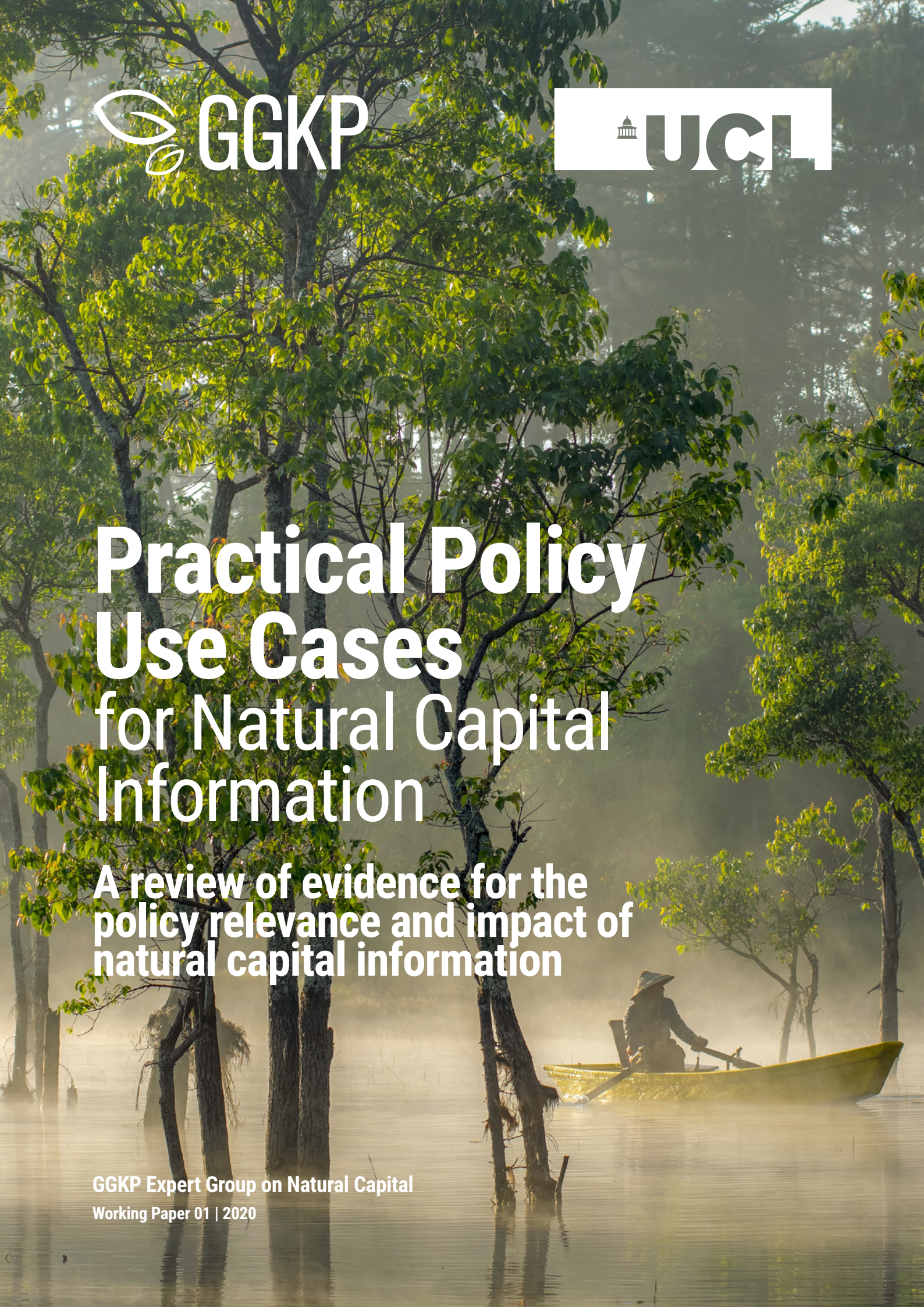

Practical Policy Use Cases for Natural Capital Information

A review of evidence for the policy relevance and impact of natural capital information

GGKP Expert Group on Natural Capital
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Practical Policy Use Cases
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June 2020

The Green Growth Knowledge Partnership (GGKP) is a global community of organizations and experts committed to collaboratively generating, managing and sharing green growth knowledge. Led by the Global Green Growth Institute (GGGI), Organisation for Economic Co-operation and Development (OECD), United Nations Environment Programme (UNEP), United Nations Industrial Development Organization (UNIDO) and the World Bank Group, the GGKP draws together over 60 partner organizations. For more information, visit www.greengrowthknowledge.org.

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The Green Growth Knowledge Partnership (GGKP) convenes inter-institutional expert groups to identify and address critical knowledge gaps in green growth theory and practice. The neutral, collaborative expert groups focus on knowledge generation, synthesis and on-the-ground application by partners and in-country stakeholders.

This report was prepared under the guidance of the GGKP Natural Capital Expert Group (hereinafter "Expert Group"). The Expert Group aims to push the knowledge frontier, mainstream natural capital in global green growth activities and support stronger implementation of natural capital commitments in national economic plans. In its deliberations, the group identified a key knowledge gap in the provision of natural capital data to inform national green growth plans.

To clarify this gap and identify pathways to address it, the Expert Group, with support from the GGKP Secretariat, commissioned the University College London (UCL) to prepare this report. This publication was produced with Expert Group guidance and synthetic research by Alison Fairbrass (UCL), Jia Hua (GGKP), Paul Ekins (UCL) and Ben Milligan (University of New South Wales). The report received substantial peer review inputs from James Vause (UNEP-WCMC) and Martin Lok (Natural Capital Coalition).

The paper received overall steering and guidance from the Expert Group, which was led by Co-Chairs Paul Ekins (Professor at University College London and Director of the Institute for Sustainable Resources) and Joe Grice (Chairman of the United Kingdom Office for National Statistics Economic Experts).

