A preliminary evaluation of the global mainstreaming of ecosystem services into policy

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Abstract:

The concept of ecosystem services (ES), the benefits humankind gets from Nature, continues to gain traction amongst stakeholders involved in environmental research and management. ES science provides a multitude of methods and frameworks to help mainstreaming study findings into regulation and policies. However, questions have been raised regarding the efficacy of upstreaming as no global benchmark monitoring the penetration of ES science into national policies exists. This study presents a preliminary analysis of a new global database of legal documents related to ecosystem services, GlobalDES. The

database has been completed by learners involved in a Massive Open Online Course (MOOC) on ES for the past two years onwards. Results show information pertaining to 46 countries, with a sharp increase in the number of documents since 2011. Most documents focus on regulatory approaches and target multiple services, with a major focus on biodiversity. We propose a research agenda that would make this database a better benchmarking tool for monitoring ES science uptake into policy-making, building on crowdsourced information favoring high temporal resolution and the integration of multiple languages.

Keywords: Ecosystem services, Environmental mainstreaming, Massive Open Online Course, Citizen Science.

1. – Introduction

In their 2017 review “Twenty years of ecosystem services: how far have we come and how far do we still need to go?” Robert Costanza and colleagues state that “the concepts of natural capital and ecosystem services have been broadly accepted” (Costanza et al. 2017: 13). Certainly, ecosystem services (ES) research is prolific. Many initiatives exist to provide tools and methods to support decision-making (McDonough et al., 2017; Seppelt et al., 2011), and given the scale of effort, the potential for mainstreaming success should be high. However, while ES-related policies are being implemented (Verburg et al., 2016), data on the extent to which ES evidence informs national environmental policy and governance around the world is limited (Costanza et al., 2017).

Large scale comparisons on how the ecosystem service concept is being operationalized, or how the knowledge is being applied or impacting ES knowledge users in practical terms, are lacking (Dick et al., 2018). ES knowledge produced in research activities can inform policy-making as a purely technical reference supporting decision-making, as a strategic tool to reach political objectives, or as a vector of policy evolution when new concepts emerge (McKenzie et al., 2014; Saarikoski et al., 2018; Waylen and Young, 2014). However, evaluating the connections between ES research, knowledge mainstreaming options, and policy outcomes is easier to conceptualize than measure in practice (Pérez-Soba et al., 2017). To the authors’ knowledge, the most rigorous empirical evidence of ES science uptake, to date, pertain only to the European Union (Bouwma et al., 2018; Maes et al., 2013; Schleyer et al., 2015).

A reason explaining the apparent lag between global ES knowledge production and mainstreaming is the difference between the scale and focus of the majority of ES research on one hand, and the sectoral nature, decision scales and timeframes of regional and national policy on the other (Laurans et al., 2013; Ruckelshaus et al., 2015). Moreover, experience to date assessing how ES concepts are operationalized in new paradigms, standards and guidelines, or integrated into existing policies show how ES knowledge impact can diffuse across a number of policy areas in environmental and natural resources management, at least in the EU context (Bouwma et al., 2018; Maes et al., 2013). ES knowledge impact in the science-

policy-practice interface for biodiversity and ecosystem services is thus multifaceted and, as a result, hard to measure and evaluate. Any future intentions to evaluate ES knowledge impact in the context of the Sustainable Development Goals will require novel monitoring approaches to produce credible and legitimate assessments in the face of this complexity (Geijzendorffer et al., 2017; Wood et al., 2018).

As a contribution to addressing this challenge, we share an initial, preliminary assessment of the extent of ES mainstreaming using a new and growing open-source database recording ES policy documents. The Global Database on Legal Documents on Ecosystem Services (GlobalDES) was created to collect information provided by the learners of a Massive Open Online Course (MOOC) teaching the fundamentals of ES science. Relying on crowdsourcing, data added to the database inform on 1) where and when ES-related policy documents were released, 2) what type of ecosystem services they target, and 3) what type of policy they support. The principal purpose of this article is to propose a research agenda to address the current limitations of the database and invite the ES community to join in improving it. Our vision is to help develop a new resource for global monitoring and evaluation efforts to understand policy impacts of ES research that will drive learning and improvements in how we design and execute these initiatives.

