approach to the Haven Gateway
GNOM	Glasgow and the Clyde Valley city region, South-west Scotland	Prioritise and inform investment in ecosystems and ES through the Local Development Plan (LDPs) and development management processes; inform land use management intervention that enlarges habitat networks and increases public access to greenspace.	Indicative of how an ecosystem approach could be adopted to LDPs and green infrastructure strategy in Scotland within the overall context of the Town and Country Planning (Scotland) Act 1997 and the Planning etc (Scotland) Act 2006.	Glasgow and the Clyde Valley Strategic Development Plan Green Network Spatial Priorities report Glasgow and Clyde Valley Green Network Partnership Opportunities Mapping pages

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157 The cases are all illustrative of the wider land use planning context in the UK which is underpinned by
158 various primary legislation, notably the Town and Country Planning Act 1990 which regulates the
159 development of land in England and Wales and the Town and Country Planning (Scotland) Act 1997
160 which does the same in Scotland. However, they also illustrate specific categories within this overall
161 UK context: 1) THESAURUS relates to green infrastructure planning as part of the Local Plan process
162 in England; 2) EERA is illustrative of the now abolished Regional Spatial Strategy (RSS) mechanism
163 which was used in England, though it could also depict other strategic regional mechanisms such as
164 the proposed regional Land Use Framework mechanism in Scotland (Kirkup *et al.*, 2016); and 3) GNOM
165 is an example of green infrastructure planning as part of the Local Development Plan (LDP) process in
166 Scotland. There are various other categories of land use planning framework that could have been
167 considered; e.g. Strategic Development Plans (SDP) in Scotland (Scottish Government, 2015), or Area

of Outstanding Natural Beauty (AONB) Management Plans (Countryside and Rights of Way Act 2000) in England and Wales. However, the objective for case study selection was to meet the four criteria listed above; criteria (1) and (3) are not always evident across examples of the other categories that can be found. This is important for future research however (section 4.4). It is also noteworthy that the primary legislation on planning matters above does not include any ecosystem approach provisions (explicitly or implicitly). However, other aspects of planning policy, especially in Scotland and Wales, do adopt the ecosystem approach (section 1).

2.3 Research questions

Informed by the issues and objectives outlined at section 1, the following research questions were used to focus the data collection and analysis:

- To what degree have the Malawi Principles been considered in the case study land use planning frameworks? Which Principles have been considered?
- What types of method/approach have the case study land use planning frameworks used to consider and integrate the Malawi Principles in their land use planning?
- What are the main strengths, weaknesses, opportunities and threats of the example land use planning frameworks in terms of how they have operationalised the Malawi Principles?

2.4 Data collection and analysis methods

2.4.1 Identifying documentary evidence for the review

The data collection method used in the research was criteria based document review. The availability of suitable documentary evidence was a key criterion for case study selection (section 2.2; Appendix 1). Case study documentation was identified through: 1) internet searches; 2) reviewing organisation websites; and 3) contacting named individuals to access internal or unpublished documents. The documents reviewed in the research (n=14) are listed at Table 2. Internet searches were implemented in Google using targeted search terms relating to the three case studies (e.g. Kent Thameside Green Grid AND strategy).

Table 2: Documentary evidence reviewed in the evaluation

Case study	Documents reviewed
THESAURUS	1. Kent Thameside Green Grid Strategy (Kent Thameside, 2006) 2. THESAURUS Research Project Final Report (Defra, 2008) 3. THESAURUS Strategic Study Report (CEP and GeoData Institute, 2008a) 4. THESAURUS Local Study Report (CEP and GeoData Institute, 2008b) 5. Spatial representation and specification of ecosystem services: a methodology using land use/land cover data and stakeholder engagement (Sheate *et al.*, 2012)
EERA	6. Environmental Capacity in the East of England Appendix 1: Draft Stage 1 Topic Reports (LUC, 2007a) 7. Environmental Capacity in the East of England Draft Stage 1 Report (LUC, 2007b) 8. Environmental Capacity in the East of England Stage 2 Report (LUC, 2007c) 9. Environmental Capacity in the East of England Stage 3 Report (LUC, 2007d) 10. Environmental Capacity in the East of England: Applying an environmental limits approach to the Haven Gateway (LUC, 2008)
GNOM	11. GCV Strategic Development Plan Background Report 08 Green Network Spatial Priorities (GCVSDPA, 2011)

Case study	Documents reviewed
	12. Strategic opportunities for the delivery of the green network: presentation to Glasgow City Council (Hislop, 2011) 13. West Dunbartonshire Green Network Opportunities Mapping Draft Interim Report V1 (GCV Green Network Partnership, 2011) 14. Green networks for people opportunity mapping methodology (GCV Green Network Partnership, undated)

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195 *2.4.2 Extracting data from documentary evidence*

196 A suite of review criteria (Table 3) was developed based on the 12 Malawi Principles (section 1). The
197 Principles have been categorised, and re-ordered for the purposes of this study (i.e. to help structure
198 the evaluation results) though the original numbering (CBD Secretariat, 1998) has been retained. The
199 three categories (Table 3) relate to ecosystem approach policy in Scotland (Scottish Government,
200 2011) where the wider research project that this paper forms part of took place (Phillips, 2014). The
201 wording of the Principles has also been shortened. The acronym "EcA" refers to the "ecosystem
202 approach" (e.g. EcA1 refers to ecosystem approach Malawi Principle No.1). Malawi Principles EcA4
203 on ecosystems and the economic context and EcA10 on balancing conservation and use of biodiversity
204 have been included under the 'ecosystem services' category (Table 3). This is because both Principles
205 include explicit consideration of human use, which is closely linked to the conception of ES as the
206 direct and indirect benefits people obtain (i.e. use) from ecosystems (MA, 2005). There are arguments
207 for alternative categorisations (e.g. including EcA10 under 'management of natural systems' given its
208 focus on biodiversity), however, we suggest that our current categorisation is a useful starting point
209 for the analysis conducted. Each Principle was treated as a headline review criterion. Several detailed
210 criteria were then developed per Principle, phrased as questions. These provided the structure for
211 the document review and subsequent evaluation of the case study planning frameworks. The criteria
212 were used to interrogate and extract data from case study documentary evidence; each document
213 was reviewed against the criteria and relevant excerpts were collected in a data extraction form.
214 Excerpts were "tagged" to denote relevance to specific criteria and notes were made highlighting how
215 the documentary evidence supports and/or works against the Malawi Principles, as informed by the
216 review criteria. None of the case studies *explicitly* considered the ecosystem approach or the Malawi
217 Principles, rather, their implicit consideration was teased out using the review criteria.

218 *2.4.3 Evaluating the case studies against the Malawi Principles*

219 For the overall evaluation of the case study planning frameworks against the Malawi Principles, data
220 collected via the process described above was reviewed against each Principle and its associated
221 review criteria (Table 3). This identified evidence (or not) of where/how each criterion was met by
222 the case study. Using a qualitative scoring approach after Phillips *et al.* (2014), we then assessed the
223 degree to which each Principle had been considered by the case study, as evidenced by the data
224 collected (section 2.4.2) from the documents reviewed (Table 2). This assessment used a three-point
225 scale: (1) Principle considered fully; (2) Principle considered partially; and (3) Principle not considered.
226 A fourth category was also used, "consideration unknown", for instances where there was a lack of
227 clear and conclusive evidence rather than a complete absence of evidence, as per category (3). Our
228 assessment was based on the following rationale: the more criteria per Principle evidenced in the case
229 study documentation, the more effectively the Principle had been considered. Overall therefore, the
230 more Principles met by a case study, the greater its potential to operationalise the ecosystem
231 approach in land use decision-making and deliver sustainable land use outcomes. The qualitative use
232 of criteria in this regard is well-established in evaluation science (Pawson, 2013), both in terms of *ex-*

233 *ante* assessments like SEA (Therivel, 2010) and *ex-post* evaluations (HM Treasury, 2011; EC, 2016).
234 Method limitations are discussed at section 4.4. The qualitative assessment was summarised in a
235 matrix using colour coded cells to indicate the degree to which each Principle had been considered.
236 Looking across all three cases and all evidence collected, the overall evaluation results were then
237 summarised using a SWOT (strengths, weaknesses, opportunities and threats) analysis. The objective
238 was to assess and summarise the strengths, weaknesses etc of the three case study planning
239 frameworks in terms of their ability to operationalise the ecosystem approach, providing an outlook
240 for ecosystem approach based land use planning (particularly in a UK context). The authors
241 collectively reviewed the evaluation evidence and 'brainstormed' potential findings for the SWOT.
242 This initial draft SWOT was refined iteratively to produce the final analysis.

243 **Table 3: Evaluation review criteria based on the Malawi Principles**

Malawi Principle	Detailed review criteria
Theme 1: Management of natural systems	
EcA3: Consider effects on adjacent ecosystems	• Does the framework define ecosystems or landscapes? • Does the framework operate at a spatial scale such that it is likely to encompass multiple ecosystems? • Does the framework consider the effects of land use/management on adjacent ecosystems, either implicitly or explicitly?
EcA5: Conserve ecosystem structure and function	• Does the framework discuss ecosystem processes/intermediate services? • Does the framework discuss ecosystem structure? • Does the framework include specific methodologies for evaluating land use/management impacts on ecosystem structure and function?
EcA6: Ecosystem management must respect environmental limits	• Does the framework refer to environmental limits? • Does the framework define specific environmental limits (e.g. for environmental state or ES indicators)? • Does the framework include specific methodologies for evaluating land use/management impacts on environmental limits?
EcA7: Adopt the ecosystem approach at appropriate spatial and temporal scale	• Does the framework work at the ecosystem or landscape scale? • What is the rationale for spatial delineation of the area of land encompassed by the framework (e.g. based on administrative boundaries or natural features)? • Is the temporal scope of the framework sufficient such that ecosystem restoration projects can be planned and delivered effectively?
EcA8: Set long-term objectives for ecosystem management	• Does the framework set long term objectives (e.g. >10 years)? • Does the framework discuss the varying temporal scales and lag effects that characterise ecosystem processes and their restoration?
EcA9: Ecosystem management must recognise that change is inevitable	• Does the framework recognise the dynamic nature of landscapes and ecosystems? • Does the framework discuss how change is inevitable?
Theme 2: Ecosystem services	
EcA4: Understand and manage the ecosystem in an economic context	• Does the framework discuss the costs and benefits associated with land management for different objectives? • Does the framework attempt to integrate non-market values of ES with decision-making?