The Expert Group is composed of members from various organizations, including Charles Akol (United Nations Economic Commission for Africa), SoEun Ahn (Korea Environment Institute), Alessandra Alfieri (United Nations Statistics Division), Carter Brandon (World Resources Institute), Raouf Dabbas (Jordan Friends of Environment Society), Gitika Goswami (Development Alternatives), Salman Hussain (UNEP The Economics of Ecosystems and Biodiversity), Katia Karousakis (OECD), Pushpam Kumar (UNEP), Glenn-Marie Lange (World Bank Group), Markus Lehmann (Convention on Biological Diversity), Anil Markandya (Basque Centre for Climate Change), Geoff McCarney (Smart Prosperity Institute), Edwin Muchapondwa (Environment for Development Initiative), Rosimeiry Portela (Conservation International), Mary Ruckelshaus (Natural Capital Project), Oyun Sanjaasuren (Green Climate Fund), Mark Schauer (Economics of Land Degradation (ELD) Initiative/Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)), Tim Scott (United Nations Development Programme), Juha Siikamäki (International Union for Conservation of Nature), Kevin Urama (African Development Bank), Annawati van Paddenburg (Global Green Growth Institute) and James Vause (UNEP-WCMC).

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EXECUTIVE SUMMARY

A number of international commitments encourage countries to take natural capital into account in economic decision-making. This has catalysed demand from countries and relevant stakeholders for evidence of success in the use of natural capital approaches to inform green growth decision-making. The GGKP Expert Group on Natural Capital has identified the need to illustrate a clear set of use cases for natural capital information consisting of a demonstrative set of examples characterized by a common set of assessment criteria.

Here, we present a global review of the use of natural capital metrics and data to inform government decision-making, structured in terms of a set of assessment criteria developed during discussions at the 2018 GGKP Natural Capital Expert Group meeting in Stanford University. Literature review was used to scope relevant use cases and assess the utility of these criteria. Detailed reviews against the criteria were undertaken for case studies in six countries: Colombia, Indonesia, Mongolia, Mozambique, Myanmar and South Africa.

This research provides a snapshot of the current status of public knowledge and documentation, concerning how different types of natural capital information are used to inform and influence government decisions. A number of key findings that emerge:

- The impact of natural capital information on government decision-making is currently profoundly under reported. The public evidence base is dominated by reports of opportunities for impact, but there is much less evidence of realized impact reported, and the specific administrative or policy contexts in which impact is realized.
- In comparison to other forms of natural capital information (i.e. data and statistics, accounts, cross-cutting information tools such as modelling), there is an acute knowledge gap in relation to the specific impact(s) of natural capital indicators on decision-making.
- The herein proposed GGKP assessment criteria (Section 2) provide a useful starting point for comparing and contrasting case studies concerning the use of natural capital information in government decision-making.

Based on these findings, we make a number of recommendations for consideration by governments and stakeholders involved in the production or use of natural capital information:

- Producers of natural capital information are encouraged to publicly report, to the extent possible and appropriate, their specific impact(s) on decision-making arising from relevant activities.
- Producers and users of natural capital indicators are encouraged to support efforts to fill the knowledge gap in relation to:
  - how natural capital indicators are being used in government decision-making
  - the associated policy impacts of incorporating natural capital indicators
- Producers and users of natural capital information are encouraged to build on the assessment criteria presented in this paper to develop practical guidelines for documenting natural capital impact case studies, including "reporting adequacy criteria", and enabling use of case studies in government decision-making. These criteria would perform the critical function of enabling government decision-makers to quickly identify, and prepare briefs on, case studies concerning natural capital information that are specifically relevant to their immediate (and often time-sensitive) needs in specific decision-making contexts.
- Producers and consumers of natural capital information are encouraged to collaborate with the United Nations Statistics Division (UNSD) on a review of use cases for natural capital information, building on the work presented here, and on ongoing efforts by UNSD to expand the evidence base of case studies on the System for Environmental Economic Accounting (SEEA) that demonstrate policy impact.

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AfDB	African Development Bank
BioFin	Biodiversity Finance Initiative
CICES	Common International Classification of Ecosystem Services
FDES	Framework for the Development of Environment Statistics
GGGI	Global Green Growth Institute
GGKP	Green Growth Knowledge Partnership
IFC PS6	International Finance Corporation Performance Standard 6
OECD	Organisation for Economic Co-operation and Development
PES	Payments for Ecosystem Services
REDD	Reducing emissions from deforestation and degradation
SDG	Sustainable Development Goals
SEEA EEA	UN System of Environmental-Economic Accounting—Experimental Ecosystem Accounting
SNA	System of National Accounts
TEEB	The Economics of Ecosystems and Biodiversity
UN PAGE	United Nations Partnership for Action on Green Economy
UNSD	United Nations Statistics Division
WWF	World Wildlife Fund for Nature

1. INTRODUCTION

The 2030 Agenda for Sustainable Development *(1)* recognizes the environment as a foundation of economic development, and requires that countries take the environment into account in decision-making (e.g. Target 15.9 and Target 17.19). Despite this, it is likely that only one in five of the strategic objectives and goals across six global agreements relating to nature and the protection of the global environment[1] are demonstrably on track to be met *(2)*. In this context, there is an urgent need for better decision-making about how we manage natural capital to avoid irreversible impact on ecosystems exacerbated by a changing climate, human health and economic costs.

There is a proliferation of metrics, data and tools—combined with the development of structured environmental-economic accounting—aimed at bringing some or all aspects of natural capital into government decision-making. Scientific assessments and initiatives have generated large volumes of biophysical data that seek to illuminate the interrelationships between the environment and the economy, for example, national ecosystem assessments in the United Kingdom *(3)*, Portugal *(4)*, Spain *(5)* and China *(6)*. Environmental economic accounting initiatives across the globe are catalysing the production and integrated use of physical and monetary natural capital statistics, and in some cases seek to quantify the monetary value and wider economic importance of natural capital *(7, 8)*. A variety of tools now exist that use these rapidly growing biophysical and economic datasets to inform decision-making on natural capital and ecosystem services *(9)*. This growing body of natural capital metrics and data provides an opportunity to make better-informed decisions about how to respond to environmental challenges.

