Navigating pluralism : understanding perceptions of the ecosystem services concept

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Abstract

Being open to multiple interpretations allows the ecosystem services concept to operate as a boundary object, facilitating communication and cooperation between different user groups. Yet, there is a risk that the resultant pluralism limits the capacity of ecosystem services assessments to directly inform decision and policy making, and that the concept could be used to support environmentally or socially harmful activities. Here, we report results from a large mixed methods survey conducted among academics, policymakers and practitioners working in the field of ecosystem services across Europe. We use these results to explore the trade-off that exists between the role of ecosystem services as a boundary object and the needs of policy and decision makers of more standardised practices. We conclude that this can be done by working towards the standardisation of ecosystem service assessments within specific jurisdictions, whilst maintaining forums for debate, collaboration, research and critical reflection within the broader ecosystem services community. We also aim to deduce guiding principles to ensure the ecosystem services concept is not used to support possible detrimental activities. The consideration of shared and cultural values, and integration of the concept of sustainability are identified as valuable guiding principles to this end.

1. Introduction

1.1. A broadly operational concept despite a lack of unity

A number of wide scale assessments have taken place to assess the status and trends of the world's ecosystem services – including the Millennium Ecosystem Assessment (MA, 2005), The Economics of Ecosystems and Biodiversity (TEEB, 2010), and the assessments of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2018a, 2018b, 2018c, 2018d). Advances have been made towards operationalizing the concept in practice (Beaumont et al., 2017; Dick et al., 2018; Jax et al., 2018), and the concept is starting to be integrated into both national and international policy (Bezák et al., 2017; Bouwma et al., 2018; Matzdorf and Meyer, 2014). Dick et al. (2018, p. 563) declared that the ecosystem services concept is 'broadly operational', despite on-going debates within the ecosystem services community regarding conceptual frameworks, assessment and valuation methodologies and even core terminology (Braat, 2018; Costanza et al., 2017; Díaz et al., 2018; Fanny et al., 2014). This lack of conceptual and methodological unity has previously been identified as a concern within the ecosystem services community (Nahlik et al., 2012), although Dick et al. (2018) suggest the concept appears to be compatible in practice with a range of approaches founded in different philosophical traditions.

1.2. The acceptance of plurality within the field of ecosystem services

Accepting that the ecosystem services concept is open to multiple interpretations is seen by some as a strength, as it allows it to operate as a boundary object between different worldviews (Abson et al., 2014; Schröter et al., 2014; Schröter and van Oudenhoven, 2016). Boundary objects are concepts that are amorphous enough to be adapted to different

contexts and worldviews, but are robust enough to act as a channel of communication between these different positions (Star and Griesemer, 1989).

The idea of ecosystem services as a boundary object is well developed in the literature (Abson et al., 2014; Galler et al., 2016; Hermelingmeier and Nicholas, 2017; Jadhav et al., 2017; Kull et al., 2015; Schröter et al., 2014; Steger et al., 2018). Saarikoski et al. (2017) found the concept operated as a useful boundary object in some of the 22 European and Latin American case studies they assessed. From their case study in German environmental planning, Galler et al. (2016) conclude that ecosystem services can act as an effective boundary object in the early stages of collaboration, but that its usefulness decreases over time due to conflicting interpretations of how the concept should be used in practice. Saarela and Rinne (2016) develop the idea that artefacts (scenarios, simulation models, indicators etc.) produced using the ecosystem services concept, rather than the concept itself, may act as boundary objects. These artefacts are still open to multiple interpretations but are not neutral objects, as they are tied to the social and institutional context, with their embedded power relations, in which they are made (Saarela and Rinne, 2016). This can limit their capacity to operate as boundary objects, as they are only able to connect actors with pre-existing shared cultural values and preferences (Turnhout, 2009).

These discussions reveal a tension in the role of ecosystem services as a boundary object. On the one hand, it is most effective as a broad concept that can accommodate a large range of perspectives and worldviews. However, this function decreases in the context of specific policy and decision-making. Undertaking ecosystem services assessments for policy requires the development of standardised classification systems, conceptual frameworks

and related methodologies; inevitably leading to certain worldviews being crowded out, and others foregrounded. If ecosystem service assessments are to become a mainstream approach for evidencing environmental policy and decisions, then such standardised practices will become institutionalised, potentially curtailing debate over the value laden choices taken to create them. This dynamic is referred to by Steger et al. (2018) as the creation of 'infrastructure'. Infrastructure are 'the tools, work practices, terms, and technologies that become embedded in and support a community of practice' (Steger et al., 2018, p. 144). The tension between ecosystem services as a broad, open boundary object and as an institutionalised concept with precise terminology and associated practices, is a key theme of this paper.

Within policy and decision-making, there is evidence that the concept of ecosystem services is beginning to enter into national policy and legislation, but usually in a manner that does not include the explicit use ecosystem services assessments and valuations (Bezák et al., 2017; Bouwma et al., 2018; Kistenkas and Bouwma, 2018; Leone et al., 2016; McKinley et al., 2018). Within the research community, continued disunity can be seen in ongoing debates over core frameworks and terminology since the introduction of the concept of 'Natures Contribution to People' (Braat, 2018; Díaz et al., 2018; Kenter, 2018; Maes et al., 2018; Pascual et al., 2017). Peterson et al. (2018) make the case here for an acceptance of pluralism to avoid a potentially harmful polarisation within the ecosystem services community. Hermelingmeier and Nicholas (2017) similarly embrace the range of perspectives that still exist around the ecosystem services concept, making the case for 'guided pluralism'.

The continued heterogeneity of interpretations and understandings of the ecosystem services concept requires an exploration of how far such a pluralistic outlook should be extended. Accepting pluralism does not mean that any work carried out either in research or policymaking using the language of ecosystem services is accepted as part of the overall canon, regardless of the theoretical basis, methodological approach or normative framing. The term 'guided' pluralism used by Hermelingmeier and Nicholas (2017) captures this idea. This term originates from the attempt of Baumgärtner et al. (2008)'s to develop a framework for coping with the heterogeneous practices within the field of ecological economics, however the idea has not been explicitly developed in the ecosystem services literature. Hermelingmeier and Nicholas (2017) only suggest the need for open dialogue over values and assumptions to establish common ground for research.

Baumgärtner et al. (2008) seek to harmonise the epistemological and methodological diversity of their field that interweaves descriptive and positive science with values and normative judgement. In applying the concept of guided pluralism to the field of ecosystem services, we carry forward this differentiation of epistemological and methodological diversity, and the view that this naturally arises from different philosophical and normative positions. We add the consideration of theoretical diversity, with theory being an intermediate stage, informed by particular epistemologies and informing methodologies. The second theme of this paper is an attempt to identify guiding principles with which to navigate this diversity, as to achieve a 'guided' pluralism within ecosystem services research and practice.

The two notions of boundary object and guided pluralism are complementary. Boundary objects accept pluralism, while the notion of guided pluralism allows space to discuss principles with which applications of the ecosystem services concept can be directed.

1.3. Aims

To analyse the work on ecosystem services as a boundary object, and the applicability of the notion of guided pluralism, it is important to understand different views within the ecosystem service community. This study hence aims to understand the way the ecosystem services concept is viewed by different user groups. Firstly, we are interested in perceptions of strengths and weaknesses in the concept, and the different ways that people see the concept being used to inform decision-making. From here we ask if the ecosystem services concept can be seen as a boundary object, and what the limitations are to this in the context of policy and decision-making. Secondly, we seek to identify guiding principles for the ecosystem services concept, by synthesizing views from different user groups.

2. Methods

2.1. Survey design

We distributed a digital mixed methods survey among 350 early registrants to the European Ecosystem Services Conference 2016[1] (EESC), which presented a good sampling pool for all three target groups: researchers seeking to gain knowledge and understanding; policymakers formulating public strategies; and practitioners making or supporting environmental management decisions. The conference – which attracted 700 delegates –

[1] www.esconference2016.eu

was organised by three large research projects (OPERAs[2], OpenNESS[3], ECOPLAN[4]), the University of Antwerp, and the Ecosystem Services Partnership[5], one of the largest international networks focused on ecosystem services, and so brought together a wide range of people from across the field. We engaged with early registrants to be able to present and discuss the outcomes at the conference. The survey was distributed through the conference organisers' official e-mail list.

The survey was divided into four categories to capture different aspects of people's views of the ecosystem services concept: its underlying purpose (P); visions (V) for its future evolution (named goals in the survey); perceived myths (M) that misrepresent the concept; and frustrations (F, named Grumbles in the survey) to capture any irritations with the ecosystem services concept not captured in the other categories.

Each category featured one closed question, and two or more open-ended questions, allowing participants to enter as little or as much text as they needed to express their ideas and opinions. Participants were asked to complete at least one category, and at the end of their first round of questions were given the opportunity to complete additional ones. Table 1 summarises the questions, which were phrased in generic terms to allow respondents the opportunity to give unrestricted open answers. The full questionnaire is included as Supplementary Material 1.

[2] www.operas-project.eu
[3] www.openness-project.eu
[4] www.uantwerpen.be/en/research-groups/ecoplan/
[5] www.es-partnership.org

Table 1. Summary of the survey questions for the four survey categories: Purpose (P), Visions (V), Myths (M), Frustrations (F). One question on supposed differences of opinion (A1) was asked to all respondents at the end of the survey. The questions were either on a 5-point Likert scale (Likert), multiple-choice multiple answers (MCMA) or open-ended (open). MCMA statements are included in Figure 2. The full survey is available as Supplementary Material 1.