Malawi Principle	Detailed review criteria
	• Does the framework consider how grants, incentives and regulation can be used to influence land use/management objectives (including private objectives)?
EcA10: Ensure an appropriate balance between conservation and use of biodiversity	• Does the framework have an overarching objective on the conservation of biodiversity? • Does the framework seek to balance the use and conservation of biodiversity? • Does the framework employ a specific mechanism in place to help balance the conservation and use of biodiversity?
Theme 3: Involving people	
EcA1: Objectives for ecosystem management are a matter of societal choice	• Does the framework seek to engage the public and affected communities in land use/management decision-making? • Does the framework employ specific consultation and engagement techniques?
EcA2: Ecosystem management should be decentralised to the lowest appropriate level	• What steps does the framework take to decentralise land use/management planning to local levels? • Is there evidence of decentralisation of land use/management decision-making happening in practice?
EcA11: Consider all forms of relevant information including scientific/local knowledge, practice and innovation	• What steps does the framework take to glean knowledge and ideas from all sectors of society to inform land use/management decision-making? • Is there evidence of diverse information, innovation and practice informing decision-making?
EcA12: Involve all relevant sectors of society and scientific disciplines	As per EcA11.

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3. Results

Each of the three research questions (section 2.3) are answered in the sub-sections below: section 3.1 assesses the degree to which the Malawi Principles have been considered by the case studies; section 3.2 identifies the main methods/approaches used by the case studies to help integrate the Principles with planning processes; and section 3.3 presents a SWOT analysis of the case studies in terms of their ability to operationalise the ecosystem approach.

3.1 To what degree have the Malawi Principles been considered in the case study land use planning frameworks? Which principles have been considered?

3.1.1 Overall consideration of the Malawi Principles

Table 4 presents a summary of the evaluation of the three case study land use planning frameworks against the Malawi Principles. The full analysis is presented in Appendix 2. Overall, the evaluation indicates that consideration of the Principles is reasonable although the Principles were considered fully in only 22% of 'instances' (12 Malawi Principles and three case studies evaluated equates to 36 possible 'instances' where the Principles could have been considered). Principles were considered partially in 42% of instances and not at all in 33% (Figure 1).

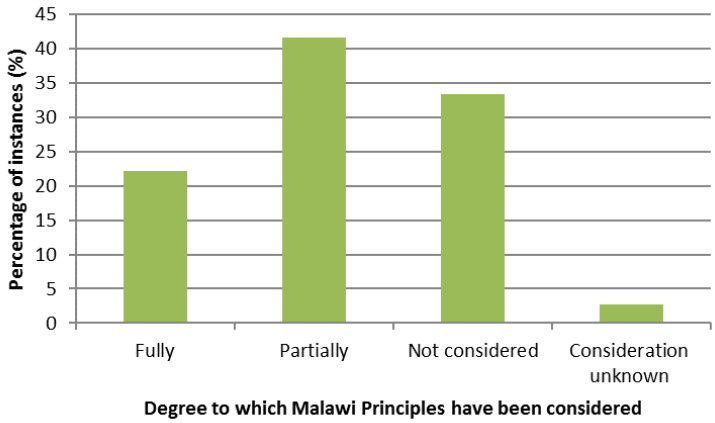

Figure 1: Degree to which Malawi Principles have been considered – percentage of instances across all three case studies

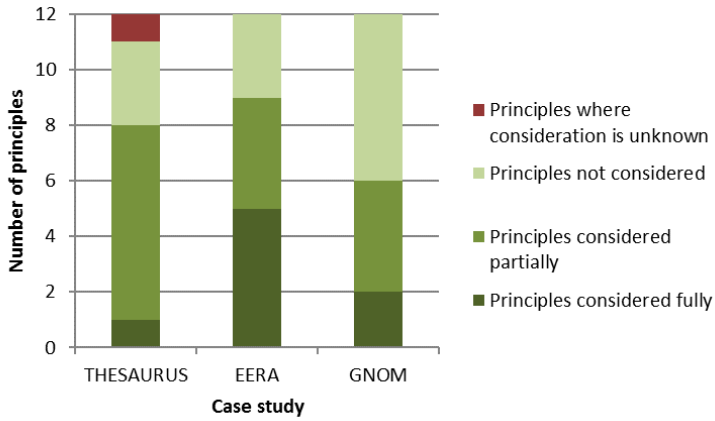

Figure 2: Degree to which individual case studies have considered the Malawi Principles

At the level of individual case study planning frameworks (Table 4 vertical analysis), EERA considered the Malawi Principles most comprehensively (five principles were considered fully and four partially) and GNOM the least (two Principles were considered fully and four partially). Whilst THESAURUS considered the least number of Principles fully (just one), seven Principles were considered partially. This is indicated on Figure 2.

3.1.2 Consideration of individual Malawi Principles

At the level of individual Malawi Principles (Table 4 horizontal analysis), several Principles have been considered fairly well by the case studies, namely: EcA3 on effects on adjacent ecosystems; EcA5 on ecosystem structure and function; EcA7 on appropriate spatial and temporal scales; and EcA4 on management of ecosystems in an economic context. These four Principles have been considered either partially or fully by all three case studies. However, several Principles were considered less well: EcA6 on environmental limits; EcA9 on the importance of ecosystem management recognising that change is inevitable; and EcA10 on balancing the use and conservation of biodiversity. These Principles have not been considered at all by at least two of the case studies. This is indicated on Figure 3. A further explanation of these findings is provided below.

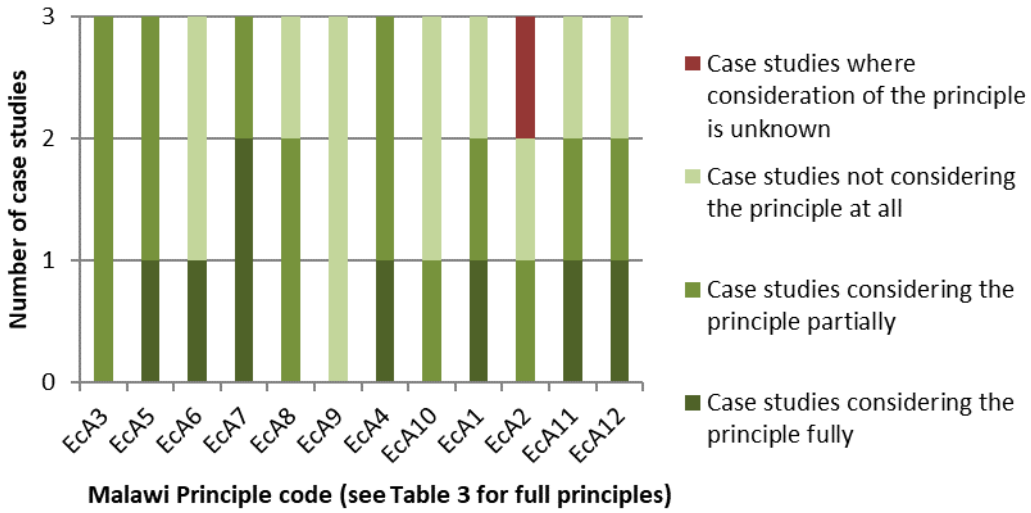

Figure 3: Degree to which individual Malawi Principles have been considered – number of instances across all three case studies

EcA7 on appropriate spatial and temporal scales has been considered most comprehensively by the three case study planning frameworks (Figure 3). All three are designed to operate at broad spatial scales (the region or sub-region) and planning at this scale means that key natural features are likely to be encompassed (e.g. large ecological networks, water catchments). Ecosystem scale planning in this regard means that the functional values of ecosystems can be meaningfully assessed (e.g. ecological connectivity, catchment wide hydrological cycle function). EERA and GNOM also operate at relatively broad temporal scales. In EERA's case, temporal scale issues are addressed by assessing pressures and trends on environmental indicators, the objective being to *"suggest the likely evolution of the current state of the environment"* (LUC, 2008 p.37). For GNOM, the framework is aligned to the statutory development planning process in Scotland, which undertakes planning across ten-year timeframes. THESAURUS makes no specific reference to temporal scale.

294 **Table 4: Evaluation of case study planning frameworks against the Malawi Principles – summary evaluation matrix**

Key to scoring		Case study land use planning frameworks			
Principle considered fully *Principle considered partially* *Principle not considered* *Consideration unknown*	**Malawi Principle**	**THESAURUS**	**EERA**	**GNOM**	**Summary comments**
Management of natural systems	EcA3: Consider effects on adjacent ecosystems				Principle considered to a degree only by all case studies; e.g. consideration of key transboundary ecosystem processes (THESAURUS) and broader scale issues beyond the study area boundaries (EERA).
	EcA5: Conserve ecosystem structure and function				Principle considered at least to a degree. THESAURUS considers the Principle fully through a comprehensive ES typology covering all ecosystem processes/intermediate services.
	EcA6: Ecosystem management must respect environmental limits				Mixed consideration. Environmental limits not considered by THESAURUS or GNOM. EcA6 type issues are the central premise of EERA where the Principle has been considered fully.
	EcA7: Adopt the ecosystems approach at appropriate spatial and temporal scale				Principle considered fully by EERA and GNOM both of which operate at a broad spatial scale (i.e. likely to encompass key natural features) and consideration of planning up to 10-year horizon.
	EcA8: Set long-term objectives for ecosystem management				Mixed consideration. Considered to a degree by EERA and GNOM but not considered by THESAURUS. For EERA and GNOM, similar issues apply as per EcA7.
	EcA9: Ecosystem management must recognise that change is inevitable				Poor consideration across all case studies; no explicit or implicit references found to EcA9 type issues in any of the material reviewed in the evaluation.
Ecosystem services	EcA4: Understand and manage the ecosystem in an economic context				Principle considered at least to a degree in all cases. GNOM considers the Principle fully; in particular, there is a strong emphasis on the role of the planning system delivering green network/ES.
	EcA10: Ensure an appropriate balance between conservation and use of biodiversity				Mixed consideration. EcA10 is not considered by EERA and GNOM. In particular, EERA places an emphasis on the potential substitutability of ES, including biodiversity.
Involving people	EcA1: Objectives for ecosystem management are a matter of societal choice				Mixed consideration. EERA considers EcA1 fully by focussing on socially based approaches to defining environmental limits. GNOM is designed to be implemented by GIS technicians/planners.
	EcA2: Ecosystem management should be decentralised to the lowest appropriate level				Mixed consideration. GNOM considers EcA2 to a degree through its focus on the economic realities of green network/ES delivery and consideration of local level delivery models.
	EcA11: Consider all forms of relevant information including scientific/local knowledge, practice and innovation				Mixed consideration. Similarly to EcA1, EERA considers this Principle fully. THESAURUS recognises that there are opportunities to consider wider information though this was not acted upon.
	EcA12: Involve all relevant sectors of society and scientific disciplines				Mixed consideration; similar issues to EcA11.

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EcA3 on effects on adjacent ecosystems has been considered partially by all three case studies. This Principle focusses on the role of ecosystem managers considering the effects of their activities on adjacent ecosystems. All three planning frameworks operate at the regional or sub-regional scale and, whilst none of the areas encompassed are delineated on the basis of ecosystem boundaries (e.g. water catchments, whole landscapes), they are of sufficient scale such that they are likely to encompass several ecosystems or natural features; e.g. multiple water catchments, contiguous areas of habitat network. As such, we suggest that all three cases have the *potential* to consider effects on adjacent ecosystems although there was no strong evidence within the documentary sources reviewed (Table 2) that this is taking place in practice.