To take advantage of this opportunity, the Green Growth Knowledge Partnership (GGKP) Expert Group on Natural Capital has identified a need for evidence of how natural capital metrics and data can be used to inform government decisions. This evidence base should be composed of a number of compelling examples that illustrate to decision makers the range of use cases that natural capital metrics and data can support, as well as relevant gaps. In addition, a set of assessment criteria should be developed that draw out the most important characteristics of exemplary use cases to bolster the growing evidence base.

Responding to this need, we present here the results of a research study conducted in two stages:

- Development of a set of assessment criteria for evaluating use cases of natural capital information and decision-making
- An evidence review of use cases of natural capital metrics and data for government decision-making using these assessment criteria

Based on the results of this research, we make recommendations concerning how to improve the public evidence base of use cases for natural capital metrics and data in relation to government decision-making.

1 The Convention on Migratory Species (CMS), Convention on International Trade in Endangered Species (CITES), International Plant Protection Convention, United Nations Convention to Combat Desertification (UNCCD), Ramsar Convention on Wetlands and World Heritage Convention

2. APPROACH

A set of assessment criteria were developed in collaboration with the GGKP Natural Capital Expert Group to characterize natural capital use cases. These include:

2.1. CLASSIFYING USE CASES

1. Types of government decisions

The types of government decisions that have been impacted by the use of natural capital metrics and data (Figure 1). This typology builds on work conducted with the Government of the United Kingdom as part of its strategic review of the relevance of natural capital to decision-making across every public body in the UK *(10)*.[2]

This typology is composed of the following five classes:

- **Policy and planning:** The policy organizes activities required to achieve a particular goal involving the creation and maintenance of policies and plans. This could, for example, include policies that guide the integration of natural capital into land use planning, green infrastructure and nature-based solutions.
- **Regulatory:** The policy guides and controls particular public and/or private actors, which can include enforcing government controls and restricting a particular sector. This could include policies that stipulate required standards in relation to natural capital use, such as implementation of International Finance Corporation Performance Standard 6 (IFC PS6) directives for the exploitation of extractives *(11)*, or the HM Treasury Green Book guidelines on natural capital *(12)*.
- **Finance and investment:** The policy manages money in such a manner to accomplish the objectives of the government. Policies could include the implementation of Payments for Ecosystem Services (PES) schemes, which use financial instruments to maintain flows of ecosystem services.
- **Operational:** The policy brings together material and/or immaterial assets to produce a particular product or service. This could include policies that operationalize the management of natural capital such as soil conservation policies.
- **Technical:** The policy gives advice about and/or improves practice in the management of natural capital. This could include the management of data and statistics such as policies to develop and maintain indicators or accounts of natural capital, including biodiversity and ecosystems.

2. Types of natural capital metrics and data

Different types of natural capital metrics and data have been used to influence government decision-making. These include raw data and statistics, accounts and indicators, which can be contextualized by an "information pyramid" *(14)* (Figure 1). Data and basic statistics are the foundation of the pyramid and support accounting systems. From the accounts are produced indicators, which can then be aggregated to produce key indicators. Indicators can be sourced both directly from data and statistics, and from the accounts. Cross-cutting information products include the use of methods such as modelling and assessments that draw on multiple types of natural capital metrics and data to produce secondary natural capital information products. This typology of types of natural capital information provides structure to organize the heterogeneous range of natural capital metrics and data now available.

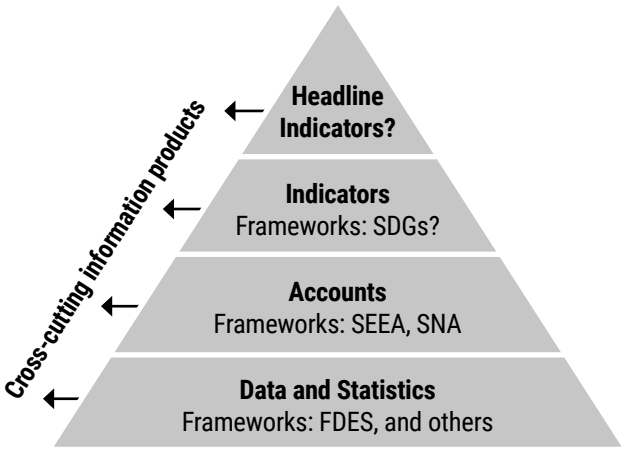

Figure 1. Typologies of natural capital (Adapted from *(14)*)

2 This typology roughly aligns with the levers of change for government action identified in "Natural Capital for Governments: What, Why and How" *(13)*. This publication additionally mentions fostering stakeholder participation as a separate category

3. Types of natural stocks, flows and associated human activities

Different types of natural stocks, flows and associated human activities are considered in the case study. Here, we use a typology of natural stocks that follows the discrete environmental assets from the System of Environmental-Economic Accounting — Central Framework *(15)*: minerals and energy resources, land, soil, timber and water. We add ecosystems as an additional type of natural asset. We also use the Common International Classification of Ecosystem Services (CICES) *(16)* typology of ecosystem services: provisioning, regulating and maintenance, and cultural. No typologies of human activities exist and therefore we rely on the descriptions of activities as they are provided in the literature.

2.2 MEASURING IMPACT

The following five assessment criteria were defined based on discussions at the GGKP Natural Capital Expert Group meeting in Stanford University in 2018 *(17)*.

1. Impact potential

A striking opportunity demonstrating how natural capital can transform ecosystems and human well-being by incorporation into policy, fiscal and financial decision-making. A clear policy agenda is a strong driver.

2. Impact pathway

Clear definitions of the goal, which stakeholder groups to engage, their specific natural capital needs, how to strategically link their interests, which methodologies are best, and what data are suitable. It was noted that some of the most important decision-making changes have been based on credible future scenario analysis. Data availability is also a key strengthener or constraint.

3. Involvement of stakeholders

Strong leadership that is ready to engage, agree on an impact pathway, make new data available, and take action to implement changes.

4. Scalability

Strong potential to be scaled up through re-application in other contexts, sectors or scales and by contributing new natural capital metrics and data. Linking public and private sector applications and ensuring that cases build towards a common, standardized set of metrics, such as that offered by the SEEA-EEA accounting framework, are important aspects for achieving scalability.