ID	Question	Type
P1	The ecosystem services concept provides a utilitarian framing of ecosystem functions as services to increase public interest in conservation.	Likert
P2	The concept of ecosystem services denotes a generic idea or metaphor to increase awareness of how human well-being in many ways depends on natural systems.	Likert
P3	Using an economic approach to environmental issues can help decision-makers to determine the best use of scarce ecological resources at all levels.	Likert
P4	Can you put down in your own words what you think is at the heart of the ecosystem services framework?	Open
P5	What would be the worst misuse of the ecosystem services framework?	Open
P6	Beyond basic research ethics and good practice, what values and principles or ideas should guide the practical applications of the ecosystem services framework?	Open
V1	In 20 years' time, what role should the ecosystem services framework have in society?	MCMA
V2	What are the main challenges for the widespread use of the ecosystem services framework?	Open
V3	What do you think are key steps to undertake in the future development of the ecosystem services framework?	Open
M1	Can you describe a common myth or misunderstanding you frequently encounter in your work?	Open
M2	Who holds these erroneous views?	Open
M3	What to your mind is the source of confusion that gave rise to these myths?	Open
M4	How would you debunk the myth?	Open
M5	Have you ever encountered one of the following claims regarding ecosystem services in your work?	MCMA
F1	What do you find most frustrating about working with the ecosystem services framework?	Open
F2	What would be the best way to resolve your frustration?	Open
F3	What to your mind is the biggest theoretical, moral or practical shortcoming of the ecosystem services framework?	Open
F4	How could that shortcoming be remedied?	Open
F5	Have you ever encountered one of the following frustrations?	MCMA
A1	In the field of ecosystem services, where do you think the biggest differences of opinion lie?	Open

2.2. Quantitative analysis

Attributes, i.e. characteristics of participants or cases (Bazeley and Jackson, 2013), were included in the survey design as open questions to prevent restricting participants in their

answers. Based on the qualitative entries we constructed attribute labels for gender, discipline, and years of experience (Table 2). For 'Field of Study' we captured unclear answers with the 'Other discipline' category. Participants were also asked whether they were an academic researcher, junior researcher or student, practitioner, policymaker or 'other'.

Each category of the survey (Purpose, Visions, Myths, and Frustrations) had one multiple-choice section for which we compiled separate bar charts to help identify themes and support for the qualitative analysis of the open questions.

Table 2. Retrofitted attribute labels describing survey participants

Open-ended	**Retrofitted Attribute labels**
Gender	Female, Male
Years of experience	<5; 5-9; 10-19; >20
Discipline	Natural/Physical Sciences, Social Sciences, Economics, SciencePolicy Nexus, Inter/Transdisciplinary, Other discipline

2.3. Qualitative analysis

A general inductive approach (Thomas, 2006) to thematic content analysis was used to examine patterns in the responses to the open survey questions (Table 2) in a replicable and systematic manner (Bryman, 2016). The general inductive approach provides an easily used and systematic set of procedures for analysing qualitative data that can produce reliable and valid analysis of underlying structure in the raw data (Thomas, 2006). Rather than making prior assumptions about the survey responses in a predefined coding frame, an inductive approach was followed because we had no comprehensive predetermined

expectations of the patterns, similar to Asah et al. (2014) and Maraja et al. (2016). The intended outcome of the inductive coding process was to create a small number of summary categories that in the evaluator's view capture key aspects of the themes identified in the raw data and are assessed to be the most important themes given the study's objectives (Thomas, 2006).

We followed the five stage of analysis described by Thomas (2006) carried out using the Nvivo qualitative data analysis software (QSR International, 2016). The full set of responses were read carefully (1) and specific text segments were identified that related to the topic of the survey category (2). These segments were labelled to create a set of initial themes (3), which were refined to reduce overlap and redundancy (4) in an iterative process both within the categories and across the whole survey, allowing responses to be coded for multiple themes. Themes that were rarely mentioned were grouped as 'other'. The final stage consists of creating a model that incorporates the most important themes into a limited set. Thomas (2006) explains that inductive coding that results in too many major themes – he suggests more than eight – can be viewed as incomplete and encourages the evaluator to make hard decisions about which themes are most important.

Given likely overlap in responses between the different survey categories we anticipated that the final step would identify a number of cross-cutting themes. The choice of these cross-cutting themes was supported by the results of the quantitative analysis and looked for both consensus and divergence in views among the respondent categories. The cross-cutting themes are illustrated with quotes and cross-references were made to the survey questions that provided answers in support of the cross-cutting theme.

2.4. Corroborating our findings and building towards a unified message

Key findings from the analysis were presented at EESC 2016 to corroborate our findings through discussions with conference attendees, and to collaboratively shape a charter (named the Antwerp Declaration) that could capture and communicate a set of recommendations based on our findings and discussions. An early findings document was compiled and distributed among conference participants in the delegate packs. This formed the basis for informed discussions and events during the conference where participants could engage with the Antwerp Declaration process: a parallel session on the second day of the conference presenting and discussing many of the themes relevant to the Declaration; a Quote of the Day booth where participants could vote and share their opinion on proposed bits of text for the Declaration; and a workshop held on the third day specifically addressing different aspects of the Declaration. Input gathered through these events was then taken forward by a writing team. At the end of the conference the final Declaration was presented in plenary and a website was opened for signing the Declaration.

3. Results

3.1. Survey response and respondent attributes

The response rate was 34%, n=121, comprising academic researchers (50%); junior researchers (24%); practitioners (15%); policymakers (7%), and 4% who did not fit these categories. The gender balance was 41% male, 51% female, and 8% not stated, and most people reported their experience in the field of ecosystem services to be under or around 10 years.

All participants were obliged to complete the questions for at least one category, and many chose to complete multiple (Figure 1). Participants were free to choose which category they completed, but the distribution among themes suggests most people followed the categories in order of listing (Figure 1), although this may also reflect their interests.

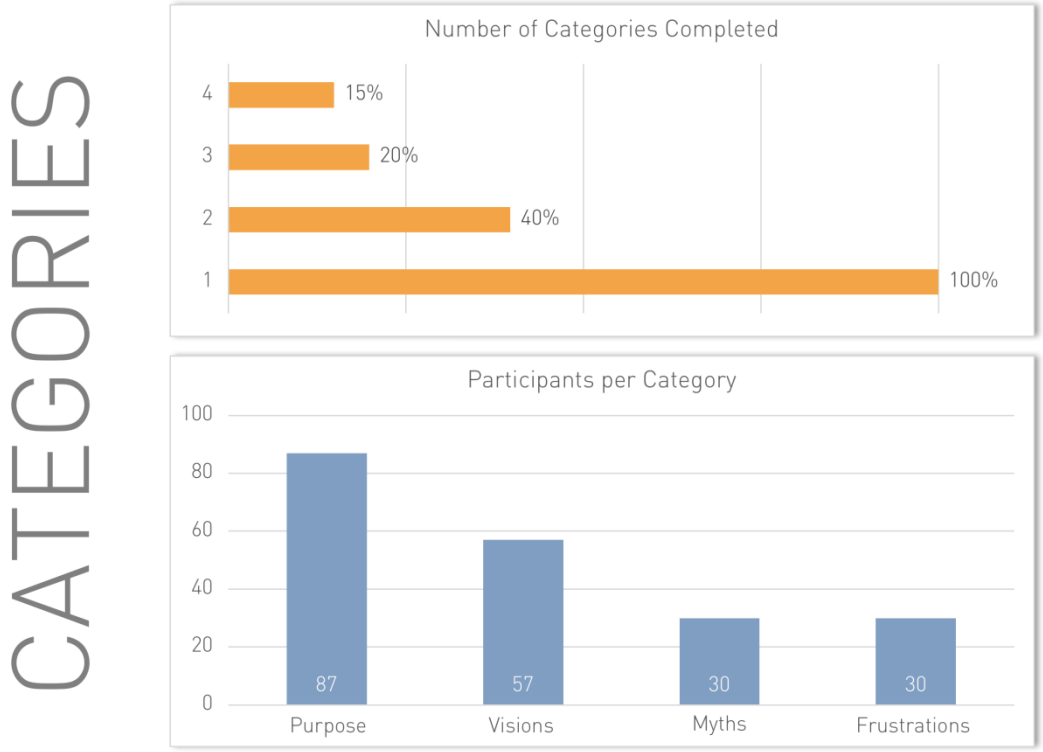


Figure 1. Number of survey categories completed by participants and number of respondents per category.

3.2. Multiple choice responses

Figure 2 presents an overview of the Likert scale and multiple-choice responses for questions P1, P2, P3, V1, M5 and F5. There was strong agreement that the ecosystem services concept could increase societal interest in conservation (P1) and raise awareness of human reliance on natural systems (P2), but opinion was divided as to whether an economic approach could support better decision-making (P3). There was a shared vision that the ecosystem services concept would achieve a paradigm shift in environmental protection

(V1C). Three myths frequently encountered were that the ecosystem services concept: does not consider the intrinsic values of nature (M5B); is a capitalist paradigm about making money (M5A); implicitly accepts that human benefits are the only things that should be protected (M5D). The most dominant frustrations with ecosystem services were: challenges to communicate non-economic research due to misconceptions that economic valuation is at the core of the concept (F5C); that it has become such a buzzword that the concept becomes increasingly vague (F5E); and that the terminology is too complicated and academic to use with non-expert audiences (F5A).