2. – Methods

This study uses data collected in 2016 and 2017 (see S1) by the participants of a Massive Open Online Course (MOOC) on ecosystem services (URL: https://docs.google.com/spreadsheets/d/18uu-PGp9g6UHCBUt_Ug6BtKaQASP6VUErFqGwCuSo2o/edit?usp=sharing). Students were asked to search for policy documents in their country/region/city of choice and to report documents that explicitly contained the expression “ecosystem service”. Auxiliary information associated with each document (Tab.1) included the type of policy document, the ecosystem services to which it referred, and the policy sector to which it applied. Learners were also asked to complete an entry in the database even if no pertinent document was found, in an effort to document true absences. The MOOC is ongoing, and entries continue to be added to GlobalDES. For our analysis the last entry was made on February 12th 2018.

Table 1: Description of the fields (columns) displayed in GlobalDES.

FIELD	Alias	Description
CASE_ID	Case	ID number
COUNTRY	Country name	Country to which the document refers
LEVEL	National/Regional/Local	If applicable, geographic level to which the document refers
NAME_NAT	Document name (native)	Name of the document in its native language
LANG_DOC	Document language	Native language of the document
NAME_ENG	Document name (English)	Name of the document in English (user-provided)
TYPE_DOC	Document Type	Regulatory approach; Economic and financial instruments; or Informational, communicative, motivational, and educational instruments.
DATE_PUB	Publication date	Publication date of the original document.
ES_TYPE	Ecosystem service type	The type of ecosystem services the document refers to: Production, Regulating, Cultural
ES_SUBTYPE	Ecosystem service sub-type	Food production; Energy production; Raw material production; Other production services; Air quality; Climate regulation (including carbon sequestration); Water purification; Other regulating services; Human health; Recreation; Education; Intrinsic value of Biodiversity; Landscape value; Other cultural values
POLICY_TYPE	Policy sector	Energy; Food; Water; Governance; Urban, Biodiversity; Science; Military; Infrastructure; Health; Education; Mobility (transportation); Other
URL	Document URL	Hyperlink to the online source
USER_NAME	Contributor	Name of the person who entered the document
USER_EMAIL	Email	Email of the person who entered the document
COM	Comments	Relevant comments giving additional context/precision related to the entry.

85 complied with standard database rules, making the table easier to manipulate in upcoming analysis steps.
86 For example, empty, erroneous, or duplicate entries were deleted; country, region, and language names
87 were standardized. The date of publication was added when missing—assigned to December 31st if only
88 the year was available. A field was added to provide a more general description of the type of ES targeted
89 in the document, i.e., provisioning, regulating, and cultural (See Tab.1, ES_TYPE). Finally, document
90 URLs were verified, and corrected when necessary after finding the document online. The entries for
91 which a document could not be found or which directed to a general information website were deleted.

92 The second step aimed at scrutinizing the content of the documents to make sure they matched the
93 scope of the database. First, using a free online translation service, we removed entries in which the
94 document did not explicitly mention “ecosystem services”, “environmental services”, “natural capital”, or
95 “nature’s benefits to people” in the title or the main text. Documents in a non-English language that could
96 not be verified with an automatic translator function were kept on the assumption that they met the key-
97 word criterion. Then, the information pertaining to the type of document, the main ES targeted, and the
98 policy sector were verified and updated when not specified or inexistent in the list of choices provided.
99 Because several entries covered multiple ES types, a ‘multiple’ category was added. General information
100 documents that did not propose an instrument (i.e., method) or did not advocate for a specific type of
101 action (e.g. change in behavior, eco-label), student dissertations, scientific articles, case studies, and
102 documents with biodiversity as the sole focus were removed. We did so to keep the scope of the final
103 database as focused as possible on the existence of documents showing ES research mainstreaming into
104 policy. The multi-staged verification process resulted in the removal of 38 of the initial 174 entries (see
105 S2).