5. Narrative

Ultimately, a use case is strong if it presents a clear and convincing narrative of how the incorporation of natural capital can make an impact. This story was must be articulated clearly and communicated widely.

2.3 EVIDENCE REVIEW

We conducted a systematized review of the scientific and grey literature on case studies of the use of natural capital information to inform national decision-making. We assessed this literature using assessment criteria 1–3 in order to rapidly provide a broad picture of the range of activities where natural capital metrics and data are being used to inform government decisions. Full methods and descriptive statistics of this review are detailed in the appendix.

In addition, we conducted a literature review focussed on the case studies from six countries: Colombia, Indonesia, Mongolia, Mozambique, Myanmar and South Africa. In addition to relevant literature sourced through the systematized review, we searched the electronic databases of organizations that we are aware are conducting green growth work in these countries including: TEEB, UN PAGE, OECD, UNSD, World Bank, Global Water Partnership, Natural Capital Coalition, WWF, AfDB, GGGI and BioFin. We assessed this literature using the full set of assessment criteria to determine the feasibility of extracting this information from literature review.

3. USE CASES FOR NATURAL CAPITAL METRICS AND DATA TO INFORM GOVERNMENT DECISIONS

Literature searches produced 340 eligible documents (266 grey literature, 74 scientific studies). Figure 2 shows the flow of documents throughout the selection process; 109 documents were excluded (98 grey literature, 11 scientific studies) due to eligibility issues including reporting not in English, access issues, length of report (< 5 pages) or not relevant. Relevance of natural capital information to government policy decision-making was discussed in 106 documents (72 grey literature, 34 scientific studies).

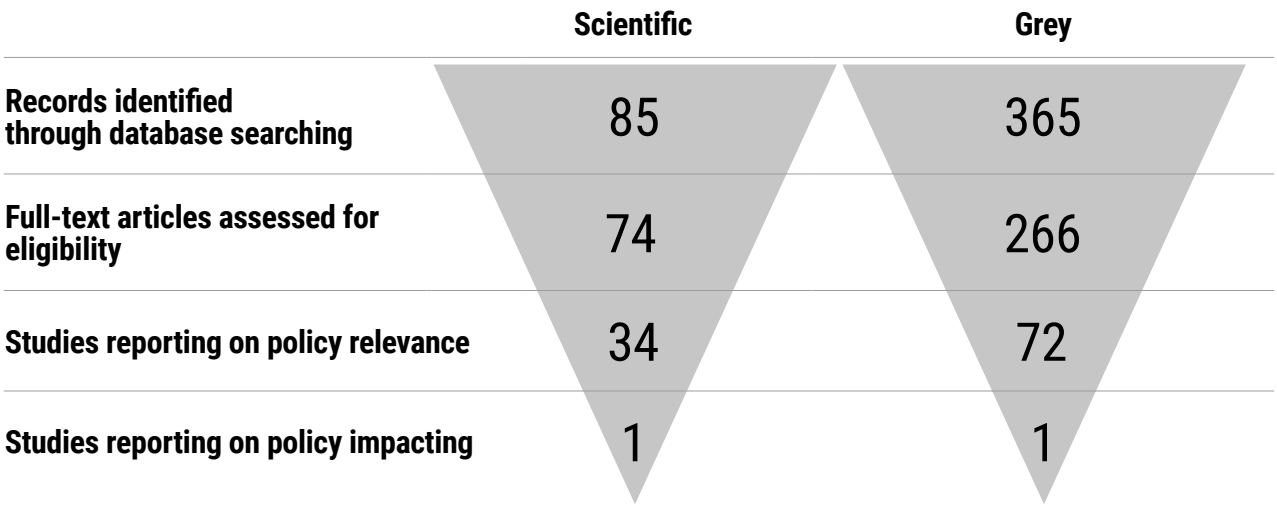

Figure 2. Study flow diagram

Of the literature reviewed here, only two studies clearly demonstrated how natural capital information had been used to successfully impact a government decision (93, 102). In contrast, the main body of the literature focused on making recommendations. This included recommendations for decisions and methodological recommendations for using natural capital information. This highlighted a gap in the set of publicly available natural capital case studies.

Organized using the typologies of government decisions and natural capital information (see above), we present a suite of exemplary use cases of natural capital metrics and data to inform decision-making. These use cases are presented alongside a demonstrative set of case study examples where natural capital metrics and data have potential to inform national green growth policy and planning (see Table 1, Table A2).

These results illustrate a range of use cases for natural capital metrics and data, such as the use of accounts to guide the spatial application of natural resource use regulations and the use of ecosystem services modelling to investigate and inform natural capital investment decisions. The results also provide evidence for the potential use of natural capital metrics and data to inform decision-making as well as highlighting evidence gaps. For example, there is a large body of evidence on the use case of informing technical advice, in particular methodological recommendations on the use of natural capital information in decision-making. In contrast, there is a dearth of evidence on the use of indicators to inform decision-making. Presenting evidence in this way provides an overview of the existing knowledge gaps in this field.

Table 1. Use cases of natural capital metrics and data

Use cases are organized using a functional typology of government decisions and types of natural capital information. Case study examples provide documented evidence for the use cases. A maximum of eight case studies are listed for each use case; an asterisk (*) indicates use cases with more than eight relevant examples. Reference numbers correspond to the source document references listed in the appendix of Table A2.