Figure 2. Responses to the closed questions in the survey.

3.3. Cross-cutting themes

Thematic content analysis helped structure the richness of the open question responses. Supplementary Material 2 provides an overview of the identified themes per question. Identical or highly related themes emerged for different questions and different survey categories. Results were therefore further synthesised to five cross-cutting themes, which are described below. The descriptions are based on the open-ended survey responses and identified themes, which are referenced, and illustrated by direct quotes.

3.3.1. Cross-cutting theme 1: Purpose of the concept

The core purpose of the ecosystem services concept is viewed by most respondents as a metaphor that raises awareness of the many ways human well-being depends on natural systems. This was evident in responses to P1 and P2 (Figure 2), and confirmed by the open-ended answers to P4. The latter reveals more complex and diverse views, which could be structured in a simplex diagram around four themes: awareness raising; decision-making; science; and a holistic approach encompassing these three themes (Figure 3). Each respondent was illustratively plotted in the diagram based on an interpretation of their response to P4. Most respondents can be placed in the 'Awareness Raising' corner of the simplex diagram based on responses such as the following two quotes.

"The ecosystem service framework is useful to quantify the multifunctionality of ecosystems and to demonstrate how human health and wellbeing depend on the multiple functions and services of ecosystems. It is a concept that can be used to increase awareness among ecosystem users and to support conservation." – Academic Researcher response to P4.

"The integrative transdisciplinary character of the approach is very suitable to raise awareness, support and integrate different valuation and quantification methods (social, ecological, economic) that all are needed to support sustainable resource management and decision making." – Academic Researcher response to P4.

The ‘Decision-making’ corner is populated by answers that emphasised how the ecosystem services concept supports natural resource management and allocation, or explicitly referred to decision-making. Note that all respondents falling in this part of the diagram are researchers while practitioners making or supporting land management decisions were absent.

Entries in the ‘Science’ corner highlighted the ecosystem services concept as a cognitive exercise, aimed at better understanding of socio-ecological systems.

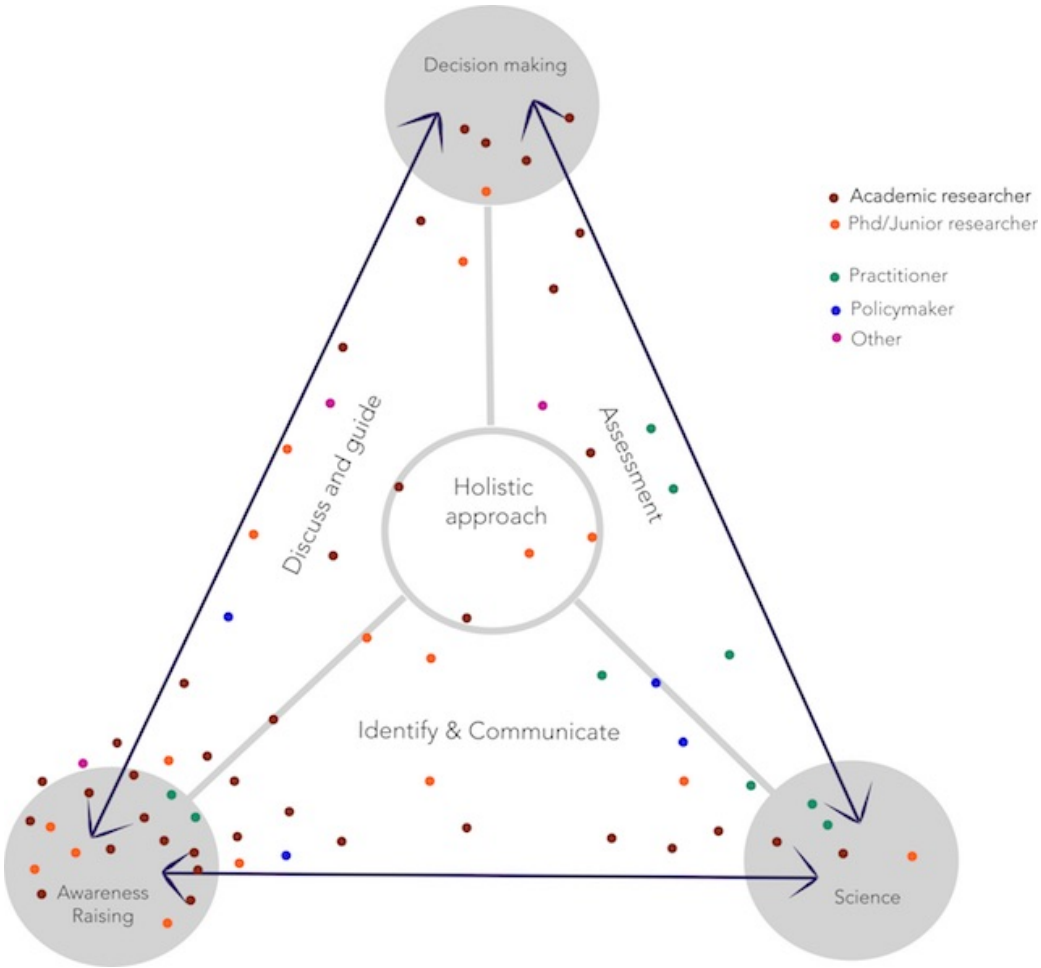


Figure 3. Simplex diagram illustrating different views about the main purpose of the ecosystem services concept expressed by 87 respondents in response to survey question P4. Each dot represents one respondent and is labelled for different respondent types.

Between the corners of the diagram, conceptual axes summarise entries and positions that combine elements from different corners. 'Assessment' connects the 'Decision-making' and 'Science' spheres, and entries were plotted here if they referred to understanding and managing ecosystem services, or specifically talked about assessment. The 'Identify and Communicate' axis between 'Science' and 'Awareness raising' is populated by entries which related to communicating with stakeholders and demonstrating the links between human and natural systems to a variety of audiences. Lastly, the 'Discuss and Guide' axis that connects 'Awareness Raising' and 'Decision-Making' features entries concerning guiding policy and influencing politicians, veering towards the action research domain. The centre of the diagram highlights the holistic approach of the ecosystem services concept. This was emphasised – to greater or lesser degree – in many answers and conceptually bridges the three corners of the triangle.

3.3.2. Cross-cutting theme 2: Economic valuation

Although frequently mentioned and occasionally criticised (V2, V3), economic valuation was – overall – not perceived to be inherently problematic, but its potential misuse was a concern for many. However, respondents disagreed whether an economic approach would help decision-making (Figure 2; P3). Participants were concerned that misuse of the ecosystem services concept could lead to poor decision-making, rushed and under-resourced assessments used to further a political agenda, and a bias towards industry interests (P5, V2). Several respondents warned against considering the ecosystem services concept as a panacea or cure-all for any environmental or resource management challenge regardless of the appropriate scale, methods and application of the framework (V2). There were also concerns about the framework potentially backfiring by providing a rationale for

environmental degradation rather than conservation (P5) as illustrated by the following quote:

"The misconception that it is all about utilitarian and monetary values. This is untrue, even to the contrary. However, this has been repeated so often, and some instances in fact do misuse the concept that way still. Kind of a self-fulfilled myth almost." – Academic Researcher response to M1.

Thematic content analysis revealed that these frustrations stem from: a polarised academic debate, and to a lesser extent from opposition with conservationists with further confusion stemming from media and high-profile publications; ecosystem services terminology and underlying conceptual framework; dominant worldviews and ideologies (M3). There was also considerable frustration about false perceptions that economic valuation is central to the ecosystem services concept, which was expressed exhaustively as a common misunderstanding (M1), but also as a frustration (F1) as illustrated by the following quote:

"That ecosystem services is all about 'valuing nature' - it's an approach that should be used very intelligently to frame environmental management challenges through a more socially relevant and integrated lens. Valuation is just one tool in the ecosystem services basket." – Policymaker response to M1.

3.3.3. Cross-cutting theme 3: Social and cultural values

Although economic valuation was not seen as problematic – as explained above – many respondents were concerned about the lack of non-economic valuation methods (V2), and the more limited interest and ability to include non-economic valuation in decision-making (V2). This bias can lead to poor decision-making (P5), and the explicit incorporation of social and cultural values into decision-making was expressed as an important step in the future development of the ecosystem services concept (V3). This would prevent misuse of the framework (P5) and help overcome a range of shortcomings currently identified (F3) –

including a bias towards economic valuation approaches and a lack of social science compared to ecological and environmental sciences and economics. Embracing social and cultural values was seen as important communication pathway to both wider society and decision makers (V3, F2, F4), countering potential misunderstandings and inappropriate use of monetary definitions of value (M4), and a key requirement to realizing the transformative potential of the framework (V3, F4). The following quote is one of many emphasising the importance of social and cultural values:

"Incorporate the cultural (and spiritual) value of nature more which brings back the connection to nature and why we care about nature." – Junior researcher or student in response to V3.