106 The third and final step set the data ready for analysis with the creation of summary statistics per
107 country, date, document type, ES type, and policy sector. In order to create a map of the global spread of
108 ES policy, the country statistic was joined to a vector file of world countries
109 (http://thematicmapping.org/downloads/world_borders.php, accessed 2018/03), using the country name as
110 the join field in ArcGIS 10.5 (Environmental Systems Research Institute, 2017) (see S3). Further graphs

were created to show the document's ES focus and temporal distribution using the Pandas library in Python 2.7 (see S4).

3. – Results

The database used for analysis contained 136 valid entries spanning 46 countries, or ~24% of the world representation (Fig.1). There were important disparities among countries. Only one entry was added for Angola and Sri-Lanka, both reporting the absence of any document. Thirty-three countries had less than five documents reported, seven countries had between five and ten documents reported, and USA and Brazil had 11 and 13 documents, respectively. From a regional standpoint, the Americas are the most productive in terms of ES mainstreaming, followed by Europe, southern Africa, southern Asia, and Oceania. However, most of Asia and Africa are not represented. The continent of Antarctica also has no document reported.

Figure 1: National counts of policy documents referring to ecosystem services, based on two years of students' voluntary contribution to GlobalDES. The current version of the database contains information pertaining to 46 countries.

The temporal distribution of the records indicates an increase in the number of documents referring to ES following 2011 (Fig.2). A majority (n= 88 out of 136; ~65%) of documents published

between 2004 and 2018 are related to regulation efforts, followed by informational documents, whereas economic and financial material is the least represented with a total of 12 documents (~9 %) released between 2013 and 2017 (Fig.2).

Figure 2: Number of documents per content type, according to the intended use of the document.

Forty-four documents address multiple ES types, with a growing proportion of all documents starting in 2011. Documents focusing on cultural services amount to 40, with a decreasing representation since 2015 when regulating or provisioning services material start to grow in number. Overall, the database contains 30 documents related to regulating services and 20 related to provisioning services (Fig.3).

Figure 3: Number of documents per ecosystem service type. 'Multiple' refers to documents focusing on more than one ecosystem service type.

The largest group of documents (n=56 out of 136; 41%) pertains to the general governance of ES, followed by 49 with a primary focus on biodiversity (but mentioned in the context of ecosystem services). Those two themes dominate the 14 years of records, with a significant increase after 2011. With 12 documents listed, water is the next most important type of ES to which policy is applied. The six next themes listed remain inconsistently reported, and always in low numbers.

Figure 4: Number of documents per policy sector. Policy refers here to the main environmental theme addressed by the document.

4. – Discussion & conclusion

This study and its associated database represent the first global effort to register the penetration of the ES concept into policy documents. While the database is neither complete nor representative of regional geographic specificities (e.g. climate, political stability, GDP), the global extent of ES-related policies shown in this preliminary analysis suggests that the ES concept is being integrated into policy in many disparate regions and at a seemingly faster pace. The spatial distribution of the GlobalDES entries present some commonalities with the global analysis of ES studies performed by Schmidt and Seppelt (2018), with Europe and the Americas being better represented than the rest of the world.

The large number of documents (n=40) focusing on cultural services counters findings by Bouwma et al. (2018) who found that cultural ES usually benefit the least from mainstreaming, and that those rare documents mainly focus on tourism, while GlobalDES only contain one entry on this sector. Legal documents focusing on provisioning services are less represented than could be expected (Geijzendorffer

et al., 2017), which can be explained by the growing representation of documents targeting multiple services at once (Wood et al., 2018). Those differences could be explained by the variability in learners' interpretation of ES terminology, but it can also come from the wording of the documents themselves. For instance, the cultural/spiritual connection with biodiversity can make the classification hard to choose. The sharp increase in the number of documents after 2011 is in line with the common assumption that policy renewal favors the mainstreaming of ES science (Bouwma et al., 2018; Claret et al., 2018), which could also be related to observed lag phenomena between the signature of international agreements, such as the Millennium Development Goals in 2000, and the feeling of 'ownership' by countries that eventually leads to their implementation into national policy. Only a deeper analysis of the documents published in 2011 in relation to global environmental governance chronology could validate this assumption.