Government decision type	Natural capital information type	Descriptions of different use cases	Case study examples
Policy and planning decisions	*Raw data and statistics*	Raw data and statistics used to support recommendations on natural resource policies and plans	Qualitative and economic data and statistics support recommendations for policies and plans regarding oil exploration and extraction in protected areas in the Democratic Republic of the Congo *(46)*
	Accounts	Accounts use to inform planning and policy regarding natural capital management; in particular, efforts focus on capturing value of natural capital in national accounts in order to inform decision-making	Natural capital accounting to inform natural resource planning in Zimbabwe *(7)*; mineral accounts used in Namibia to plan how to deal with predicted exhaustion of mineral assets *(22)*; valuation of Bonaire's ecosystem services to guide decision-making regarding the protection of Bonaire's ecosystems *(47)*; cost-benefit analysis of Finland's water protection measures *(54)*; valuation of ecosystem services in Mozambique *(55)*; mapped monetary value of ecosystem services to support land use planning in Indonesia *(61)*
	Indicators	--	--
	Cross-cutting information products	Assessments that draw on a range of different information types to produce information that can inform policy and planning; ecosystem services and planning processes are most common assessments in this category	Valuation of natural capital to inform planning and policy in Queensland, Australia *(29)*; planning process analysis to inform planning process in Rotterdam, Netherlands *(36)*; planning process analysis to inform tourism management in China *(40)*; combining raw data and statistics with policy analysis to inform natural resource management in multiple countries *(41)*; ecosystem service valuation to inform ecosystem management in the Netherlands *(71)*; ecosystem service assessment to inform conservation and development planning and policy in Myanmar *(78)*; ecosystem service assessment in agricultural landscape in Germany *(79)*; ecological footprint modelling to inform regional development plan of Jiangsu Province, China *(85)*

Government decision type	Natural capital information type	Descriptions of different use cases	Case study examples
Regulatory decisions	*Raw data and statistics*	Raw data and statistics used to support recommendations on natural resource regulations	Qualitative and economic data and statistics support recommendations for regulations regarding oil exploration and extraction in protected areas in the Democratic Republic of the Congo *(46)*
	Accounts	Accounts information used to spatially interrogate natural resource use in order to inform spatial application of natural resource use regulations	Natural capital accounting to inform natural resource investment planning in Zimbabwe *(7)*; natural resource accounts used in Tanzania to spatially inform to application of regulations for forest protection *(18)*
	Indicators	--	--
	Cross-cutting information products	Different types of information, most commonly accounts and the indicators produced from them, are used to inform decisions about the development and application of regulations	Planning process analysis to inform planning regulations in Rotterdam, Netherlands *(36)*; combining accounts and indicators to inform decisions about water and agriculture regulations in Europe *(48)*; accounts and indicators used to advise on oil palm permit regulations in the Philippines *(63)*
Finance and investment decisions	*Raw data and statistics*	Raw data and statistics, most commonly spatial data, is used to inform decisions about funding and investment for natural capital	Socioeconomic data used to inform marine management strategies in Central America *(39)*; spatial data used to recommend investment in water catchments in South Africa *(52)*; spatial data used to inform funding decision for green infrastructure in Europe *(60)*
	Accounts	Accounts information used to analysis financial policies	Resource rents in accounts used to analyse Namibia's taxation policies *(8)*
	Indicators	--	--
	Cross-cutting information products	A range of information types, such as accounts and indicators, and methods, such as ecosystem service assessments and modelling, used to investigate and inform financial and investment decisions	SEEA and a net savings index used to improve economic performance of Chad and Mauritania *(37)*; planning process analysis to inform tourism management in China *(40)*; ecosystem service assessment used to support call for increased investment in protected areas in Romania *(51)*; modelling of raw data and statistics to assess value of, and advise on investment in, national forestation in the Republic of Korea *(83)*; modelling used to understand farmers decisions to invest in organic viticulture in Spain *(84)*
Operational decisions	*Raw data and statistics*	Qualitative and spatial data and statistics used to inform operational advice regarding natural capital and natural disaster management	Qualitative data and statistics used to inform operational advice regarding flood resilience *(53)*; spatial data used to inform operational advice regarding the restoration of green infrastructure in Europe *(60)*; qualitative data and statistics use to investigate and make operational recommendations about disaster resilience in Taiwan *(87)*
	Accounts	--	--
	Indicators	--	--
	Cross-cutting information products	Modelling used to investigate natural capital operational management decisions	Modelling used to understand farmers decisions to convert operations to organic viticulture in Spain *(84)*

Government decision type	Natural capital information type	Descriptions of different use cases	Case study examples
Technical advice	*Raw data and statistics*	Raw data and statistics used to make methodological recommendations from future research	Qualitative and economic data used to make methodological recommendations for research into national economic policy using Mongolia as a case study *(62)*
	*Accounts**	National experiences of implementing natural capital accounting are used to provide technical advice on future implementation	Empirical analysis of natural capital accounting in Costa Rica *(5)*; advise on the use of accounting methods to assess timber stocks in Brazil *(9)*; review national experiences of environmental accounting to identify use cases in a range of OECD and non-OECD countries *(13)*; assess the utility of using SEEA to compile accounts of wild fish stocks in Iceland *(14)*; evaluation of policy impact of valuation of forests in Tunisia *(50)*; reporting implementation of forest accounting and links to REDD in Ethiopia *(64)*; reporting on implementation of forest accounting in Canada *(74)*; analysis of natural capital accounting in Japan and its use to produce indicators *(75)*
	Indicators	Technical advice produced on developing indicators of natural capital	Guidance on the development of indicators for ecosystem services *(59)*
	*Cross-cutting information products**	Providing technical advice on the use of a range of methodologies and information types for assessing and managing natural capital at national and regional scales	Reports on experiences of producing natural capital raw data and statistics, accounts and indicators in the Netherlands, Sweden, US and UK *(3)*; report on methods of natural capital accounting and producing indicators in Austria *(16)*; advice on use of accounting and indictors for natural resource management in Norway *(33)*; valuation of biodiversity and identification of biodiversity indicators for India *(34)*; advice on the use of modelling for valuation of water in the Mediterranean *(45)*; advice on how multi-criteria analysis can be used to appraise wetland development proposals in Italy *(70)*; assessment of ecosystem service models as decision support tools using Haiti and the Democratic Republic of Congo as case studies *(72)*; utility of ecosystem service assessments of evaluation of soil management practices in Europe *(86)*

4. EVALUATION OF USE CASES CRITERIA

Assessment criteria were applied for case studies from six countries that demonstrate the use of natural capital metrics and data to inform government decision-making (see Table A3 for detailed results of this assessment). This includes a selection of priority countries for members of the GGKP Natural Capital Expert Group: Colombia, Indonesia, Mongolia, Mozambique, Myanmar and South Africa.