3.3.4. Cross-cutting theme 4: Inter- and transdisciplinarity

Many respondents hope the ecosystem services concept would be considered a paradigm shift in environmental protection within the next 20 years (35% or responses; V1C Figure 2). Despite this apparent enthusiasm, a broad range of challenges impeding the widespread use of the ecosystem services concept were raised (V2) including: the lack of training and awareness of the concept among policymakers and practitioners; a lack of demonstrable policy impact and evidence of halting environmental degradation; institutional barriers and 'silos' in research and governmental bodies; and the technocratic and/or utilitarian terminology. These challenges were mirrored in frustrations about the bias and limitations in methods and decision-making processes (F3).

There was recognition that the ecosystem services concept has been a catalyst for promoting collaboration across disciplines (P4), but that expanding collaboration is essential to stimulate dialogue and generate common understanding that is necessary to achieve

societal impact (V3, F4). Framing the challenges around issue-based research will encourage transdisciplinary collaboration between disciplinary experts, business stakeholders and public body representatives (V3, F4). The involvement of knowledge brokers and the media is critical in supporting collaboration and in communicating outcomes (F4). The following quote is one of many calling for interdisciplinary research:

"Ultimately, it is critical for a more interdisciplinary approach to the scientific research agenda to enrich the research and facilitate better policy translation and a reduction in the emergence of perverse policies." – Respondent from 'other' category in response to V2.

3.3.5. Cross-cutting theme 5: Ecosystem services in practice

From the policy and practitioner side, a clear need for practical learning emerged (V2, F1, F3, F4), and case study research was mentioned frequently as a way to progress the implementation of the framework to support land management decision-making (V3, F4). Several key steps for further development of the ecosystem services concept were identified (V3, F4): develop and share targeted information, packaged and communicated appropriately to selected audiences; engage stakeholders and public; bring business and researchers together to encourage innovation and creation of new flexible business models that integrate ecosystem services; include more socio-cultural values and by extension social scientists; and strengthen the integration of ecosystem services into all policy sectors, in dialogue with researchers and practitioners.

There were many frustrations related to the user-friendliness of the ecosystem services concept (F1, F2). Irritations about the academic nature or the terminology (F5A, Figure 2), has already been mentioned in this respect, but the content analysis revealed frustration around the lack of standardisation (F2), insufficient suitable and accessible methods (F3),

and a lack of data (V2, F3). Practitioners also signalled being overwhelmed by the variety of categorisations and tools available, and the background information required for their appropriate application (F3). Challenges remain to move the ecosystem services concept into the mainstream of natural resource management, with many calls to increase the user-friendliness of planning and decision support tools to support their application beyond current users and to better share the large amount of knowledge and learning that is generated by case study research (V3, F2, F4). The following quotes illustrate the frustration with the user-friendliness of the ecosystem services framework:

"The language – and therefore the concept – suffers from its technocratic, utilitarian image." – Academic researcher in response to V2.

"It is frustrating how many parties seem obsessed with re-classifying ecosystem services on a continual basis - this is often unnecessary and unhelpful when seeking to implement a joined-up approach across different interest groups." – Policymaker response to F1.

3.4. The Antwerp Declaration

The 'early findings' document, included in the EESC delegate pack (see Supplementary Material 3), formed the basis for the participatory exercises during the conference, which received input from approximately 100 individuals. These participatory events largely confirmed the cross-cutting themes summarised in section 3.3, although greater emphasis was placed on the importance to focus the ecosystem services concept on the principles of sustainability. The discussion also provided guidance about how to translate the findings to a short Declaration that forms a call for action that was signed (on a voluntary basis) by the conference delegates. The resulting Declaration (Figure 4) was presented at the closing

plenary and has been signed by 331 people on the website www.antwerpdeclaration.com following the conference (last count 17 August 2018).

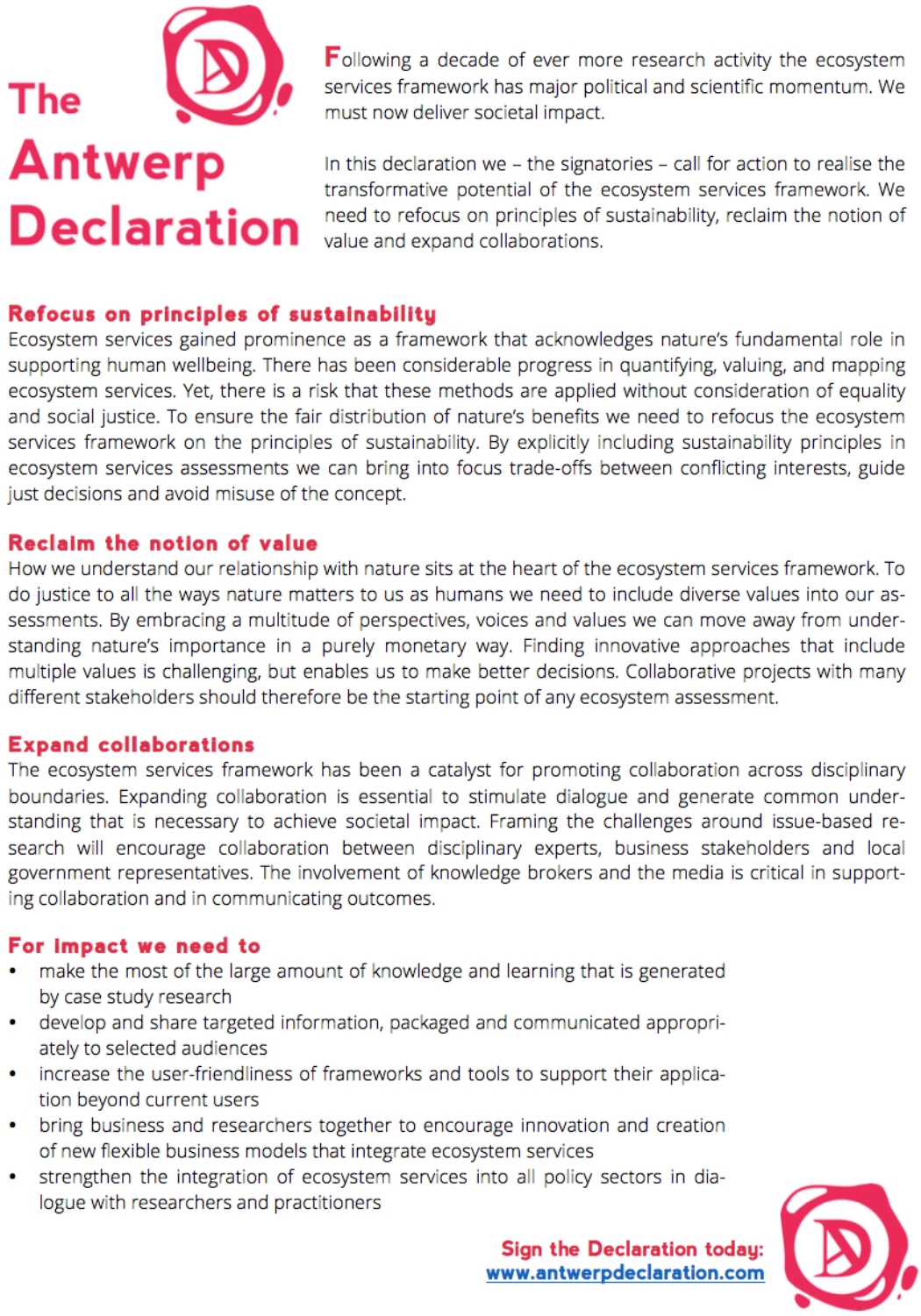


Figure 4. The Antwerp Declaration – www.antwerpdeclaration.com

4. Discussion

The EESC represented a rare opportunity to collect the views of a varied group of researchers, practitioners and policymakers engaged with the ecosystem services concept. We recognise our result reflects a primarily Eurocentric perspective. However, the survey received many responses and the events held at the conference were well attended, allowing us to collect insights from a diverse group.

4.1. The role of the ecosystem services concept in the science-policy interface

Responses to our survey demonstrate the tension between the different roles that the ecosystem services concept can play at the science-policy interface. Many participants expressed the view that the concept was a useful awareness raising tool and could be used to integrate different perspectives and approaches in environmental management (Cross-cutting theme 1). That is, to function as a boundary object. Many academics in our study did not identify scientific inquiry as the primary role of the ecosystem services concept, instead clustering to a much greater extent in the 'Awareness Raising' corner. This could indicate a perception among academics of ecosystem services as an advocacy tool, rather than a primarily scientific concept (Barnaud and Antona, 2014; Crouzat et al., 2017).

There were also concerns around the lack of standardisation and the user-friendliness of the concept for decision makers (Cross-cutting theme 5). Indeed, many practitioners and policymakers did not see the core purpose of the ecosystem services concept as contributing directly to decision-making (Figure 3). This is consistent with recent literature suggesting that, despite a number of projects and toolkits aimed at integrating ecosystem services into decision-making, assessments rarely play an instrumental role in influencing

decisions (Dick et al., 2018; Martinez-Harms et al., 2015; Ruckelshaus et al., 2013; Saarikoski et al., 2018).

Standardisation was the most frequently cited remediation for the issue of user-friendliness, amongst both practitioners and academics (F2). Efforts are being made to standardise the categorisation of ecosystem services (primarily through the Common International Classification of Ecosystem Services (CICES[6])), and several calls and attempts to standardise conceptual frameworks and assessment/valuation approaches have appeared in the literature (Boerema et al., 2017; Boyd and Banzhaf, 2007; Seppelt et al., 2012, 2011). However, standardisation involves the curtailment of some of the conceptual and methodological diversity that exists within the ecosystem services community, potentially hampering inter- and transdisciplinary dialogue and communication supported by our respondents (Cross-cutting theme 4: Inter- and transdisciplinarity). Standardisation correlates to the creation of 'infrastructure', and we follow Steger et al. (2018) in suggesting that such a move would limit the capacity of ecosystem services to function as boundary objects.