EcA5 on the conservation of ecosystem structure and function was considered fully by THESAURUS and partially by EERA and GNOM. This Principle focusses on the functional aspects of ecosystems; i.e. the interaction of biotic and abiotic components (natural capital "assets") giving rise to ES "flows" (UN, 2014). THESAURUS includes a comprehensive assessment of ecosystem processes and intermediate services (e.g. hydrological cycle function and ecological networks) through the use of network analysis and spatial representation of ES at the land parcel level (section 3.2.1). EERA and GNOM are less comprehensive in this regard, focussing on one or two aspects of ecosystem function only; e.g. ecological networks (GNOM) or a very abiotic focus only (EERA).

EcA4 on management of ecosystems in an economic context was considered fully by GNOM and partially by THESAURUS and EERA. The GNOM case has a distinct focus on the economic drivers for sustainable land use initiatives (enhancement of the green network – see Appendix 1) including the need to "sell the benefits" to developers and decision-makers[2] and using spatial datasets on development and regeneration priorities in the analysis to identify areas of change where regulatory drivers (and potentially incentives) can be used to influence sustainable land use outcomes. Overall, GNOM has a strong focus on using the tools available within the statutory planning system (regulation and incentives) as a driver for delivering sustainable land use and enhanced ES. The THESAURUS case recognises how context can influence the value of ES (including monetary value) including costs associated with land management to ensure a desired level of service.

Several Principles were considered less well. EcA6 on respecting environmental limits was not considered at all by THESAURUS and GNOM though it was considered fully by EERA (this being the focus of the initiative). Poor consideration of EcA6 is particularly concerning given the importance of environmental limits for the sustainable management of land and other forms of natural capital (Haines-Young *et al.*, 2006) and its prevalence in policy at various levels (HM Government, 2005; EC, 2013b; Scottish Government, 2014). EcA9 on ecosystem management recognising that change is inevitable was not considered at all by any of the case studies. This is a critical issue for land use planning where adaptive management Principles should be built into policies and monitoring regimes in recognition of future uncertainty and the need to maintain flexibility. EcA10 on balancing the use and conservation of biodiversity was also considered poorly; it was considered partially by THESAURUS and not at all by EERA and GNOM. THESAURUS addresses biodiversity explicitly though there is no specific mechanism in place for balancing its use and conservation. EERA's poor consideration of EcA10 is particularly concerning as the approach emphasises transferability: *"opportunities to import, recreate or substitute the services [provided by the study area]"* (LUC, 2008 p.20). Any such transferability should not be applied to critical natural capital assets (e.g. biodiversity, water, soil) in order to maintain ecosystem resilience and sustain ES flows (Walker *et al.*, 2010).

[2] The impact of green infrastructure and environmental quality on commercial property values (the "green edge") has been assessed using hedonic pricing (Panduro and Veie, 2013) and is an area of ongoing research and policy-development (Clements *et al.*, 2013).

3.2 What types of method/approach have the case study land use planning frameworks used to consider and integrate the Malawi Principles in their land use planning?

The second evaluation question considered the methods and approaches used by the case studies within their land use planning activities; the rationale being that they can help to integrate the Malawi Principles. We define methods/approaches after Scott *et al.* (2014 p.19): *"specific mechanisms or methods that aid, influence or inform PPPP [policy, plan, programme or project] processes and outcomes"*. Drawing on the analysis in sections 3.2.1 - 3.2.3 and Appendix 2, Table 5 summarises the methods/approaches identified and their potential to help integrate the Malawi Principles. The assessment in Table 5 provides an initial indication only of the potential linkages/support between the methods in use by the case studies and their potential to help integrate the Principles. It is based on the authors' knowledge of land use planning processes (especially in the UK) and the results of the case study analysis at section 3.1. However, this is a key area for future research; e.g. undertaking summative evaluations (HM Treasury, 2011) of case study planning frameworks with and without the use of certain methods/approaches to try and isolate their effect on specific Principles (section 4.4).

Table 5: Land use planning methods/approaches utilised by the case studies and their potential to help integrate Malawi Principles with planning

KEY

✓✓ **Good potential to help integrate the Principle**

✓ **Some potential to help integrate the Principle**

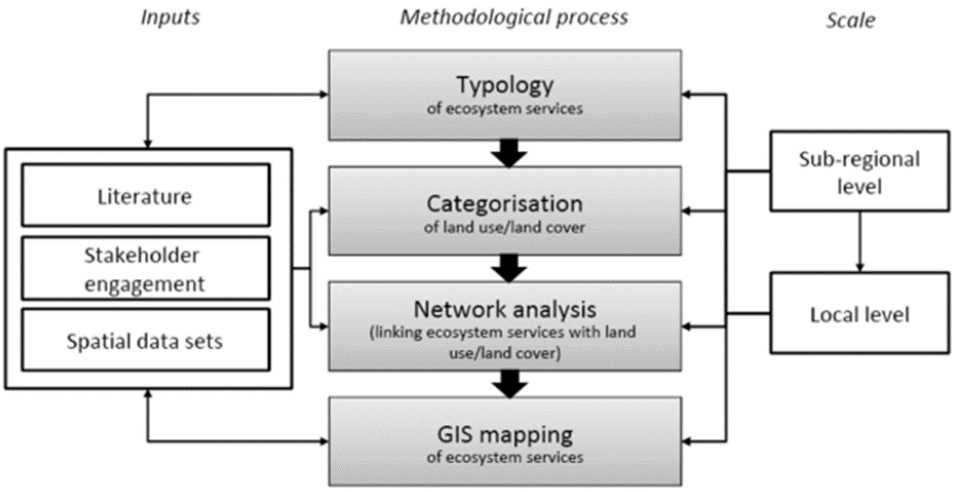
Method/approach utilised by the case study	**Malawi Principle (see Table 3 for full Principles)**											
	EcA3	**EcA5**	**EcA6**	**EcA7**	**EcA8**	**EcA9**	**EcA4**	**EcA10**	**EcA1**	**EcA2**	**EcA11**	**EcA12**
Methods/approaches utilised by THESAURUS												
1. Use of a "place-based" approach to define natural capital assets and flows in the plan area	✓	✓✓	✓	✓✓	✓✓	✓	✓✓	✓✓	✓✓	✓	✓	✓
2. Two-tiered approach to developing a place specific ES typology	✓	✓✓	✓	✓	✓	✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
3. Combined land use/cover and causal variable based mapping of ES proxies	✓✓	✓✓	✓	✓	✓	✓	✓	✓✓	✓✓	✓✓	✓	✓
Methods/approaches utilised by EERA												
4. Environmental limits mapping for key natural capital assets	✓✓	✓✓	✓✓	✓✓	✓✓	✓	✓	✓	✓✓	✓	✓✓	✓✓
5. Literature and stakeholder based characterisation of ES flows and pressures in the plan area	✓	✓✓	✓✓	✓	✓	✓	✓	✓✓	✓✓	✓	✓✓	✓✓
6. Using environmental limits mapping to refine existing environmental planning tools	✓✓	✓✓	✓✓	✓	✓	✓	✓	✓✓	✓✓	✓	✓✓	✓✓
Methods/approaches utilised by GNOM												

Method/approach utilised by the case study	Malawi Principle (see Table 3 for full Principles)											
	EcA3	EcA5	EcA6	EcA7	EcA8	EcA9	EcA4	EcA10	EcA1	EcA2	EcA11	EcA12
7. GIS based opportunities mapping for sustainable land use	✓✓	✓	✓	✓✓	✓✓	✓	✓✓	✓✓	✓✓	✓	✓✓	✓✓
8. Close integration with statutory land use delivery mechanism	✓✓	✓	✓	✓✓	✓✓	✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓

356

357 *3.2.1 THESAURUS – key methods/approaches*

358 The evaluation of THESAURUS identified three key aspects of methodology (Table 5). An overview of
359 THESAURUS' approach is shown at Figure 4. Firstly, a "place-based" approach was used as an overall
360 framing to define an ES typology for the study area. This approach was proposed in a related Defra
361 research project (Haines-Young and Potschin, 2008) as a means of taking an integrated view of
362 habitats, ES and their interrelationships, within a defined area. It also defines the stakeholders and
363 communities affected by decisions, linking to the *involving people* Principles. THESAURUS recognised
364 that the approach must be tailored to the specific decision-making context; urban/peri-urban land use
365 planning at the sub-regional scale. In particular, it was important to *"express the ecosystem services*
366 *identified in a language and context familiar to planners"* (Sheate *et al.*, 2012 p.8). Accordingly,
367 openspace categories from extant planning policy were used as the unit of analysis for ES assessment;
368 these were familiar to planners and land use/cover data for these categories was available at a suitably
369 granular scale for sub-regional analysis.



370

371 **Figure 4: THESAURUS – overall methodological approach** (Source: Sheate *et al.*, 2012)

372 Secondly, aligned with the overall place-based approach, THESAURUS adopted a two-tiered approach
373 to developing an ES typology for the study area (indicated on the left of Figure 4). A typology in this
374 regard *"describes and categorises the ecosystem services provided in [a study] area"* (Sheate *et al.*,
375 2012 p.7), recognising that the range and type of services provided will be place specific. The typology
376 development involved two steps: (1) literature review; and (2) stakeholder engagement. The
377 literature review considered wider and locally relevant literature; the former (e.g. national ecosystem
378 assessments) helped to define a generic typology which was then refined by the latter (e.g. local

planning frameworks, community surveys). Stakeholder engagement then further validated the literature defined typology. Both steps support key ecosystems approach Principles, especially EcA11 on considering all forms of relevant information.

Thirdly, THESAURUS visually represented the ES identified in the typology exercise using a Geographic Information System (GIS) *"so that planners could see which areas were likely to provide which services"* (Sheate *et al.*, 2012 p.15). Using GIS to map ES in this manner can provide a useful visual depiction of the benefits and potential multifunctionality (where multiple services coincide) of existing land use/cover (Figure 5). THESAURUS mapped proxy ES using a combination of land cover data and causal variables which are the spatial-contextual factors that influence the importance of a given ES, in a given location (Eigenbrod *et al.*, 2010). Incorporating causal variables like this can improve the quality of a basic land cover proxy (ibid); a key innovation within THESAURUS was the identification of causal variables for all ES identified through the typology exercise.

3.2.2 EERA – key methods/approaches

The evaluation of EERA identified three key aspects of methodology (Table 5). Firstly, EERA has developed a workable methodology for mapping environmental limits for several natural capital assets. This includes: (1) defining indicators; (2) identifying suitable datasets; and (3) determining environmental limits for each asset considered (with stakeholder input). The mapped outputs are 1km x 1km cells with a binary "acceptable" or "unacceptable" score in terms of the environmental limit for the asset considered (Figure 6). These maps have clear utility informing spatial planning as per EERA's objectives; development should be avoided in areas where the status of natural capital assets is unacceptable and/or appropriate restoration or mitigation action should be taken first.