This assessment highlighted a series of important factors in relation to the use of natural capital metrics and data to inform government decision-making:

- The case studies produced and tested methods that could be applied in different contexts, but this was often difficult, due to differences in data availability, social, political and environmental contexts.
- Some case studies suggested that environmental ministries lacked the clout to make impact, and that it was more desirable to engage with finance ministries to achieve impact.
- The utility of national-scale studies and policies was questioned. It was argued that natural capital methods required a small-scale approach that would be appropriate to the contexts of different local and regional areas. The importance of local scale information was stressed.
- The crucial importance of stakeholder engagement and participation for project success was stressed in many case studies. There were also notable omissions of discussions of stakeholders in several reports.
- Impact pathways frequently involved building government capacity to implement recommendations and use data and tools through the projects.

Our literature review has identified a number of strengths and weaknesses of the criteria in relation to informing government decision-making using natural capital metrics and data.

1. Type of natural capital information

A simple criterion that is easy to apply to literature.

2. Types of decision(s)

A simple criterion that is easy to apply to literature, but it depends on the author's description of the government decision.

3. Type of natural capital stocks, flows and associated human activities

A simple criterion that is easy to apply to literature. Natural stocks were most commonly reported on, followed by flows (e.g. ecosystem services).

4. Impact potential

Impact, both intended and realized, was discussed in the majority of literature. However, the potential for impact was very difficult to assess. A suggested amendment would be to put the focus of the criteria on delineating between whether the impact discussed is proposed or realised.

5. Impact pathway

This was one of the more difficult criteria to apply. The impact pathway was discussed in detail in some case studies, but in most cases the impact pathway was limited to a list of recommendations for action.

6. Involvement of stakeholders

One of the most frequently discussed topics was the engagement with stakeholders. There were different levels of stakeholder commitment evident from the literature. This ranged from studies led by governments, studies co-authored by governments with international organization (IO) and non-government organization (NGO) partners, studies led by IOs and NGOs, which included the government in consultation, and studies where there was no obvious involvement of the government. It was not possible to assess from the literature whether there was a relationship between project impact and the level of commitment from the government.

7. Scalability

Spatial scale was the most commonly discussed topic in relation to this criterion and was discussed in relation to the spatial scale of application of methods and policy. Application to the private sector, or contribution to a common set of metrics, was rarely discussed. A suggested amendment to this criterion would be to make it more specific in terms of what is meant by scalability and break it down into a few separate sub-criteria, such as spatial scale, application to the private sector, and link to other systems of metrics and data.

8. Narrative

The depth of narrative varied widely across the literature. Some reports gave a very detailed account of the context, method and impact of the case study. Others provided little discussion, beyond the immediate study, of the study context. An in-depth narrative was typically accompanied by more discussion relevant to the other criteria presented here, suggesting that greater narrative my correlate with a "better" case study, in terms of our assessment criteria.

5. RECOMMENDATIONS IN SUPPORT OF POLICY IMPACT

Informed by the findings of our desk research, we propose several recommendations for the attention of policymakers, experts and other stakeholders who use and produce natural capital information:

- **Encourage all producers of natural capital information to publicly report, where possible and appropriate, their specific impacts on decision-making.** This is required to address the acute shortage of such evidence, and the apparent mismatch between the production of natural capital information and the documentation of its practical utility in different policy contexts. GGKP partner organizations, such as the UN Statistics Division, TEEB and the Natural Capital Project, are working to document evidence of success in decision-making and we encourage other organizations to invest in production of such documentation.
- **Support efforts to fill the knowledge gap in relation to the impact of natural capital indicators on decision-making.** This could include support for the UN Statistics Division's work to develop indicators linked to national ecosystem accounts and the GGKP Natural Capital Expert Group's ongoing work to create a comprehensive natural capital indicators framework.
- **Build on the assessment criteria to develop guidance on "reporting adequacy criteria" for natural capital impact case studies.** The purpose of these criteria would be to provide clear guidance to technical experts, concerning the practical evidence needs of advisors who brief senior policy decision-makers on matters which affect or are affected by natural capital assets and services. These needs should be clearly classified and differentiated according to common set of sectoral (e.g. agriculture, mining) and functional (e.g. regulation, planning, finance) use cases for natural capital information in government decision-making.
- **Collaborate with the UN Statistics Division on a review of natural capital use cases that builds on the work presented here and UNSD's ongoing work on expanding the evidence base of SEEA case studies that demonstrate policy impact.** UNSD is currently conducting a review of case studies that demonstrate policy impact of SEEA. In response to the presentation of an early iteration of this work at the 14th Meeting of the UN Committee of Experts on Environmental-Economic Accounting in New York in June 2019, future collaboration was discussed to combine efforts in the production of an evidence base of policy impact *(18)*.

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METHODOLOGICAL APPENDIX

SUPPLEMENTARY METHODS AND RESULTS OF BROAD LITERATURE REVIEW

1. Search strategy

Searches of the scientific literature were conducted using the Scopus electronic database up to June 2019 and were restricted to English language publications that reported a national case study of natural capital information for policy. The search strategy consisted of the term "natural capital" and "case study" and "national" or "country". Searches of the grey literature were conducted up to February 2019 using the online public electronic libraries of relevant organizations, research centres and national statistics offices and included both national and sub-national results.

2. Literature selection

All documents, 431 in total, reporting on a national case study of natural capital information were eligible to be included in this review, including scientific studies, government reports, country development plans, and project/methodology implementation reports from organizations. The literature identified in the search was initially screened for relevance on the basis of their titles and abstracts/summaries. Subsequently, the full text of potentially relevant documents was assessed and case studies selected where policy relevance or impact was reported. Documents were classified in terms of location of case study (country), types of natural capital studied, type(s) of natural capital information used, type(s) of government decision discussed in terms of relevance or impact. Documents were judged as being policy relevant if the relevance of natural capital information on government decision-making was discussed, such as if policy recommendations were made based on findings from natural capital information. Policy impact was judged by the reporting of concrete impact on government decision-making using natural capital information, such as the adaptation of a policy based on the use of natural capital information.