Decreasing existing ambiguity around the ecosystem services concept, and space for disagreement or multiple interpretation, may limit the ability of ecosystem services to act as a boundary object and facilitate communication and collaboration between different stakeholders, decision makers and local communities. This supports the conclusion of Galler et al. (2016), that ecosystem services may function most effectively as a boundary object

[6] www.cices.eu

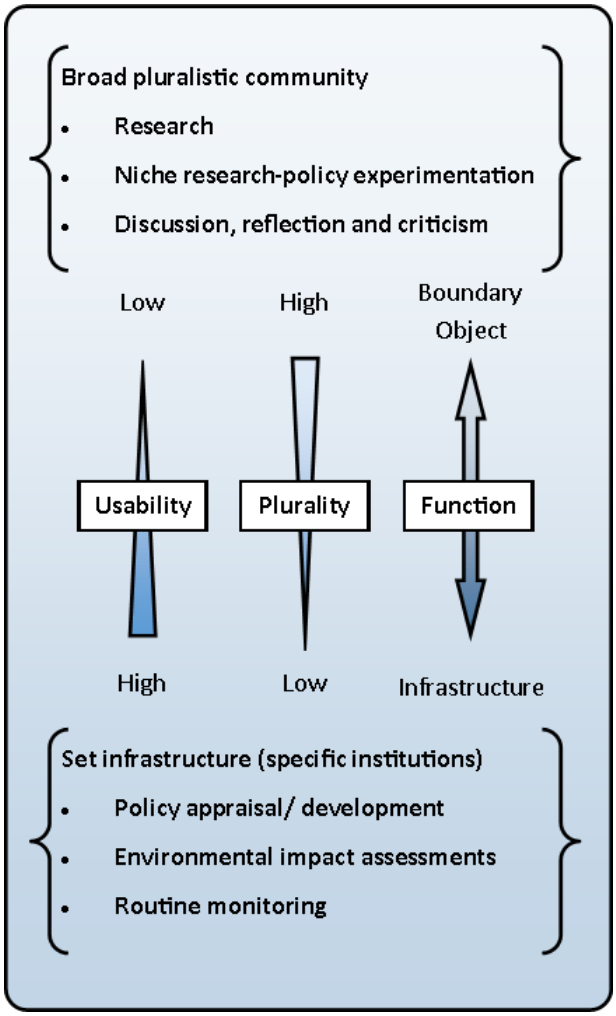
above the level of specific policy or management decisions. This does not imply that the concept plays no role in policymaking; others have identified conceptual learning, consistent with the boundary role of ecosystem services, as a promising impact pathway of ecosystem services assessments and research (Beaumont et al., 2017; Carmen et al., 2018; Dick et al., 2018; Ruckelshaus et al., 2013).

There is a potential conflict between those who see ecosystem services as a tool for raising awareness and discussion, and those who wish to see it standardised and used in decision-making. We argue that this can be reconciled by accepting that the concept is capable of playing both roles at once, and that whilst the creation of standardised infrastructure should be supported, it is necessary to maintain a more pluralistic notion of the concept within academic and policy debates (Figure 5).

The creation of infrastructure will reflect and embody the norms of the context in which it is developed (Saarela and Rinne, 2016; Turnhout, 2009). This can be a necessary trade-off to improve usability and uptake of the concept directly in decision and policymaking, however it can become problematic for two reasons: 1) if the knowledge, views or values of a particular group or groups within this context are excluded; or 2) if such infrastructure is transplanted to a cultural context that is significantly different from where it was created (as may be the case in transnational environmental governance settings).

Experimentation with the ecosystem services concept in different policy contexts is increasing, and it is possible that we will see a continued construction of infrastructure within different administrative jurisdictions (at a sub-national, national, and international

scale) (Bezák et al., 2017; Bouwma et al., 2018; Mauerhofer, 2018; Mauerhofer and Laza, 2018; McKinley et al., 2018). As this happens, retaining a highly pluralistic notion of the concept that exists above any contextually specific infrastructure has two distinct advantages over full standardisation of the concept. First, it maintains space for worldviews that are excluded through the construction of infrastructure, allowing ecosystem services to still function as boundary objects that enhance debate and awareness raising over the relationship between nature and human well-being. Secondly, it allows space for more critical, dissenting voices and academic disciplines to highlight constantly the way that the



creation of infrastructure can obfuscate and normalise political choices made during its creation (Kull et al., 2015; Turnhout et al., 2016).

Figure 5. Trade-offs between the function of ecosystem services as a boundary object and as set infrastructure capable of informing policy and decision-making, in terms of usability and plurality.

4.2. Valuation of ecosystem services

Values, and valuation, are useful vehicles to explore the dynamics between ecosystem services in the broad, pluralistic sense (where it is most effective as a boundary object), and ecosystem services as set infrastructure. Our results show a clear desire for social and cultural values to be better captured in ecosystem services assessments (Theme 3: Social and cultural values). This was reaffirmed through input to the Antwerp Declaration, where the need to 'reclaim' the notion of value was raised. This desire resulted from the dual perception that 1) integrating a plurality of values is essential to ensure that ecosystem services assessments lead to inclusive decision-making, and 2) a perception exists that only a limited definition of value is captured within the ecosystem services concept.

The concept of ecosystem services has stimulated much debate about the notion of value, and how best to measure it; bringing together scholars from a wide range of disciplines (Chan et al., 2016, 2012; Edwards et al., 2016; Fanny et al., 2014; Fish et al., 2016; Jacobs et al., 2018, 2016; Jax et al., 2013; Kenter et al., 2016c, 2015; Ranger et al., 2016; Sagoff, 2011). Here, we see ecosystem services function as an effective boundary object, and many methodologies now exist for integrating different types of values into ecosystem service assessments (Iniesta-Arandia et al., 2014; Jacobs et al., 2016; Kenter, 2016; Kenter et al., 2016c, 2016a; Ranger et al., 2016). Such methodologies are now established as a part of the plethora of existing ecosystem services approaches and practices. Operationalizing these methods in real world decision-making was a core priority that emerged from our survey

(Theme 3: Social and cultural values). However, none of these methods are capable of capturing all types of value (Jacobs et al., 2018), and it is not necessarily the case that such methods will become standard practice within policy and decision-making. In the UK for example, despite recognition of the importance of shared and cultural values within the UK National Ecosystem Assessment (UK NEA, 2014), the Treasury 'Green Book' which dictates suitable valuation methods for public body decision-making in the UK relies exclusively on methods derived from neoclassical economics (Treasury, 2011). As much as an economic figure might be open to boundary work (Jadhav et al., 2017), it cannot be removed by the institutional context that created it and cannot be neutral; this is totemic of the broader issue of creating infrastructure for ecosystem service assessment and valuation.

Narrow economic valuation of ecosystem services was criticised by some respondents to our survey, however it was largely not seen to be inherently problematic (Theme 2: Economic valuation); matching findings from previous studies (Fisher and Brown, 2015; Hermelingmeier and Nicholas, 2017). Concerns were raised however regarding the potential for ecosystem services studies to be misused to further specific political agendas or support environmentally destructive activities, as may be the case if infrastructure is created in the context of highly extraction-driven, capitalistic norms. Maintaining a pluralistic notion of the ecosystem services concept will ensure that space remains for the critical reflection of the use of the concept within different institutional settings. Within this context, the desire to ensure that social and cultural values are captured offers a potential guiding principle.

Epistemologically, meaningful knowledge can be generated both about how others see and value the world, and about how collectives of individuals do at different scales, moving

beyond the notion that value is held only be individuals. There is a growing body of theory on how shared and cultural values are formed and created, and how these relate to other value types (Kenter et al., 2016b, 2016c; Raymond et al., 2014). Using the notion of shared and cultural values as a guiding principle of the ecosystem services community, it is necessary to engage with this theory to adopt methods consistent with this. This has implications for neoclassic approaches to economic valuation, due to the inadequacy of the theory of marginal utility value to meaningfully engage with the concept of shared values. Neoclassical approaches are prevalent in ecosystem services values, both at the research and experimental policy assessment level, and in settings where the valuation of some services is institutionalised. However, such hegemony of neoclassic economics means that rejecting valuation based on marginal utility theory entirely might significantly reduce the space for ecosystem services with national and international policymaking.

4.3. Inter- and transdisciplinary approaches

Increased collaboration, both between academic disciplines and between academia and wider society, was identified as a key area for the development of ecosystem services research and practice. The expansion of inter- and transdisciplinary work was a clear desire of the respondents (Theme 4: Inter- and transdisciplinarity), and matches aspirations in the literature (Carmen et al., 2018; Jacobs et al., 2015). The inclusion of more social scientists within ecosystem services assessments was particularly stressed as a necessary step to increase the integration of social and cultural values (Theme 5: Ecosystem service in practice).