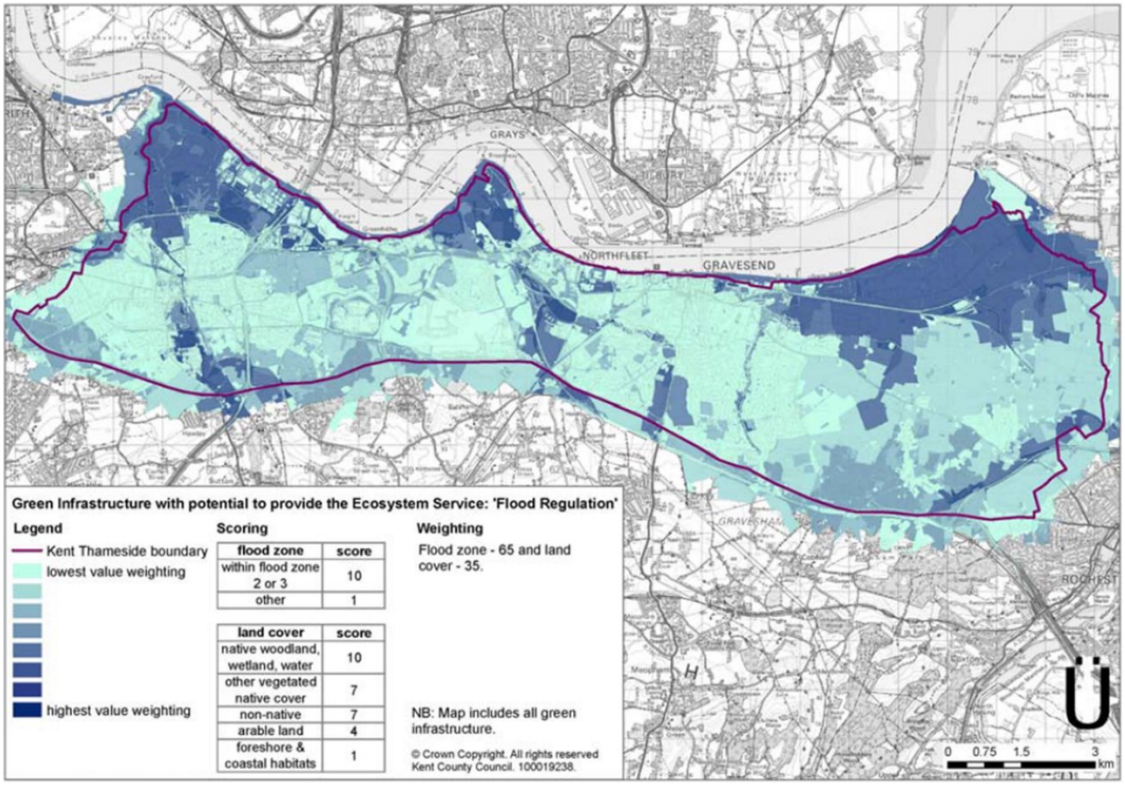


Figure 5: THESAURUS – flood regulation proxy ecosystem service map (Source: CEP and GeoData Institute, 2008a)

Secondly, EERA developed a literature and stakeholder based characterisation[3] of the ES flows provided by various natural capital assets (e.g. water, air, landscapes, biodiversity) and linked these various components of natural capital to drivers and pressures that can affect their extent and condition (e.g. climate change, land take, population growth). Land use related mitigation responses to the pressures are also identified as an input to planning processes and tools (see below).

Thirdly, following the natural capital characterisation above, EERA is designed to add value to SEAs of land use plans by helping to determine the significance of environmental effects. Specific links are made between natural capital assets, ES flows and environmental limits and the pressures that can affect these. Where the SEA identifies the potential for spatially explicit environmental effects (pressures), these are linked to environmental limits maps (Figure 6) to help determine effect significance enabling *"more spatially specific conclusions to be drawn about where within the plan area environmental mitigation may be required, and for which [assets] and service"* (LUC, 2008 p.14). EERA's alignment with SEA may also support the delivery of *involving people* related Malawi Principles (Tables 3 and 5) as the process of defining environmental limits in EERA is predicated *"[not just on] scientific knowledge but also local perceptions of the relative value of environmental features or benefits"* (ibid). In essence, the SEA and environmental limits mapping are mutually supportive; the former provides a public engagement platform for the latter (via statutory consultations) whilst the latter adds robustness to the former.

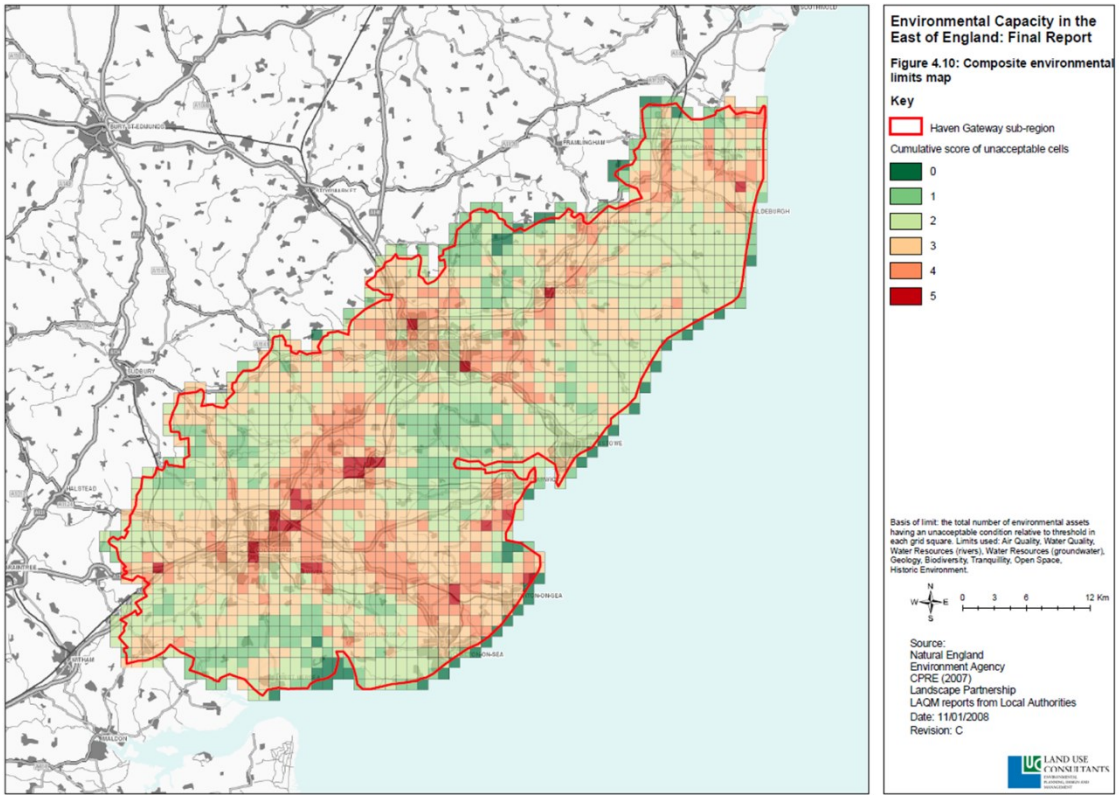


Figure 6: EERA – composite environmental limits map (Source: LUC, 2008)**. Note:** Figure 6 is an overlay of all individual environmental limits maps produced in EERA. The cumulative score of "unacceptable" cells is calculated in GIS for each cell; the higher the cumulative score (dark red cells), the lower the environmental capacity and *vice versa*.

[3] This is similar to the "two-tiered typology" method from in THESAURUS (section 3.2.1) although the objective is different.

3.2.3 GNOM – key methods/approaches

The evaluation of GNOM identified two key aspects of methodology (Table 5). Firstly, a GIS based method was developed that identifies spatial opportunities for enhancing green network sites[4] and associated ES. The overall objective is to identify spatial priorities for targeting green network investment. This is achieved using spatial datasets and weighted raster overlays to answer spatial queries concerning: (1) the available green network resource; and (2) its functionality in terms of key ES. GNOM's analysis considers ecological connectivity and recreation/active travel as key functions of the green network. Shortfalls in both of these services are assessed as green network priorities; i.e. spatially defined gaps in provision highlighting demand for additional green network (Figure 7).

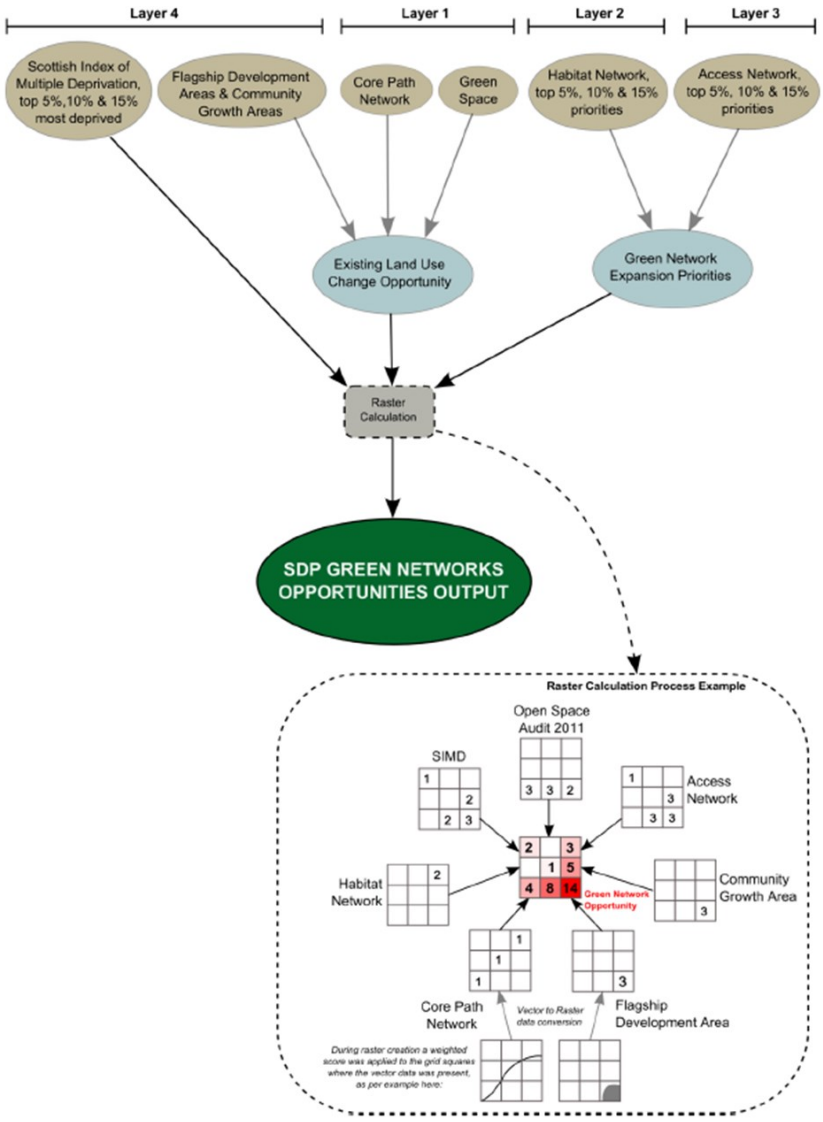


Figure 7: GNOM – GIS methodology schematic (Source: GCVSDPA, 2011). **Note:** Each layer in the raster analysis can be weighted to focus the analysis on different priorities (e.g. ecological networks vs. socio-economic deprivation). The final output is a weighted priority score; the higher the score the greater the priority for green network investment in that cell/area.