3. Quality assessment and data extraction

The reporting quality of the grey literature was assessed based on document length; any document shorter than five pages in length was judged to be too short to report useful information and was excluded from the review. No quality criteria were applied to the scientific literature as we relied on the rigor of the peer-review process to provide a suitable level of quality; 98 grey literature and 11 scientific studies were excluded for a revised dataset of 340 cases. Descriptive data were extracted using a standard form. Data collection included general characteristics of the case study document (year of publication and type of document), case study characteristics (country, types of natural capital stock and flows following *(19)*, methodological features (types of natural capital information following the information pyramid), and impact (type of government decision following the typology described in the government decision types section of this report, reported policy impact).

4. Description of the eligible literature

The selected 340 documents were published between 1989 and 2019, with over half (n=186) published in 2015 or later (Figure A1). The most commonly reported countries included India (12, 10 in grey and 2 in academic), Indonesia (11, 10 in grey and 1 in academic) and the Philippines (10 in grey). The most common natural capital stock types were ecosystems (139, 117 in grey and 22 in academic). Accounts was the most commonly reported information type (87, 78 in grey and 9 in academic), followed by cross-cutting information products (58, 35 in grey and 23 in academic), indicators (13, 5 in grey and 8 in academic) and raw data and statistics (14, 13 in grey and 1 in academic), while most of the studies and reports applied multiple methods (e.g. cost-benefit analysis, qualitative research and modelling). The majority of literature provided methodological and/or policy recommendations. The literature dataset compiled for this review will be available to view upon publication.

Figure A1. Bar chart of number of documents reporting national natural capital information case studies over time. The number of documents published in each year is shown for grey (filled bars) and academic (white bars) literature.

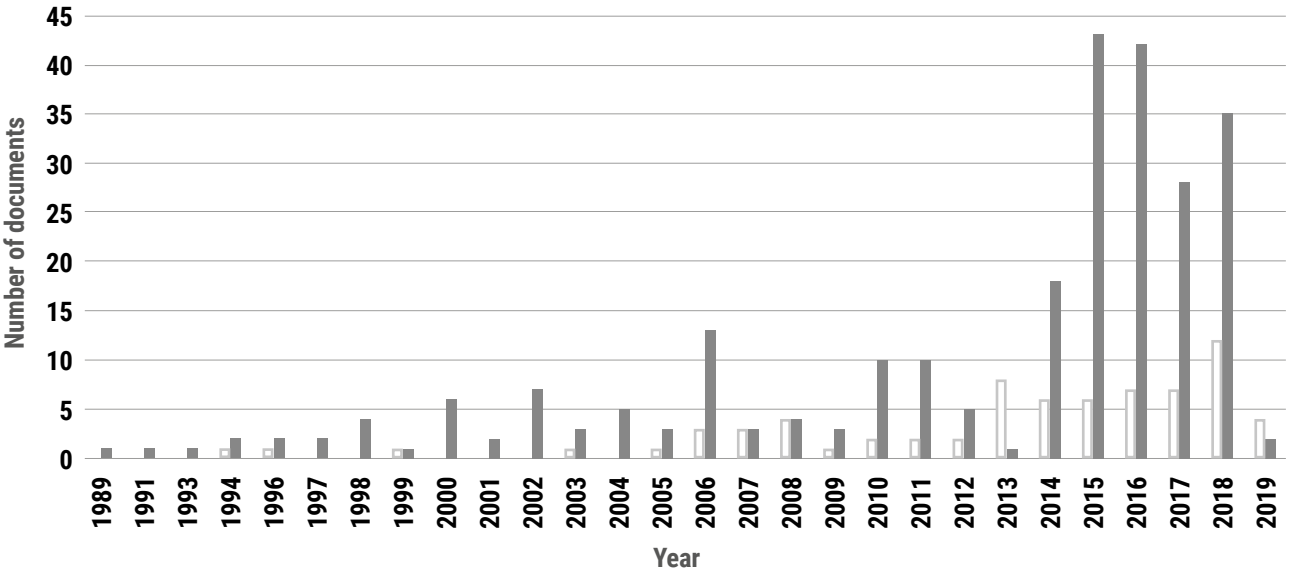

Table A1. Descriptive characteristics of literature reporting national natural capital information case studies in this review (n=340)

Only countries and natural capital stocks that were reported in three or more documents in either scientific or grey literature are reported.

Country	Scientific	Grey
Multiple	9	64
China	9	4
United Kingdom	6	5
Netherlands	3	5
India	2	10
Nepal	2	8
Indonesia	1	10
Botswana	1	8
United States of America	3	8
Italy	1	5
Peru	1	4
Japan	1	3
Philippines	0	10
Norway	0	6
Canada	0	5
Czech Republic	0	4
Namibia	0	4
Uganda	0	4
South Korea	0	3

Country	Scientific	Grey
Rwanda	0	3
New Zealand	0	3
Mozambique	0	3
Ethiopia	0	3
Natural capital stock	**Scientific**	**Grey**
Multiple	6	42
Minerals and energy	4	20
Ecosystems	22	117
Soil	3	3
Land	3	8
Water	2	14
Other biological resources	2	0
Aquatic resources	4	4
Information type	**Scientific**	**Grey**
Multiple	6	1
Cross-cutting information products	23	35
Raw data and statistics	13	1
Accounting	9	78
Indicators	8	5

5. Reporting quality

Of the 340 eligible documents, 56% (191 documents) reported what type of natural capital information was used, and over 80% (276) of documents described what type of government decision was relevant to, or impacted by, the information.