The ecosystem services concept arose at the interface of ecological and economic science, however is now engaged with and functions as a boundary object between a large range of disciplines (Chaudhary et al., 2015). Yet physical, economic and social geographers are just a few groups to have been identified as having useful, but underutilised insights (Barnaud and Antona, 2014; Dempsey and Robertson, 2012; Potschin and Haines-Young, 2011). Even large scale efforts at interdisciplinary working, such as the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), are dominated by natural scientists (Timpte et al., 2018) and within IPBES the need for a stronger engagement of social science and humanities was particularly emphasised (Díaz et al., 2018).

Our results, suggesting the lack of engagement from some disciplines, may be due to the way the concept is perceived. Although respondents to our survey did not see economic valuation as central to the ecosystem services concept (P4), the perception that the two are closely interlinked was commonly encountered by participants; primarily being held by other scientists and, to a lesser extent, conservationists (Theme 2: Economic valuation). One respondent suggested that many groups and scientists simply refuse to engage with ecosystem services (P2), due to its image as a technocratic and utilitarian approach. This finding matches others who have noted the tendency to conflate 'ecosystem services' with 'payments for ecosystem services' (PES) schemes, and the potential for such confusion to deter some from engaging with the concept (Schröter et al., 2014; Schröter and van Oudenhoven, 2016).

The perception that the concept of ecosystem services is equivalent to putting a price on nature limits its capacity to function as a boundary object, as some may regard it as

antithetical to their way of viewing the human-nature relationship. We suggest that future collaborations may be assisted by addressing false perceptions of the ecosystem services concept, particularly regarding the centrality of economic valuation. Increasing integration of other disciplines into ecosystem services research may be assisted by improving communication to overcome myths about the concept (see section 5.1.3: Economic valuation), and by demonstrating the contributions that different disciplines can make through the expansion and publication of case study research.

As infrastructure is created to embed ecosystem services assessments with specific governance institutions, it will be impossible and potentially unnecessary to maintain the disciplinary heterogeneity that exists within the community. However, ecosystem service assessments still require skilled interdisciplinary teams, particularly if they are to capture social and cultural values as well as the biophysical elements of ecosystem services. Assessment approaches also legitimise some knowledge claims at the expense of others, meaning that in the context of transdisciplinary assessments it is important to co-develop the design of the research between knowledge holders and to be open about methodological and data-related choices. This consideration requires the deployment of trained social scientists to develop suitable processes for knowledge co-production. Equipping public bodies with the necessary skills therefore requires significant investment, as currently environmental impact assessments and policy appraisals are not necessarily conducted by teams of researchers with interdisciplinary skills (Rozas-Vásquez et al., 2018; Turnpenny et al., 2014; Wawrzyczek et al., 2018).

It is in this context that it becomes crucial to retain a diverse, pluralistic community of practice outside of any specific attempt to institutionalise the concept. Such a community can play at least two vital roles: 1) continuing to bring different groups together in inter- and transdisciplinary research projects to better understand the relationship between nature and human well-being; 2) to critically appraise the construction of infrastructure within particular institutional contexts, specifically in relation to which knowledge or groups are excluded from the process. Critical geographers are uniquely positioned to offer such critique, as their discipline is well versed in exploring the power relations around the social construction and mobilisation of emerging and 'taken for granted' concepts and practices (Kull et al., 2015; Turnhout et al., 2016).

Inter- and transdisciplinary research and assessment approaches are strongly supported within the ecosystem services community (Ainscough et al., 2018; Albert et al., 2017; Carmen et al., 2018; Costanza et al., 2017; Steger et al., 2018). This acts as a guiding principle in the broad sense that it rejects narrow disciplinary approaches to ecosystem service assessment and valuation. This brings the norm of collaborative working and respect for different knowledge types. However, whilst important, this commitment does not offer a guide to the breadth of pluralism within the ecosystem services community per se; as it is more an acceptance that plurality itself is a positive thing.

4.4. Sustainability and ecosystem services

A need to focus on the principles of sustainability was emphasised during events at the conference and became a core element of the Antwerp Declaration. Sustainability is usually understood as equitably meeting the needs of current generations without reducing the

capacity of future generations to meet their needs (WCED, 1987). As sustainability is not necessarily implied by the ecosystem services concept, many authors have sought to synthesize the two concepts to ensure that the ecosystem services concept is applied in a manner that is consistent with the principles of sustainability. This literature makes two key points. First, that the biophysical processes underpinning ecosystem services (and inherent limits in their ability to survive under different levels of stressors) should not be lost behind the 'stock' metaphor of ecosystem services. Secondly, stakeholder preferences and values should form part of ecosystem service assessments, to ensure people's needs are equitably accounted for.

Jacobs et al. (2013) stressed the need to refocus ecosystem services research around a 'strong' notion of sustainability; suggesting that the majority of ecosystem services research focuses on the efficient use of ecosystem services, but not the inherent limits and boundaries of the reproductive capacities of underlying natural capital. These authors suggest that there is high uncertainty around the capacity of natural capital to be maintained which should factor into the assessment of ecosystem services and any related scenario modelling or policy analysis. These authors also emphasise the centrality of fairness and equity to the sustainability concept and suggest that distributional effects should be central to any ecosystem services analysis.

Schröter et al. (2017) discuss ecosystem services as a descriptive and normative scientific concept, whose application may conflict with the principles of sustainability. They claim that 'if the ecosystem service concept is understood as contributing to sustainability, ecosystem services need to be conceptualised through sustainability strategies rather than assessing all

forms of natural resource use in aggregated, snap-shot assessments' (Schröter et al., 2017, p. 41). Cavender-Bares et al. (2015) seek to synthesise economic, ecological and systems theory to integrate ecosystem services and sustainability. Principally, they suggest accounting for the ecological mechanisms underpinning services in the way assessments are carried out, particularly the inherent biophysical limits of these processes. By integrating preferences and values of different stakeholders, coupled with a systems dynamics approach, ecosystem services assessments could consider how the whole system might develop over time (Cavender-Bares et al., 2015). Similarly, Bennett and Chaplin-Kramer (2016) point to the development of a socio-ecological systems perspective as a step forward in integrating sustainable use to the ecosystem services research agenda (although it is not clear that this is an 'advancement' as much as a return to the roots of ecosystem services science, given its origins in systems ecology (Costanza et al., 2017; Odum, 1971). Despite all these calls, sustainability issues of ecological thresholds and fairness are still often ignored in ecosystem services research and practice (Dendoncker et al., 2018).

Focusing on principles of sustainability, coupled with consideration of social and cultural values of ecosystem services, was seen as key to ensuring the concept was not misused or used to justify environmentally degrading activities (Theme 2: Economic valuation). Here we reiterate, with the support of respondents who contributed to the development of the Antwerp Declaration, the call to adopt the normative and analytic content of the concept of sustainability in discussion and application of the ecosystem services concept. We add the caveat that, as the ecosystem services concept is embedded as infrastructure in planning and decision-making in different contexts, the need for this to be coupled with the principles of sustainability becomes greater.

In terms of the main types of pluralism we have discussed, the notion of sustainability provides limits to the epistemological and methodological approaches within ecosystem services research, whilst also placing it within a broader normative framing. It is therefore a useful concept to guide the discussion and practice around the ecosystem services concept. This obviously has ramifications for the types of epistemological, theoretical and methodological approaches to ecosystem services research and practice compatible with sustainability.

A heavy focus on human values, or biophysical processes, whilst not precluded by a commitment to sustainability, should also be treated with caution. Methodologies that seek purely to understand how humans value their environment will not capture ecological dynamics and limits. Similarly, approaches focused purely on the biophysical underpinning of ecosystem services may miss the important distributional impacts of changes between different user groups. At the broad level of research and policy-science innovations, this is not problematic as studies may seek to answer certain questions or develop new methods. However, as infrastructure is created, it is important that neither values, nor biophysical dynamics are neglected. This reinforces the need to ensure that inter- and transdisciplinary practices are carried forward as the concept is institutionalised.

5. Concluding remarks

There are advantages and disadvantages to the ecosystem services concept being a boundary objects or set infrastructure, and likely these roles represent poles on a spectrum rather than a binary split. We find these two notions useful lenses for understanding the

role of the ecosystem services concept at the science-policy interface, and for framing the views of different user groups. As the concept is further institutionalised in governance institutions, it is important to remain cognizant of the trade-off that exists between these two roles and to not lose sight of the political choices necessary for the creation of set infrastructure.

The integration of the principles of sustainability, and the inclusion of social and cultural values have been prevailing in the literature for some time. We suggest that these can operate as guiding principles to the application of the ecosystem services concept, however do not suggest this is an exhaustive list. The work of guiding the multitude of interpretations and applications of the ecosystem services concept is an ongoing reflexive task of the wider community, and we suggest that surveys such as ours can provide useful data for such a process.

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Conflicts of interest

None

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Supplementary Material

SM1 – Full questionnaire

SM2 – Coding Matrix

SM3 – Early findings documents

Supplementary Material 1

Full survey circulated among 350 early registrants to the European Ecosystem Services Conference 2016.