[4] The GNOM delivery partnership defines the green network as: *"a strategic programme of greenspace enhancements designed to promote healthier lifestyles, better environments, greater biodiversity, stronger communities and economic prosperity"*: http://www.gcvgreennetwork.gov.uk/ [accessed 12/09/16]

The analysis also considers drivers of land use change: (1) existing poor-quality greenspace; (2) sites zoned for development; and (3) areas experiencing high levels of socio-economic deprivation. The intention is that well-designed green network intervention can help to address these issues whilst delivering multiple benefits. As per Figure 7, GNOM's weighted raster overlays assess all input datasets to determine an overall priority score for each cell. These scores then feed into formal land use planning processes.

Secondly, the GNOM approach is designed to be fully integrated with statutory land use planning processes in Scotland; specifically, Local Development Plans (LDP) as per the Planning etc (Scotland) Act (2006). The Scottish planning system is "plan-led" whereby development plans set out how places should change in the future. LDPs set out where most new developments will happen at the local level and policies to guide decision-making on planning applications (Scottish Government, 2015). GNOM outputs are designed to inform the LDP-development process, feeding into the draft plan at an early stage to help set strategic priorities for green network intervention. The statutory planning system is then used as a strong (legal) mechanism for green network delivery; e.g. as a condition of planning consent, developers are required to deliver relevant green network projects within/near their development (e.g. active travel infrastructure, habitat creation, sustainable urban drainage). This aspect of GNOM is particularly relevant to EcA4 on understanding and managing the ecosystem in an economic context; GNOM demonstrates a critical awareness of the need to use economic levers (development) to deliver sustainable land use outcomes.

3.3 What are the main strengths, weaknesses, opportunities and threats of the example land use planning frameworks in terms of how they have considered and integrated the Malawi Principles?

This section synthesises the results through a SWOT analysis (strengths; weaknesses; opportunities; threats) at Table 6 and considers the implications for practice elsewhere. A main finding from the SWOT is that the cases analysed exhibit more strengths than weaknesses. This reflects their assessment against the Malawi Principles whereby Principles were incorporated at least "partially" in 64% of instances (Figure 1). Key strengths relate to: (1) using specific methods and approaches to communicate findings from ecosystem assessments effectively; (2) using stakeholder input to refine and validate technical modelling and assessments; and (3) some good consideration of ecosystem processes (functional values). A key theme within the identified strengths is their relevance to the *involving people* category of Malawi Principles (Table 3). The main weaknesses identified relate to poor consideration of environmental limits (EcA6) and biodiversity (EcA10). Inadequate consideration of biodiversity in planning may mean that this critical component of natural capital is eroded through poor land use management decisions (e.g. sustained loss of natural and semi-natural habitats). Effective consideration of environmental limits could provide a "backstop" to protect critical natural capital though this is absent in two of the three cases.

Related to these strengths and weaknesses, there are also several opportunities and threats that should be considered in the development of land use planning policy and practice (Table 6). This is particularly true for the case studies considered in this research and their broader categories (section 2; Table 1; Appendix 1), however, they are also likely to be important considerations for land use planning practice elsewhere. In terms of strengths, firstly, the focus on stakeholder engagement and the *involving people* Malawi Principles (Table 3) arguably creates an opportunity for further democratisation of land use planning processes. Deliberative engagement with stakeholders and affected communities at key decision-making junctures can improve decision outputs (e.g. plans and policies) and enhance accountability (Bourgoin and Castella, 2011; NAFRI, 2012). Furthermore, formal *ex-ante* assessment procedures (e.g. SEA) can provide a mechanism for this engagement (Geneletti, 2012) and there are many examples of deliberative, participatory land use planning in practice (e.g.

Brown, 2005; Raymond *et al.*, 2009; Phillips *et al.*, 2016). Secondly, there is an important opportunity to improve consideration of temporal scale in planning (EcA7). Whilst spatial scale was considered effectively in all cases, planning timeframes were generally insufficient to identify and facilitate ecosystem restoration which can take many 10s – 100s of years, requiring a much longer-term approach (Bennett *et al.*, 2015). Finally, as all three cases undertook some form of proxy based ecosystem assessment/mapping there is an opportunity to improve the accuracy of outputs and subsequent decisions by using better indicators and data (Eigenbrod *et al.*, 2010). The most critical threat identified relates closely to poor consideration of biodiversity and environmental limits (a key weakness) and the subsequent risk of land use management continuing to drive the degradation of natural capital assets (Schröter *et al.*, 2005; Foley *et al.*, 2006). This is particularly important in relation to recent assessments of status, trends and pressures on natural capital at global and European levels; e.g. in Europe the continued loss, fragmentation and degradation of natural and semi-natural habitats is being driven by land use management issues related to urban sprawl, agricultural intensification and intensive forestry practices (EEA, 2015a).

501 **Table 6: SWOT analysis of case study land use planning frameworks in terms of their ability to operationalise the ecosystem approach**

Strengths	Weaknesses
• **Relatively comprehensive consideration of ecosystem processes and intermediate services:** EcA5 focusses on conserving ecosystem function; i.e. maintaining the natural capital assets that underpin ES flows. THESAURUS considered all relevant aspects of ecosystem function through a network analysis approach. EERA and GNOM both considered some aspects though less comprehensively. • **Effective consideration of spatial and temporal scale:** EcA7 requires the ecosystem approach to be adopted at appropriate spatial and temporal scales. All three cases considered spatial scale effectively. EERA and GNOM considered temporal scale relatively well. • **Disaggregating the natural environment using management units familiar to planners:** THESAURUS disaggregated the natural environment into discrete spatial units for planning and management purposes (green land parcels). • **Use of qualitative stakeholder input to validate quantitative modelling:** all three cases used aspects of spatial analysis and ecosystem assessment. The expert-led nature of these methods means that less-technical stakeholders (e.g. local communities) can be excluded from participation. THESAURUS and EERA incorporated an explicit stakeholder engagement stage to validate key aspects of the modelling, supporting EcA1, 11 and 12. • **Visual presentation of land use management issues to communicate key messages:** all three cases visually presented spatial data/results to communicate important messages to decision-makers; e.g. THESAURUS used ES maps to demonstrate different values of existing land use. • **Using a multi-staged, mixed methods approach to refine proxy based methods for ES assessment:** land cover based proxies can be used in the absence of suitable primary data to map ES however they provide only poor estimates for many services (Eigenbrod *et al.*, 2010). THESAURUS used this type of approach but added several additional inputs to refine the basic proxy maps.	• **Poor consideration of environmental limits:** EcA6 focusses on ecosystem management respecting environmental limits. Only one case considered environmental limits (EERA). This is an issue given the importance of limits/thresholds for the sustainable management of land and other natural capital assets. • **Poor/mixed consideration of biodiversity:** EcA10 highlights the importance of striking an appropriate balance between conservation and use of biodiversity. All three cases considered biodiversity within their planning though none had a mechanism in place to balance use and conservation. This is a key concern for EERA which seems to promote transferability between natural capital assets (including biodiversity). • **Limited consideration of regulating services:** GNOM has limited consideration of regulating services (e.g. flood storage) and instead focusses on cultural services and some ecosystem processes. A balanced approach to land use/management is likely to require consideration of all service categories.
Opportunities	**Threats**
• **Further democratisation of land use planning processes:** two of the three case studies incorporated a stakeholder engagement step to help validate modelling processes. In conjunction with formalised *ex-ante* assessments such as SEA (Geneletti, 2012), there is an opportunity to further democratise land use planning processes by promoting stakeholder and community engagement at key decision-making junctures (Bourgoin and Castella, 2011; NAFRI, 2012). This would strengthen the delivery of all *involving people* Principles (Table 3). • **Improving the accuracy of proxy based ES maps:** all three case studies undertook some form of proxy ES assessment and mapping. There is an opportunity to improve the accuracy of these maps (and therefore the efficacy of related land use management decisions) by using better indicators and data (Eigenbrod *et al.*, 2010). • **Improving consideration of temporal scale:** spatial scale was considered adequately in all cases. Appropriate consideration of temporal scale (EcA7) however requires an extension of planning time horizons (EcA8) such that lengthy ecosystem restoration processes can be considered adequately; the literature suggests that ecosystem restoration timescales can vary from 1-5 years (eutrophic ponds) to 1,000-5,000 years (blanket bogs) (Bennett *et al.*, 2015). There is a key opportunity for land use planning to take a longer-term view (e.g. 15-30 years) to ensure that restoration of natural capital assets (and therefore ES flows) is considered adequately.	• **Continued degradation of key natural capital assets and flows:** generally poor consideration of biodiversity (EcA10) and environmental limits (EcA6) within the case studies highlights the risk of land use management continuing to drive degradation of key natural capital assets including biodiversity and soils (Schröter *et al.*, 2005; Foley *et al.*, 2006). Effective consideration of environmental limits in planning can provide an important "backstop" to protect critical natural capital assets. • **Land use planning may not identify nature based solutions for climate risk management:** much recent attention has been given to the role of nature based solutions helping to mitigate climate change risks (EEA, 2015b). Land use planning has a key role to play by identifying and protecting the habitats and green infrastructure that provide important regulating services (e.g. flood storage, local climate control). Poor consideration of regulating services in planning processes may mean that such opportunities are missed.

502

4. Discussion

The ecosystem approach can help deliver sustainable land use by embedding different values for ecosystems within land use decision-making, ensuring that the dynamic nature of ecosystems is considered and responding to the needs of affected communities (section 1). The case studies analysed in this research illustrate three potential models of ecosystem approach based land use planning from the UK. Given the limited empirical examples available (Korn *et al.*, 2003; Waylen *et al.*, 2013; Phillips *et al.*, 2014; von Haaren *et al.*, 2016), these can provide critical insights for practice elsewhere, particularly for related planning frameworks within the same broad category (section 2; Table 1; Appendix 1). Whilst our research had a UK focus, the results have relevance to land use planning elsewhere globally and in the EU, particularly in states/regions with similar planning traditions (EC, 1997, Schmitt *et al.*, 2013). Our analysis highlights several interesting results with implications for future practice and research. These are outlined in the sub-sections below.