What forces drive policy uptake? A common assumption is that a knowledge base is a prerequisite for policy uptake (as is suggested by Costanza et al., 2017). Conversely, several authors argue that providing more knowledge does not automatically lead to better and more informed decisions and a faster uptake of new ideas in decision fora (Jax et al., 2018; Ruckelshaus et al., 2015; Saarikoski et al., 2018). As the collection of documents into GlobalDES will grow, we envision a comparison to the amount of scientific articles and data related to ES released at a global scale (Wilson et al., 2016) and explore if other elements besides pure scientific knowledge are important to achieving ES mainstreaming outcomes. We draw out two tentative hypotheses as to what these elements could involve:

- The countries with uptake of ES policy in the database were offered extensive capacity development (including financial investments) or training that exposed national policy actors to the ES concept through a significant initiative i.e. IPBES regional assessments, National Action Plans on Biodiversity, ongoing Civil Society outreach), and perhaps some related funding to implement it in national policy.
- A specific event lead to paradigm changes in the policy frameworks of the countries in our database that has meant ES efforts are highly relevant to a current policy problem and so have

landed on fertile ground. For instance, sudden crisis such as drought or flooding, sudden changes in stakeholder network configurations, or new threats to biodiversity hotspots.

We cannot explore these hypotheses with the current database, but they are important to understand if we are to improve how we measure and assess bi-directional links between ES research and policy (Claret et al., 2018). Verifying those hypotheses will first require the improvement of the database. GlobalDES is currently only two years old and the number of entries is therefore limited, but future sessions of the MOOC in the years to come will help gather more data. Opening the database to a larger public, adding a ‘supporting services’ category, secondary language options, and providing more guidance to fill the table could also enhance user involvement. The design of the original database online can also evolve to be more database-savvy (e.g. field name and aliases, domains and sub-types, required fields) so data processing and analysis are made easier and faster. Other data analysis options can be explored; instead of country-level boundaries, political and economic regions (e.g. EU, ASEAN, NAFTA, BRICS, ECOWAS) may provide a better global depiction of ES policy enforcement.

Once those improvements are implemented, we will pursue this project with a global-scale analysis of the triggers that lead to the integration of ES knowledge into national policy frameworks. Multiple variables can be considered for such changes. A comparative (and cumulative) analysis of the triggers for change can provide useful information on more or less favorable conditions for the integration of ES knowledge in policy frameworks. A recent publication by Claret and others (2017) looking at the factors constraining ES science upstreaming in Scotland indeed lists reasons such as the policy agenda, governmental willingness, terminology issues, understanding of scientific outputs, and costs as variables that can strongly influence ES science upstreaming. Such understanding could then help design new or reinforce existing protocols for assessing policy impacts of ES knowledge. If the world is to reach the SDGs, the contribution of ES-science mainstreaming to the reduction of policy fragmentation, given the concept is supposed to highlight linkages between economic, social and environmental spheres, is of prime importance (i.e., shared-policy framing or problem identification, strengthening networks of policy

actors, creation of cross-sectoral and cross-scale policy goals, integration or creation of new institutional structures and procedures, and coordinated implementation of policy instruments (Briassoulis, 2004)).

We provided here a simple yet useful benchmark based on crowdsourced data to measure the success of the science-policy interface. Such work, relying on knowledge of MOOC learners, is necessary to monitor the often-mentioned ‘gap’ existing between scientific results, their operationalization, and their eventual social acceptance (Bonney et al., 2014). Specifically, the fluency of the learners in non-English languages is determinant, as 60% of the documents were only available in another language. The growing urgency in meeting the Sustainable Development Goal imperatives underlines the value of citizen science, where anyone can add to knowledge building, for monitoring the impact of ES research (Dickinson et al., 2012). Although many challenges remain as to the efficiency of MOOC-type education (Margaryan et al., 2015) and the quality of crowdsourced data (Margaret et al., 2016), data collected during our ES online course nonetheless present the obvious advantage of quickly presenting a global-scale and multi-year survey of ES mainstreaming into policy.

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6. – Supplementary material

- 239 • S1: Original raw data (xls format)
- 240 • S2: Clean data (xls + csv format)
- 241 • S3: World shapefile + joined data
- 242 • S4: Python code for graphs

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