Q1. What would you like to talk about? *(Multiple-choice, single choice, mandatory)* A) Values B) Goals C) Myths D) Grumbles
Purpose (Values In the original survey)
What do you think is at the heart of the Ecosystem services framework? […] Please indicate how closely each of the following statements resembles your own thinking: P1) The ecosystem services concept provides a utilitarian framing of ecosystem functions as services in order to increase public interest in conservation. *(5-point Likert scale)* P2) The concept of ecosystem services denotes a generic idea or metaphor to increase awareness of how human well-being in many ways depends on natural systems. *(5-point Likert scale)* P3) Using an economic approach to environmental issues can help decision-makers to determine the best use of scarce ecological resources at all levels. *(5-point Likert scale)* P4) Now that you've gone through the literature statements, can you put down in your own words what you think is at the heart of the ecosystem services framework? *(Open-ended)*
P5) What, to your mind, would be the worst misuse of the ecosystem services framework? (Open-ended)
P6) Beyond basic research ethics and good practice, what values and principles or ideas should guide the practical applications of the ecosystem services framework? *(Open-ended)*
Visions (Goals in the original survey)
V1) In 20 years time, what role should the ecosystem services framework have in society? *(Multiple-choice, tick all that apply)* A) All policy is centred on the ecosystem services framework, from local to international agreements B) It is a household term, something everyone is familiar with and needs little explanation C) It is considered the paradigm shift that turned environmental protection into a core priority D) It's around but remains quite a technical term, confined to academia and high-level policy E) Everyone has finally come to their senses and moved on to a more useful framework F) Other (please describe below)
V2) What are the main challenges for the widespread use of the ecosystem services framework *(Open-ended)*
V3) What do you think are key steps to undertake in the future development of the ecosystem services framework? *(Open-ended)*
Myths
M1) Can you describe a common myth or misunderstanding you frequently encounter in your work? *(Open-ended)*
M2) Who holds these erroneous views? *(Open-ended)*
M3) And what to your mind is the source of confusion that gave rise to these myths? *(Open-ended)*
M4) How would you debunk the myth? *(Open-ended)*
M5) Have you ever encountered one of the following claims regarding ecosystem services in your work? *(Multiple-choice, tick all that apply)* A) The ecosystem services framework is based on economic terminology and therefore a capitalist concept, it's just an extension of the capitalist paradigm and all about making money B) The ecosystem services framework undermines the widely held moral-aesthetic value arguments for environmental protection and does not consider the intrinsic value of nature.

C) The ecosystem services framework implicitly accepts that happiness and wellbeing can be quantified. D) Ecosystem services are purely human-centric, the framework implicitly accepts that human benefit is the only good and that we should solely protect services if they benefit humans. E) The traditional, ethical arguments for conservation have failed, so the ecosystem services framework embodies an appeal to self-interest instead. F) The ecosystem services framework cannot support decision-making nor can it create a solution that pleases everyone and therefore has no use in informing environmental policy. G) Other (please describe below)
Frustrations (Grumbles in the original survey)
F1) What do you find most frustrating about working with the ecosystem services framework? *(Open-ended)*
F2) What would be the best way to resolve your grumble? (*Open-ended)* What to your mind is the biggest theoretical, moral or practical shortcoming of the ecosystem services framework? *(Open-ended)*
F3) How could that shortcoming be remedied? *(Open-ended)*
F4) Have you ever encountered one of the following frustrations? *(Multiple-choice, tick all that apply)* A) The terminology of ecosystem services is too complicated and academic, impossible to use with non-expert audiences. B) The ecosystem services framework is so contentious, the use of the term is best avoided when applying the framework in practice, to avoid shouting matches and people disengaging on principle. C) In people's perceptions the ecosystem services framework is equalled with monetary valuation and selling off nature, making it a hard sell even if the study at hand doesn't look at economic aspects at all. D) Policy makers have adopted the ecosystem services framework for their own purposes, without really paying attention to its theoretical underpinnings. E) Ecosystem services is such a hyped buzzword, it is becoming increasingly vague and opaque, everybody uses it without much regard for what it actually entails. F) The phrase 'ecosystem services' is used to cover a growing variety of quite distinct concepts and approaches. G) Other
Background
A1) In the field of ecosystem services, where do you think the biggest differences of opinion lie? (*Open-ended)*
A2) What do you do? *(Multiple-choice, single option)* A) Student/Junior Researcher B) Academic Researcher C) Policy maker D) Practitioner E) Other
A3) What is your main field of study? *(Open-ended)*
A4) How long have you been working with the ecosystem services approach? *(Open-ended)*
A5)What gender do you identify with *(Open-ended)*
A6) Schedule permitting, would you be interested in attending a follow-up workshop at the conference, to discuss some of the topics raised here in more detail? (*Yes/No)*
That was all, thank you so much for taking part and we're looking forward to meeting you in September. Would you like to do another theme? *(Yes/No)* [If yes, redirects to Q1]

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Supplementary Material 2

Coding matrix of the inductive thematic content analysis. Counts refer to the number of times each theme was mentioned by each user group.

Theme	*Summary of responses coded under theme*	Academic Researcher	Student/Junior Researcher	Practitioner	Policy maker	Other	Total
Purpose (Values)							
P4 - Can you put down in your own words what you think is at the heart of the ecosystem services framework?							
Decision-making aid	*ES as tool/support for decisionmaking & resource management*	7	1	2	1	1	**12**
Scientific approach	*ES as a scientific endeavour, expanding knowledge*	4	2	3	1	0	**10**
Awareness raising	*ES to demonstrate value of nature*	22	11	4	0	1	**38**
Holistic approach	*ES as an encompassing approach to complexity*	3	3	0	1	1	**8**
Advocacy x Science	*Responses combining science and awareness raising, focus on general public*	8	4	1	2	0	**15**
Decision x Activism	*Responses combining awareness raising and decision support, focus on policy*	4	4	0	2	1	**11**
Science x Decision	*Responses combining science and decision support, technocratic focus*	2	0	4	1	0	**7**
Other		4	1	1	0	0	**6**
P5 – What would be the worst misuse of the ecosystem services framework?							
Backfiring	*ES used to demonstrate that environmental degradation is affordable*	3	0	0	0	2	**5**
Monetary valuation	*ES solely used to put a price on nature*	28	8	4	2	1	**43**
Panacea	*ES used a cure-all applied without concern for context or applicability*	3	0	0	2	0	**5**
Poor decision making	*ES used in flawed decision-making processes*	7	2	1	1	1	**12**
Selling off nature	*ES used to commodify nature*	8	4	3	1	1	**17**
Other		6	4	4	0	0	**14**
Visions (Goals)							
V2 - What are the main challenges for the widespread use of the ecosystem services framework?							
Education & awareness	*Adressing lack of knowledge of ES framework and theoretical underpinnings*	6	2	2	2	1	**13**
Impact	*Lack of tangible impact (i.e. Halting of environmental degradation)*	0	1	0	0	2	**3**
Institutional barriers	*Historic and organisational challenges in academica and governance*	3	4	1	0	1	**9**
Methods, date & tools	*Methodological improvements needed and concerns around data gaps/quality*	11	4	5	2	1	**23**
Policy & decision making	*Lack of political will and vested interests in decision making*	4	2	2	0	2	**10**
Terminology	*Overly technical ES terminology acting as a barrier to widespread use*	9	3	0	0	0	**12**
Un-niching	*Need to move ES beyong a scientific margin into policy and public mainstream*	3	0	0	0	1	**4**
Other		1	0	0	1	0	**2**
V3 - What do you think are key steps to undertake in the future development of the ecosystem services framework?							
Better communication- General	*Responses citing better communication*	2	2	1	1	0	**6**
Better communication- Holistic emphasis	*Responses citing communication to promote holistic nature of ES framework*	0	1	0	1	0	**2**
Better communication- Stakeholder & public engagement	*Responses citing better communication with non-expert audiences*	1	1	3	0	0	**5**
Better decision-making	*Improving the decision-making process*	1	0	0	0	0	**1**
Better science- General	*Responses citing the need for better science in general (tools, methods, data, theory)*	9	2	3	3	0	**17**
Better science- Accounting	*Responses specifically citing need for better accounting for ES*	1	0	0	0	0	**1**
Better science- Include cultural values	*Responses focusing on improving inclusion cultural values in ES research/valuations*	3	2	0	1	0	**6**
Better science- Interdisciplinarity	*Responses citing need for working more interdisciplinarily in ES*	3	0	1	1	0	**5**
Science-policy	*Improvements to the science-policy interface and evidence based decisions*	15	5	1	1	0	**22**