4.1 Relevance of land use planning to the ecosystem approach

Our results show (implicitly) how three case study planning frameworks have incorporated the Malawi Principles reasonably well in terms of process aspects, although key gaps remain (section 4.2). This is in line with perspectives from stakeholders (Howard *et al.*, 2013), policy (EC, 2013a; Scottish Government, 2016) and research (Scott *et al.*, 2014) where land use planning has been identified as an important opportunity area for the ecosystem approach. Further, there are several specific aspects where land use planning could be particularly well suited to operationalising the approach, including: the need for regional cooperation; integration with formalised planning systems/mechanisms; enabling societal choice through participatory processes; partnership working between sectors; and the use of formalised *ex-ante* assessments, like SEA (Korn *et al.*, 2003; Geneletti, 2012). There may also be synergies between these factors (e.g. SEA providing a legal basis for public participation). Our SWOT analysis (Table 6) illustrates some of these aspects, especially in terms of opportunities for further democratisation of land use planning processes and outcomes. It has also been suggested that the ES concept, as part of the wider ecosystem approach, could provide a unifying framework for participatory decision-making (Scott *et al.*, 2014) helping stakeholders and communities to articulate shared land use outcomes (Waylen *et al.*, 2015b). We suggest, therefore, that participatory ecosystem approach based land use planning is an important avenue for future research and evaluation (e.g. Phillips *et al.*, 2016).

4.2 Mixed consideration of the Malawi Principles – possible implications

Our evaluation was undertaken on the basis that all 12 Malawi Principles are equally important (section 2.4.3). We concluded, therefore, that the case studies adopted the ecosystem approach reasonably well in terms of the degree to which the 12 Principles were considered (Figure 1). This finding is in line with other case study research and stakeholder perspectives where certain aspects of the approach have been identified as more challenging than others (Howard *et al.*, 2013; Waylen *et al.*, 2013; 2014). However, there are similarities and differences in terms of which Principles were found to be challenging; e.g. aligned with our results, Waylen *et al.* (2013) found that EcA5 on ecosystem structure and function and EcA7 on appropriate spatial and temporal scales were addressed most consistently. Conversely, EcA3 on effects on adjacent ecosystems was considered poorly in Waylen *et al.* (ibid) whereas this Principle was a relative strength in our cases (Figure 1). One possible reason for this is that our cases all operate at the regional level and, by definition, encompass multiple ecosystem/landscape types. Conversely, one critique of many existing cases is that they are often ecosystem specific and focussed on smaller areas, such as discrete catchments (section 1). While our analysis and other case study research identifies areas of weaker implementation, some

548 commentators suggest that adoption of the ecosystem approach should acknowledge context and
549 avoid being overly formulaic (Howard *et al.*, 2013). However, different interpretations of the focus of
550 the approach (Waylen *et al.*, 2013) could have implications for Malawi Principle specific outcomes;
551 e.g. focussing on ES aspects may result in societal choice and equity being overlooked (Howard *et al.*,
552 2013). This raises important questions over the relative importance of the Principles; e.g. are some
553 Principles always non-negotiable or relevant in certain contexts only? As our research has focussed
554 on process aspects, this highlights the importance of outcome/summative evaluation (HM Treasury,
555 2011) focussed research (section 4.4). Also, our analysis of methods/approaches used by the case
556 studies (Table 5) highlights tools that could operationalise specific Principles. Further research on
557 methods/approaches in this manner could be useful where there is a risk of specific Principles being
558 overlooked (section 4.3).

559 *4.3 Methods/approach for adopting the ecosystem approach – no silver bullet*

560 Our research identified eight methods/approaches in use by the case studies that have the potential
561 to help integrate the Malawi Principles with planning processes (section 3.2). To the best of our
562 knowledge, most existing peer reviewed research on methods/processes for planning and the
563 ecosystem approach relates to the marine/coastal zone context (e.g. Gilliland and Laffoley, 2008;
564 Ghoneim and Ibrahim, 2016), although there is a growing grey literature relating to land (e.g. Tucker,
565 2010; Scottish Government, 2011; James *et al*, 2013; Kirkup *et al.*, 2016; Phillips *et al*, 2016).
566 Conversely, Scott *et al.* (2014) approached the issue from a generic perspective, identifying six
567 categories of "tool" to help embed nature within generic planning processes: Futures; Valuation;
568 Incentives; Regulatory; Ecosystem Services; and Public Engagement. Their "tools" framework was
569 designed to complement all stages of the plan-development process: IDEAS-SURVEY-ASSESS-PLAN-
570 DELIVER-EVALUATE (ibid). Our focus on plan documents and supporting assessments/evidence
571 reports (i.e. 'outputs' in evaluation terms) meant that only the earlier stages of plan-development
572 were considered (up to "PLAN"). Also, the methods identified in our research fit almost exclusively
573 within the Scott *et al.* (ibid) "Ecosystem Services" and "Public Engagement" categories (the exception
574 being GNOM's efforts to integrate ES outputs with statutory land use delivery mechanisms; i.e. a
575 "Regulatory" approach). This is perhaps a reflection of our focus on the early stages of plan-
576 development; i.e. whereby the cases used "Ecosystem Service" methods to characterise the plan area
577 and inform assessments (e.g. SEA in EERA) before validation of results via "Public Engagement"
578 (THESAURUS; EERA). Also, the relatively immature nature of our cases (2007-2011) means that the
579 more innovative tools in Scott *et al.* (ibid), such as "Valuation" (e.g. natural capital accounting) and
580 "Incentives" (e.g. payment for ecosystem services), would have been much less mature and therefore
581 less realistic options. Further, an important barrier to using the ecosystem approach in planning
582 concerns the prevalence of complex ecosystem tools/models (ibid). From our cases, THESAURUS
583 adopted a relatively complex process and attempted to assess/map all relevant ES in the plan area.
584 Conversely, GNOM was much simpler though it only assessed a small handful of ES (certainly there
585 will be many important ES that were not considered e.g. flood storage). This highlights the trade-offs
586 between the complexity, accessibility and comprehensiveness of methods/approaches for use in
587 ecosystem approach based planning. The discussion here also shows how there is no "silver bullet"
588 method that can address all decisions stages and contexts (ibid). Rather, multiple methods will need
589 to be used in sequence throughout the plan-development process.

590 *4.4 Recommendations for future practice and research*

591 There are three key aspects of the research approach that could be progressed and expanded through
592 future research. Firstly, the evaluation of case study "performance" using the Malawi Principle
593 derived criteria (Table 3) was based on a limited sample of documentary evidence (Table 2), although

this was mitigated through careful selection of sources (section 2.4.1; Appendix 1). Secondly, it would have been valuable to use additional data collection methods for triangulation purposes (e.g. interviews with relevant stakeholders). This was not possible due to time constraints but we suggest that any future research in this area should employ at least two data collection methods. Thirdly, whilst the three case studies considered are broadly representative of land use planning in a UK context, there are several other categories that were not considered (section 2.2). Future research should identify cases from all relevant categories that satisfy the selection criteria. This should include quantitative studies to identify correlation and potential relationships (if any) between different categories of planning framework and level of operationalisation of the approach.

Our research was inherently focussed on procedural aspects of planning; we considered evidence in case study plan and assessment outputs of how/where the Malawi Principles had (implicitly) been adopted (section 2.4). The assumption, therefore, is that adopting an ecosystem approach will lead to better planning decisions and more sustainable land use outcomes. However, the lack of empirical data on ecosystem approach outcomes (section 1) raises the pressing need for summative (outcome focussed) evaluation of cases that have adopted the approach (Scott *et al.*, 2014; Waylen *et al.*, 2014; 2015b). This should address multiple contextual factors and research design issues including: (1) paired case study "with and without" (ecosystem approach) designs; (2) assessment of cases that have explicitly adopted the approach; (3) comparing results from formative (process) evaluations with summative (outcome) evaluations; (4) assessing the impact of cases that have adopted specific ecosystem approach guidance and methods (Scott *et al.*, 2014); and (5) assessing case examples from all relevant categories of land use planning framework in the context considered (e.g. UK).

Our results and other related research (Waylen *et al.*, 2013) show how some Malawi Principles can be problematic to implement. This is due to technical and institutional factors but also because of issues with the Principles themselves. Consequently, there is a need to evaluate the Principles in terms of their internal coherence (Waylen *et al.*, 2014); e.g. some could be consolidated (Korn *et al.*, 2003). Our evaluation identified a degree of redundancy; e.g. EcA11 on considering all forms of relevant information and EcA12 on involving all relevant sectors have a degree of overlap (e.g. 'considering all forms of information' in EcA11 could be partially achieved by 'involving all relevant sectors of society' in EcA12). Whilst there are risks associated with conflating these two Principles (e.g. a watering down of the Principles overall), there may be a case for tightening the scope of each Principle to focus on their distinct aspects only. Similar concerns are highlighted in Korn *et al.* (ibid). Key technical and institutional factors to address concerning the Principles include:

1. The need to better understand thresholds in ecosystems (Waylen *et al.*, 2015b). This is important for biodiversity and environmental limits (EcA10; EcA6), both of which were considered poorly by the cases in our research. Related to this, it is important to better understand exactly *why* biodiversity (EcA10) and environmental limits (EcA6) were considered poorly, given that these are key requirements of several EU policies (e.g. Water Framework Directive, Nitrates Directive, EU Biodiversity Strategy);
2. The dominant economic paradigm means that ES valuation tends to focus on monetary values; e.g. natural capital accounts in the UK (ONS, 2017). However, there is a need to balance biodiversity concerns with ES and stakeholder needs (Waylen *et al.*, 2015b), which are often framed in more utilitarian terms (e.g. monetary values). Functional and wider socio-cultural values (Scholte *et al.*, 2015) of ecosystems and ES need to be incorporated with land use planning as part of the ecosystem approach; and
3. The notion of institutional "sticking points" can create inertia towards the adoption of new ways of working, such as the ecosystem approach (Waylen et al., 2015a). Whilst our cases

640 show a reasonable interpretation of the approach, there is room for improvement. Although
641 ecosystem approach policy/guidance exists in the EU and UK (sections 1 and 2.2), public sector
642 organisational change may be required to more firmly embed the approach in policy and
643 practice (Waylen et al., 2015b). This could potentially be achieved by embedding the
644 ecosystem approach in relevant primary legislation (section 2.2).

5. Conclusions

Land use planning provides an important opportunity to operationalise the ecosystem approach due to its strategic and integrated nature; plan areas are often large enough such that they encompass whole ecosystems and strategic planning can integrate the impacts of multiple sectors and activities. Despite this, there are few empirical examples (internationally or in the UK) of land use planning practice comprehensively adopting the ecosystem approach (section 1). This research identified and evaluated three case study planning frameworks that had implicitly adopted key aspects of the ecosystem approach, thus providing important empirical insights with implications for policy and practice elsewhere. The research developed a new suite of evaluation criteria, based on the Malawi Principles, that may have utility in land use research and evaluation projects elsewhere (Table 3).

The evaluation highlighted how the case studies have considered the ecosystem approach Malawi Principles at least "partially" in 64% of instances (Figure 1). This finding suggests that the case study planning frameworks present a reasonable interpretation of the ecosystem approach that planning practice elsewhere can learn from. Several aspects were considered well or less well however. Half of the "management of natural systems" Malawi Principles were addressed consistently well as was EcA4 on management of ecosystems in an economic context; Principles considered less well relate to environmental limits (EcA6) and biodiversity conservation (EcA10). Poor consideration of these aspects is worrying as critical natural capital (biodiversity) may be eroded without effective environmental limit "backstops".