Theme		Academic Researcher	Student/Junior Researcher	Practitioner	Policymaker	Other	Total
Myths							
M1 - Describe a common misunderstanding or myth around ecosystem services you frequently encounter in your work?							
All about the money	*ES revolves around monetary valuation of nature*	10	2	3	1	0	**16**
Other		5	1	3	0	0	**9**
M2 - Who holds these erroneous views?							
Conservationist	*Responses citing conservationists and/or environmentalists as myth believers*	4	1	0	1	0	**6**
Lay people	*Responses citing lay people as myth believers*	6	1	0	0	0	**7**
Scientists	*Responses citing other disciplines and scientists as myth believers*	8	3	1	0	0	**12**
Policymakers & practitioners	*Responses citing policymaker and/or practitioners as myth believers*	2	0	2	1	0	**5**
Other		2	0	2	0	0	**4**
M3 - What to your mind is the source of confusion that gave rise to the myth you've just described?							
Media & publications	*Responses citing certain ES publications or media in general as source of myths*	2	1	2	0	0	**5**
Terminology & concept	*Confusion seen as inherent to the language and concept of ES*	3	0	1	0	0	**4**
Woldview & ideology	*Responses citing ideological bias and vested worldviews as source of myths*	4	1	2	0	0	**7**
Other		5	1	1	1	0	**8**
M4 - How would you debunk the myth?							
Communication	*Improving communication around ES*	8	3	4	0	0	**15**
Expanding disciplinarity	*Working across disciplines and audiences*	3	0	1	0	0	**4**
Refine concept	*Improve ES framework conceptually*	1	1	0	0	0	**2**
Other		3	0	1	0	0	**4**
Frustrations (Grumbles)							
F1 - What do you find most frustrating about working with the ecosystem services framework?							
External skepticism	*Responses citing negative attitudes to ES framework*	3	0	0	0	1	**4**
Misuses	*ES framework being misapplied*	2	0	0	0	0	**2**
User friendliness	*Difficulties with terminology and high expertise needed to use ES & tools*	7	2	4	2	0	**15**
Practial implementation	*Difficulties with applying ES framework in practice*	4	0	1	2	0	**7**
Science shortcomings	*Scientific issues raised - lack of data, accounting methods, conceptual flaws*	5	4	2	1	0	**12**
Silos-Niche	*Lack of mainstreaming and inter/cross disciplinary work within ES*	4	1	0	0	0	**5**
F2 - What would be the best way to resolve your grumble?							
Best practice	*Spreading best practice guidance and knowledge sharing*	0	0	0	1	0	**1**
Educate	*Improving education around ES framework*	2	1	0	0	0	**3**
Interdisciplinarity	*Working across disciplines and audiences*	3	0	0	1	0	**4**
More research	*Issues can be addressed by further research into challenges*	1	1	0	0	0	**2**
Pick & roll	*Picking one ES framework methodology and sticking with it across all ES research*	0	0	1	0	0	**1**
Standardisation	*Standardising existing frameworks and methodologies (plural)*	3	2	3	1	0	**9**
Tailor & complement	*Tailoring ES framework to local contexts and use in conjunction with other tools*	1	0	0	0	1	**2**
F3 - What to your mind is the biggest theoretical, moral or practical shortcoming of the ecosystem services framework?							
Bias	*Problems relating to perceived ideological biases in ES framework*	0	1	0	0	0	**1**
Concept & method deficit	*Problems cited relating to the theory, concept and method of ES framework*	5	4	2	1	1	**13**
Decision-making deficit	*Issues with use of ES framework in (flawed) decision-making processes*	1	0	0	1	0	**2**
Practical implementation deficit	*Lack of practical applications of ES framework*	1	0	1	0	0	**2**
Social science deficit	*Lack of inclusion of social sciences in ES research*	4	1	1	0	0	**6**
F4 - How could that shortcoming be remedied?							
Communication	*Improved communication can address challenges*	3	0	0	1	0	**4**
Inter/ transdisciplinarity	*Improving and increasing work across disciplines and audiences*	5	0	1	0	0	**6**
More research	*Additional studies needed*	1	1	1	0	1	**4**
Public/ stakeholder engagement	*Better inclusion and outreach to general public and stakeholders*	1	1	0	2	0	**4**
Standardisation	*Standardising existing frameworks and methods*	2	3	1	0	0	**6**

Supplementary Material 3

Early findings documents circulated in the delegate pack to the all participants in the European Ecosystem Services Conference 2016.

The Antwerp Declaration

The Antwerp Declaration will outline a clear message from the conference participants about ecosystem services that is relevant to the wider world. It provides a means of communicating high-level views to a range of potential audiences including decision makers, academics and practitioners. The Declaration embodies a legacy for the conference and a statement of intent from the scientific community.

Survey

To inform the discussions on the conference we sent out an online survey in July to 350 early registrants. The questionnaire gathered views from the participants on the Values, Goals, Myths and Grumbles they encounter in their work with ecosystem services. A big Thank You goes out to the **121 participants** who contributed!

Values

The Values theme asked what participants considered the core of the ecosystem services framework.

> *Ecosystems services are a wide window through which we have to realise that our survival is dependent on the planet's ecology and that we have to start to work hand in hand with it.*

At its heart, the ecosystem services framework is still viewed by most as a metaphor that **raises awareness** of the many ways human wellbeing depends on natural systems. Although frequently mentioned and occasionally criticised, economic valuation was on the whole not perceived to be inherently problematic. Its potential misuse on the other hand was a concern for many and resonated strongly with responses in the Myths theme as well.

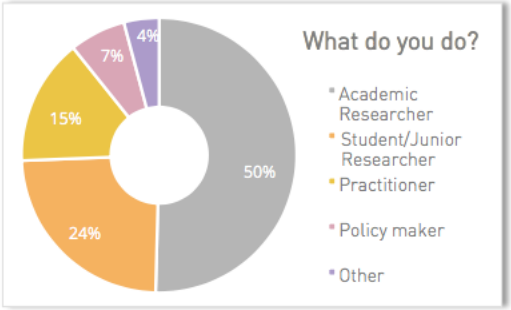
> *It's an approach that should be used very intelligently to frame environmental management challenges through a more socially relevant and integrated lens. Valuation is just one tool in the ES basket.*

However, most of our respondents come from an academic background, which begs the question from policy makers, applied researchers and practitioners:

Q – What are the practical benefits of using the ecosystem services framework on the ground? Does it indeed enable awareness raising and a more socially relevant approach to environmental management?

Goals

The ecosystem services community certainly does not lack ambition: in the Goals section the majority of respondents expressed a hope that in 20 years time the ecosystem services framework will have catalysed **a paradigm shift** that turned environmental protection into a core priority. However, despite this widespread enthusiasm and high-held hopes for the concept, a broad range of challenges was raised.



> *The language - and therefore the concept - suffers from its technocratic, utilitarian image. It has been used in this way so long that it is impossible to broaden it to embrace real-world problems (and their less tangible but essential values) fully. This is demonstrated by the still awkward and clumsy state of the cultural services debate, and the blunt refusal of many movements - and scientists - to work with it as a central concept. The time has come to face the fact that there are frontiers, and confine this concept to its safe operating space.*

We also asked what key steps are necessary for the future development of ecosystem services, and the answers were surprisingly homogenous: better communication, emphasising the holistic nature of the approach, more inclusion of socio-cultural values (and by extension social scientists), improve stakeholder engagement and strengthen the science policy nexus.

Q – Is concentrating on incorporating cultural values through transdisciplinary work and participative projects with many different stakeholders the most transformative frontier of the ecosystem services framework

Myths

We asked what myths people most frequently encountered in working with ecosystem services, and there was a very clear answer: it's all about the money. Economic valuation and commodification of nature was the most frequently raised point in this section. Interestingly enough, the reported sources of these myths and their audiences (who subscribe to the reported myths) show that it is mostly **a quarrel between scientists**. 'Other scientists' was the most cited audience to misunderstand ecosystem services, followed by conservationists, lay people, and finally policymakers & practitioners.

The remedies offered resonate with those mentioned in other themes: better communication and working more interdisciplinarily. However the direction of communication suggests an engagement gap between scientists and policymakers & practitioners, those who would arguably be one of the most important target audiences to reach. One respondent raised an interesting point in terms of the potential impact of applying the ecosystem services framework and the limits of scientific evidence:

> *[It is a myth] that describing a range of (natural) ecosystem services could counterbalance the conflicting interests of industry (and politics).*

Many respondents, especially from the policy and practitioners side called for best practice examples and effective case studies to demonstrate how ecosystem services are used in decision-making processes on the ground and to promote best practice.

Q — How can we encourage case study research of successful applications of ecosystem services that are actually being used in the decision making process?

Grumbles

A lot of the frustrations voiced in the Grumbles section had to do with **user friendliness** in various forms. On the scientific side there were complaints around the lack of standardization in the framework as well as insufficient methods, and a lack of data. Practitioners on the other hand signaled being overwhelmed by the variety of categorisations and tools available, and the background information required for their appropriate application.

Q — Instead of further adaption and refinement of ecosystem services frameworks, efforts should be focused on ensuring the existing frameworks and tools are understood by and accessible to practitioners and policymakers.

Events during the conference

Monday - Introduction

Opening address by Ben Delbaere.

Quote of the Day

From Tuesday to Thursday a statement will be up in a central location for you to discuss, leave comments and vote on. Stickers for voting have been provided: a different colour for each day and white for comments.

Tuesday - G4 Session

11:00-12:30

There will be an opportunity to discuss themes related to the Declaration in the G4 session *"Reflections on the last decade of ecosystem services research: Rights, Wrongs and the Way Forward"*. This session is organised by Alexander van Oudenhoven, Matthias Schröter and Sander Jacobs, and will take place in room K.201.

Wednesday – AD16 Workshop

12:30-16:30 (at the latest)

The main AD16 discussion event will be an interactive workshop style session, taking place over lunch and into the afternoon on Wednesday. We will ply you with food and drink, and set your brilliant minds to work over some of the puzzles thrown up by the survey results and previous discussions. Location TBC.

NOTE: This event runs parallel to the field excursions, and has limited spaces. If you would like to attend please e-mail: aster.devrieslentsch@ed.ac.uk.

Thursday – Drop-In Session

09:00-12:30

We will run a drop-in session in the morning. Pop in to discuss the Declaration progress, share your thoughts on the Quotes or take a seat and to be our armchair critic!

Friday – Official launch

Social Media - #AD16 (Twitter)

CONTACT

If you have any questions about the Antwerp Declaration, please get in touch with Aster via e-mail: aster.devrieslentsch@ed.ac.uk.

All quotes used were taken directly from the survey as illustrative examples of points raised.