The evaluation also identified eight discrete methods/approaches, in use by the case studies, that could help to operationalise the ecosystem approach. In particular, all cases undertook some form of ES assessment and mapping whilst two cases devised approaches for incorporating stakeholder input with these technical modelling processes, as a validation and refinement step. This reflects the broader EU context for ecosystem mapping and assessment derived from Action 5 of the EU Biodiversity Strategy (EC, 2011). We suggest that the methods identified may be applicable in land use planning practice elsewhere; the matrix at Table 5 mapping the methods identified to the Malawi Principles could be particularly useful in this regard. Our results are particularly relevant to planning frameworks within the same category as the case studies (section 2.2; Table 1); e.g. the GNOM case is representative of ecosystem approach based planning in the context of LDPs delivered under the Planning etc (Scotland) Act 2006.

Finally, the analysis in this research points to two key areas of outlook that we would like to draw attention to. Firstly, poor consideration of environmental limits and biodiversity across the case studies highlights the risk of land use management decisions continuing to contribute to the degradation of critical natural capital. Secondly, key case study strengths relate to stakeholder engagement as per the *involving people* Malawi Principles. There is an important opportunity for further democratisation of land use planning processes, via deliberative engagement with stakeholders and affected communities, that could help to improve accountability and land use outcomes simultaneously. We suggest that these two aspects are important considerations for the future development of sustainable land use planning policy and practice in the UK and internationally.

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Appendix 1: Introduction to the case study land use planning frameworks

Case study	Summary details	Consideration of ecosystems approach – initial assessment at case study selection	Availability of documentary evidence	Representativeness
THESAURUS: Thames Gateway Ecosystem Services Assessment Using Green Grids and Decision Support Tools for Sustainability	• Pilot project as part of the UK Government Department for Environment, Food and Rural Affairs' (Defra) Natural Environment Research Programme. • The overall aim was to assess the value and appropriateness of using an ecosystem services approach within existing land use planning frameworks (Defra, 2008). • Principally this related to strategic green infrastructure (GI) planning at the sub-regional scale; the project developed an ecosystem services approach to GI planning and trialled this in Kent Thameside. • Kent Thameside is one of the main areas for growth in the Thames Gateway region, located to the east of London.	*The project:* • Was grounded in an assessment of ecosystem services as an input to strategic land use, landscape and GI planning. • Undertook a spatial assessment of ecosystem services. • Was undertaken at the landscape scale (the Kent Thameside sub-region).	• Various documentary evidence was produced as part of the Defra pilot including several technical reports and annexes (e.g. Defra, 2008; CEP and GeoData Institute 2008a; 2008b). • A peer reviewed journal publication was produced summarising the main results and innovations (Sheate *et al.*, 2012).	• The pilot was undertaken to inform consideration of ecosystem services and GI within the then (2008) extant English planning system. • This included: Local Development Frameworks (LDF), Regional Spatial Strategies (RSS) and Sustainability Appraisal (SA). • Regional planning was abolished through the Localism Act 2011 (DCLG, 2015) although GI and local development planning is still undertaken.
EERA: East of England Regional Assembly	• Regional Spatial Strategies (RSS) provided a basis for regional level spatial planning, across eight English regions[5], until they were abolished by the Localism Act 2011.	*The project:* • Included specific consideration of ecosystem/abiotic assets	• Various documentary evidence was produced as part of the commissioned study	• The study was undertaken to inform policy-development for the East of England RSS.

[5] UK Government National Archives – Government Office for the East of England Region Finder: http://webarchive.nationalarchives.gov.uk/20100528142817/http://gos.gov.uk/goeast/regionFinder [accessed 07/07/16]

Case study	Summary details	Consideration of ecosystems approach – initial assessment at case study selection	Availability of documentary evidence	Representativeness
(EERA) Environmental Limits Mapping Project	• At the examination of the draft East of England RSS, concern was expressed that the scale and location of proposed growth would exceed the environmental capacity of the region, with a risk that environmental limits could be exceeded (LUC, 2008) • In response, the East of England Regional Assembly (EERA), a body that no longer exists, commissioned a study to develop a new method that could inform spatial planning at the regional and sub-regional levels by taking better account of environmental limits in decision-making. • The method was designed for application across the whole East of England Region, however it was developed and trialled using a specific coastal sub-region known as the Haven Gateway.	(e.g. air, water, geology, marine based flora and fauna) and associated flows of ecosystem services (Petersen and Gocheva, 2015). • Had a key focus on the assessment of environmental limits for the ecosystem and abiotic assets considered. • Undertook a spatial assessment of natural capital (ecosystem and abiotic assets relative to environmental limits). • Was undertaken at the landscape scale (the Haven Gateway sub-region).	including several technical reports and annexes.	• Although the RSS mechanism has now been revoked in England (DCLG, 2015), regional spatial planning is still undertaken in Scotland via Strategic Development Plans (SDP) and regional planning is a critical issue across the European Union (EU) as part of EU policy on territorial cohesion. • The EERA method also has key relevance at the sub-regional level, such as in Local Planning which is still a requirement of the English planning system (DCLG, 2015).
GNOM: Glasgow and Clyde Valley Green Network	• The Glasgow and Clyde Valley (GCV) Green Network Partnership[6] is a collaboration between the eight local authorities in the GCV Strategic Development Plan (SDP) region and other key stakeholders.	*The project:* • Implicitly considered ecosystem services (framed as green network benefits).	• Various documentary evidence has been produced as part of the GNOM project including internal method notes and protocols, green	• Green network and GI are embedded within Scottish Government planning policy (Scottish Government, 2014).

[6] GCV Green Network Partnership homepage: http://www.gcvgreennetwork.gov.uk/ [accessed 07/07/16]

Case study	Summary details	Consideration of ecosystems approach – initial assessment at case study selection	Availability of documentary evidence	Representativeness
Opportunities Mapping	• The Partnership aims to embed green network thinking in relevant policies (especially planning) to *"make the Glasgow metropolitan region one of Europe's most attractive places to live, work and play through the creation of a large, functional green network"* (GCV Green Network Partnership, 2013). • The green network is defined in terms of networks of high quality greenspaces and semi-natural habitats delivering multiple benefits. The concept is based in landscape ecology principles including structural and functional elements of patch and network (GCV Green Network Partnership, 2011). • The Partnership have developed a Geographic Information System (GIS) based method for identifying spatial green network opportunities (GNOM). It identifies strategic priority locations for green network delivery through the planning system. The approach has been implemented in the GCV SDP and several Local Development Plans (LDPs).	• Undertook a spatial assessment of green network gaps (ecosystem service deficiencies). • Was undertaken at the river basin scale (the river Clyde).	network policy descriptions in the GCV region SDP and various LDPs, presentations by the Partnership manager and GNOM studies for specific local authorities.	• Green network planning is a statutory requirement for all 32 planning authorities in Scotland and the four strategic planning authorities.

Appendix 2: Detailed evaluation of case studies against the Malawi Principles

Key to scoring		Case study ecosystems approach based urban land use planning frameworks					
Principle considered		**THESAURUS**		**EERA**		**Green Network Opportunities Mapping**	
Considered to a degree		**References:** Kent Thameside, 2006; CEP and Geodata Institute, 2008a and 2008b; Defra, 2008; Sheate *et al.*, 2012.		**References:** LUC, 2007a, 2007b, 2007c and 2007d; LUC, 2008.		**References:** GCV Green Network Partnership, undated and 2011; GCV SDPA, 2011; Hislop, 2011.	
Principle not considered							
Ecosystems approach principle		**Score**	**Summary comments/rationale**	**Score**	**Summary comments/rationale**	**Score**	**Summary comments/rationale**
	*EcA3. Consider effects on **adjacent ecosystems***		**To a degree** – the ES typology adopted in the THESAURUS approach considers key ecosystem processes and intermediate services including hydrological cycling and wildlife habitats/networks. Although not stated explicitly, these services are likely to have implications beyond the boundaries of single ecosystems e.g. strategic habitat networks, hydrological cycle impacts of vegetation on adjacent catchments (transpiration and transportation of water) etc.		**To a degree** – the EERA approach recommends that additional spatial environmental information is used in conjunction with environmental limits maps for the study area (see EcA6). The intention is to provide a wider contextual understanding (e.g. in spatial terms) of the implications for spatial planning. The approach also considers broader scale issues beyond the geographical scope of the study area including *"opportunities to import, recreate or substitute the services [provided by the study area]"* (LUC, 2008 p.20).		**To a degree** – the approach is designed primarily for use in an urban context with a focus on urban greenspace enhancement, access improvements and meeting the greenspace/green infrastructure needs of new development. In this regard, opportunities to think strategically about effects on adjacent ecosystems are limited. However, the approach does include provision for consideration of wider/landscape scale issues through the analysis of individual high scoring cells (i.e. clustered priorities where multiple high scoring cells cluster together are generally focussed around urban areas with multiple green network issues). These cells often represent habitat enhancement opportunities in the wider countryside.
	*EcA5. Conserve ecosystem **structure** and **function***		**Principle considered** – as per the above, the ES typology incorporates key ecosystem processes/intermediate services, many of which are key for ecosystem structure and function. Crucially, natural succession is also considered, exemplifying the importance of ecosystem structure i.e. maintaining diversity in ecosystem structure by natural processes.		**To a degree** – EERA's approach to mapping environmental limits (see EcA6) is based on state based indicators for discrete environmental topics taken from strategic environmental assessment (SEA) legislation[7]. This sort of topic based approach can work against the integrated nature of ecosystems though there is recognition that the approach has been dictated by data availability i.e. the data required to support ES indicators wasn't available. Ecosystem function issues are picked up to a degree by some of the topic indicators		**To a degree** – the approach includes some consideration of ecosystem structure and function issues though the focus is very much on ecological connectivity (i.e. joining up areas of fragmented habitat) as opposed to wider ecosystem processes/intermediate services such as water cycling and soil formation. Consideration of EcA5 type issues is facilitated through the use of a biodiversity opportunities layer that *"identifies locations where intervention would yield the greatest benefit in*

[7] See Annex I of the EC SEA Directive: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2001:197:0030:0037:EN:PDF.

Key to scoring		Case study ecosystems approach based urban land use planning frameworks					
Principle considered		**THESAURUS**		**EERA**		**Green Network Opportunities Mapping**	
Considered to a degree		**References:** Kent Thameside, 2006; CEP and Geodata Institute, 2008a and 2008b; Defra, 2008; Sheate *et al.*, 2012.		**References:** LUC, 2007a, 2007b, 2007c and 2007d; LUC, 2008**.**		**References:** GCV Green Network Partnership, undated and 2011; GCV SDPA, 2011; Hislop, 2011.	
Principle not considered							
Ecosystems approach principle		**Score**	**Summary comments/rationale**	**Score**	**Summary comments/rationale**	**Score**	**Summary comments/rationale**
					(e.g. land and marine based flora and fauna considers ecosystem resilience and stability issues) which relate to biotic natural capital assets.		*terms of improving habitat connectivity"* (GCV Green Network Partnership, 2011 p.13)
	*EcA6. Ecosystem management must respect environmental **limits***		**Principle not considered** (either explicitly or implicitly).		**Principle considered** – consideration of environmental limits and capacity is the key objective of the EERA approach. Environmental limits are defined using state based indicators for key environmental issues/topics (see EcA5) drawing on readily available data. A two-phase model is used where the issue/topic is described as either within or exceeded in relation to the defined limit. Limits are identified with reference to literature, policy and through stakeholder engagement.		**Principle not considered** (either explicitly or implicitly).
	*EcA7. Adopt the ecosystems approach at appropriate **spatial** and **temporal scale***		**To a degree** – the approach recognises how a *"typology of ecosystem services can be developed for any location and at any scale"* (Sheate et al, 2012 p.7). There is also consideration of how different stakeholders can help understand the context specific value of ES at different scales. Crucially the approach has also been tested at different scales – sub-regional (i.e. the whole of the Kent Thameside area) and local (i.e. for a specific settlement within the study area). There is no specific consideration of the ecological rationale for using different scales and neither is there any reference to temporal issues.		**Principle considered** – the approach is designed to operate at the regional/sub-regional scale. Although this will be defined by administrative boundaries (i.e. the Regional Spatial Strategy area), such a broad scale will likely encompass key natural features e.g. strategic ecological networks, catchments etc. Indeed there is explicit recognition of how *"consideration of environmental limits requires thinking at a broad spatial scale"* (LUC, 2008 p.8). Crucially, the EERA approach also considers temporal scale issues including the need to balance land use conflicts in time and space. The consideration of pressures and trends in relation to the environmental issues/topics for which limits have been defined is an additional temporal element.		**Principle considered** – the approach includes extensive consideration of issues relating to spatial scale. The GIS based element is designed for use at the local authority (regional) scale though it identifies priorities/opportunity areas at the local scale. For example, the analysis undertaken for the West Dunbartonshire Council (WDC) area identified four hotspots for green network intervention at either the town and neighbourhood scale. Similarly, outputs are designed to feed into LDP policy at broader scales as well as informing masterplans, design studies and, ultimately, Development Management decisions at the neighbourhood and site scales. Temporal scale issues are considered implicitly as the outputs of the approach are designed to inform LDP green network policy. In this regard, green network policy (as with other areas of policy within the

Key to scoring		Case study ecosystems approach based urban land use planning frameworks					
Principle considered		**THESAURUS**		**EERA**		**Green Network Opportunities Mapping**	
Considered to a degree		**References:** Kent Thameside, 2006; CEP and Geodata Institute, 2008a and 2008b; Defra, 2008; Sheate *et al.*, 2012.		**References:** LUC, 2007a, 2007b, 2007c and 2007d; LUC, 2008**.**		**References:** GCV Green Network Partnership, undated and 2011; GCV SDPA, 2011; Hislop, 2011.	
Principle not considered							
Ecosystems approach principle		**Score**	**Summary comments/rationale**	**Score**	**Summary comments/rationale**	**Score**	**Summary comments/rationale**
							LDP) should focus on proposals up to year 10 from the LDP's adoption.
	*EcA8. Set **long term objectives** for ecosystem management*		**Principle not considered** (either explicitly or implicitly).		**To a degree** – as per EcA7 above, the EERA approach incorporates consideration of key temporal scale issues. Specific timescales are not defined however (e.g. quantifying what is meant by long term in relation to environmental pressures and trends as well as objectives for spatial planning).		**To a degree** – as per EcA7 above, the approach incorporates implicit consideration of key temporal scale issues though specific timescales are not defined. In essence though, this would be the role of the local authority (i.e. the green network opportunities mapping is undertaken by the GCV Green Network Partnership on behalf of the eight local authorities within the wider GCV region).
	*EcA9. Ecosystem management must recognise that **change is inevitable***		**Principle not considered** (either explicitly or implicitly)		**Principle not considered** (either explicitly or implicitly)		**Principle not considered** (either explicitly or implicitly)
	*EcA4. Understand and manage the ecosystem in an **economic context***		**To a degree** – a key part of the rationale for this approach is recognition that ES are context specific (i.e. ES are more or less valuable depending on a range of contextual issues such as population density, flood risk, soils etc). Context in this regard can also include consideration of existing planning and management arrangements for ecosystems including key economic issues such as costs associated with land management for a given level of service.		**To a degree** – there is a strong emphasis on the value and importance of ES including recognition that *"large sections of the economy are dependent on a high quality natural environment"* (LUC, 2008 p.7). Operationally, the approach has been designed to facilitate the transparent consideration of conflicts and trade-offs between different ES (or aspects of the environment/natural capital assets providing the services) including the use of sensitivity analysis in the GIS mapping of environmental limits (e.g. to explore stakeholder preferences for specific services). However there is no specific consideration of costs and benefits.		**Principle considered** – the approach has a distinct focus on the need to understand and manage green networks and the urban natural environment in an economic context. In particular, the GIS analysis seeks to answer the question *"where are the major areas of land use change"* (GCV Green Network Partnership, 2011 p.11) through the use of spatial datasets on development and regeneration sites. In essence, areas of change and investment are regarded as opportunities for the enhancement of ecosystems and ES (e.g. through the creation of habitat mosaics that are integrated with development to provide key ES such as water management, climate regulation and environmental settings). There is also a particular focus on the role of the planning

Key to scoring		Case study ecosystems approach based urban land use planning frameworks					
Principle considered		**THESAURUS**		**EERA**		**Green Network Opportunities Mapping**	
Considered to a degree		**References:** Kent Thameside, 2006; CEP and Geodata Institute, 2008a and 2008b; Defra, 2008; Sheate *et al.*, 2012.		**References:** LUC, 2007a, 2007b, 2007c and 2007d; LUC, 2008**.**		**References:** GCV Green Network Partnership, undated and 2011; GCV SDPA, 2011; Hislop, 2011.	
Principle not considered							
Ecosystems approach principle		**Score**	**Summary comments/rationale**	**Score**	**Summary comments/rationale**	**Score**	**Summary comments/rationale**
							system delivering *"multiple green network [ES] benefits through the targeting of resources"* (GCV Green Network Partnership, 2011 p.18). Other than ecological connectivity and access networks/recreation however the approach does not include provision for the spatial analysis/targeting of any other ES.
	*EcA10. Ensure an appropriate **balance** between **conservation** and **use** of biodiversity*		**To a degree** – biodiversity (and other important elements of biodiversity including habitats, semi-natural greenspace and ecological networks) is incorporated within the ES typology adopted in this approach. However, there is no specific method, approach or mechanism identified for balancing biodiversity conservation with use.		**Principle not considered** – biodiversity issues are incorporated to a degree within the selection of state indicators for mapping environmental limits (i.e. land and marine based flora and fauna). However, there is no specific method, approach or mechanism identified for balancing conservation with use of biodiversity.		**Principle not considered** – biodiversity issues are incorporated to a degree within the biodiversity opportunities dataset though there is no specific method, approach or mechanism identified for balancing conservation with use of biodiversity.
	*EcA1. **Objectives** for ecosystem management are a matter of **societal choice***		**To a degree** – the approach defines stakeholders as *"anyone who believes they have a stake/is thought to have a stake in a specific issue or activity relating to the Kent Thameside Green Grid (KTGG). They may be individuals or representatives of organisations, government bodies or groups of interest"* (Sheate et al, 2012 p.8). In this regard, the approach includes clear provision for engagement with a broad range of stakeholders (including local communities and other publics) that may facilitate the development of ecosystem management objectives through societal choice. Despite this, the research only engaged with technical stakeholders/agencies so this premise is yet to be tested.		**Principle considered** – the EERA approach recognises that there are two ways in which environmental limits can be determined i.e. scientifically or socially determined. Crucially, the approach recognises that *"environmental limits need to be predetermined and supported by stakeholders"* and how *"the UK's democratic planning process lends itself well to this approach"* (LUC, 2008 p.12). The EERA project was only able to engage technical stakeholders, presumably due to available resources as per Sheate et al (2012), but recognises that stakeholder views in this regard can provide a proxy for the views of the wider public. Were the approach to adopted wholesale in spatial planning, it is feasible that the wider public would be engaged in the process of determining environmental limits.		**Principle not considered** – the approach provides a technical, GIS-led solution for developing *"robust and defensible green network policies for LDPs"* (GCV Green Network Partnership, 2011 p.1). Although, in principle, the outputs of the approach will inform proposals within LDP Main Issue Reports (MIR), the approach itself is designed to be undertaken by GIS technicians/planners without wider input from the public or affected communities.

Key to scoring		Case study ecosystems approach based urban land use planning frameworks					
Principle considered		**THESAURUS**		**EERA**		**Green Network Opportunities Mapping**	
Considered to a degree		**References:** Kent Thameside, 2006; CEP and Geodata Institute, 2008a and 2008b; Defra, 2008; Sheate *et al.*, 2012.		**References:** LUC, 2007a, 2007b, 2007c and 2007d; LUC, 2008**.**		**References:** GCV Green Network Partnership, undated and 2011; GCV SDPA, 2011; Hislop, 2011.	
Principle not considered							
Ecosystems approach principle		**Score**	**Summary comments/rationale**	**Score**	**Summary comments/rationale**	**Score**	**Summary comments/rationale**
	*EcA2. Ecosystem management should be **decentralised** to the **lowest** appropriate level*	**?**	**Unknown** – development of the approach to date has only considered key practical issues concerning identifying the ES in a given area, linking these to land use/cover using network analysis and mapping ES using GIS. The approach has not yet informed practical land use/management decision-making.		**Principle not considered** (either explicitly or implicitly).		**To a degree** – as described at EcA7, the approach is designed to identify priority areas for green network/urban natural environment enhancement projects. There is strong recognition of the economic practicalities of such projects (see EcA4) and the approach accounts for this, to a degree, by promoting the (implicit) decentralisation of management responsibility to developers, landowners and community groups.
	*EcA11. Consider all forms of **relevant information** including scientific/local knowledge, practice and innovation*		**To a degree** – see comments above against EcA1. There is a specific opportunity to incorporate a range of relevant information through the GIS methodology adopted: *"the assumptions made [when combining spatial data sets in the GIS to evaluate proxy ecosystem services] and their relative weight would be an opportunity for stakeholders to become involved and tailor the process to locally selected criteria"* (Sheate et al, 2012 p.18).		**Principle considered** – see comments above against EcA1. The approach recognises the importance of engaging stakeholders and the wider public in the determination of environmental limits. This approach will allow for the consideration of a range of different information including *"local perceptions of the relative value of environmental features or benefits"* (LUC, 2008 p.14).		**Principle not considered** – see comments above against EcA1.
	*EcA 12. **Involve** all relevant **sectors of society** and scientific disciplines*		**To a degree** – see comments above against EcA1 and 11.		**Principle considered** – see comments above against EcA1 and 11.		**Principle not considered** – see comments above against EcA1.

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