6. Policy relevance and impact

The relevance of natural capital information to national policy decision-making was discussed in 106 documents (72 grey literature and 34 scientific studies)

About half of the documents reporting policy relevance of natural capital information were focused on accounts, the majority of these documents being from the grey literature. Over half of scientific studies reporting policy relevance were focused on cross-cutting information products such as modelling studies and ecosystem assessments. Only four documents discussed policy relevance in relation to indicators discussing the selection, development and use of ecosystem service indicators for policymaking *(20)*. The policy relevance of raw data and statistics were discussed by 10 scientific studies in comparison to a single grey literature document. Only two studies showed how the input of natural capital information led to the successful adoption of a policy, i.e. had policy impact. These two cases were in Costa Rica and Belize (93, 102). Characteristics of this literature are provided in Table A2 alongside full references to all documents reporting policy relevance or impact for natural capital information.

Table A2. Source documents reporting policy relevance or impact of natural capital information

Source documents are presented in chronological order. Full references follow the table and ID corresponds to numbering in the reference list. The last 18 case studies were added in October and thus do not follow the previous chronological order.

ID	Reference	Country	Natural capital stock	Natural capital information type	Government decision type
1	Repetto *et al.* (1989)	Indonesia	Multiple	Accounts	Technical advice
2	Van Tongeren and Schweinfest (1991)	Mexico	Multiple	Accounts	Technical advice
3	United Nations (1993)	Netherlands, Sweden, UK, USA	Multiple	Cross-cutting products	Technical advice
4	Adger *et al.* (1994)	Mexico	Ecosystems	Accounts	Technical advice
5	Hamilton and Lutz (1996)	Costa Rica, Indonesia, Japan, Mexico	N/A	Accounts	Technical advice
6	Kellenberg (1996)	Ecuador	Natural resources	Accounts	Technical advice
7	Crowards (1996)	Zimbabwe	Multiple: Forest, Soil, Minerals	Accounts	Planning and policy decisions; finance and investment decisions
8	Lange and Motinga (1997)	Namibia	Multiple	Accounts	Finance and investment decisions
9	da Motta and Amaral (1998)	Brazil	Ecosystems	Accounts	Technical advice
10	Francisco and Los Angeles (1998)	Philippines	Soil	Accounts	Technical advice
11	European Commission (1999)		Ecosystems	Accounts	Technical advice
12	Haripriya (2000)	India	Ecosystems	Accounts	Technical advice
13	Hecht (2000)	Canada, France, Germany, Namibia, Netherlands, Norway, Philippines, Sweden, USA	N/A	Accounts	Technical advice
14	Danielsson (2000)	Iceland	Aquatic Resources	Accounts	Technical advice
15	Korea Environment Institute (2000)	Republic of Korea	Multiple	Accounts	Technical advice
16	European Commission (2000)	Austria	Natural resources	Cross-cutting products	Technical advice

ID	Reference	Country	Natural capital stock	Natural capital information type	Government decision type
17	European Commission (2001)	Netherlands	Multiple	Accounts	Technical advice
18	Mkanta and Chimtembo (2002)	Tanzania	Ecosystems	Accounts	Regulatory decisions
19	OECD (2002)	Czech Republic	Ecosystems	Accounts	Technical advice
20	OECD (2002)	Hungary	Ecosystems	Accounts	Technical advice
21	Sullivan (2002)	Guyana	Ecosystems	Accounts	Technical advice
22	Lange (2003)	Namibia	Energy and minerals	Accounts	Planning and policy decisions
23	Statistics New Zealand (2003)	New Zealand	Energy and minerals	Accounts	Technical advice
24	Statistics New Zealand (2004)	New Zealand	Energy and minerals	Accounts	Technical advice
25	Ščasný (2004)	Czech Republic	Soil	Accounts	Technical advice
26	Balzamo *et al.* (2004)	Italy	Natural resources	Cross-cutting products	Technical advice
27	Statistics New Zealand (2005)	New Zealand	Energy and minerals	Accounts	Technical advice
28	Sanyal *et al.* (2005)	India	Ecosystems	Accounts	Technical advice
29	Asafu-Adjaye *et al.* (2005)	Australia	Multiple: forest, minerals	Cross-cutting products	Planning and policy decisions
30	Statistics Canada (2006)	Canada	Natural resources	Accounts	Technical advice
31	Høie and Brunvoll (2006)	Norway	Multiple	Cross-cutting products	Technical advice
32	Schoer (2006)	Germany	N/A	Cross-cutting products	Technical advice
33	Alfsen and Greaker (2006)	Norway	Natural resources	Cross-cutting products	Technical advice
34	Sanyal *et al.* (2006)	India	Ecosystems	Cross-cutting products	Technical advice
35	Femia and Vignani (2006)	Italy	Natural resources	Cross-cutting products	Technical advice
36	Palerm (2006)	Netherlands	N/A	Cross-cutting products	Regulatory decisions; planning and policy decisions
37	Auty (2007)	Chad and Mauritania	N/A	Cross-cutting products	Finance and investment decisions
38	Gaddis *et al.* (2007)	USA	Coastal	Accounts	Technical advice
39	Loper *et al.* (2008)	Central America, South Asia, Southeast Asia, Indian Ocean, Pacific, Caribbean	Ecosystems	Raw data and statistics	Finance and investment decisions
40	Catibog-Sinha and Wen (2008)	China		Cross-cutting products	Technical advice; finance and investment decisions; planning and policy decisions
41	Drakenberg *et al.* (2009)	Lao People's Democratic Republic, Mozambique, Peru, Tajikistan, Uganda	Multiple	Raw data and statistics	Regulatory decisions, finance and investment decisions

ID	Reference	Country	Natural capital stock	Natural capital information type	Government decision type
42	Lenglart *et al.* (2010)	France	Air	Accounts	Technical advice
43	European Environment Agency (2010)	Europe (Mediterranean)	Ecosystems	Accounts	Technical advice
44	Abson *et al.* (2011)	UK	Ecosystems	Accounts	Technical advice
45	La Notte *et al.* (2012)	Europe (Mediterranean)	Ecosystems	Cross-cutting products	Technical advice
46	WWF (2013)	Democratic Republic of the Congo	Ecosystems	Raw data and statistics	Policy and planning decisions; regulatory decisions
47	TEEB (2013)	Bonaire, The Netherlands	Ecosystems	Accounts	Planning and policy decisions
48	Somma (2013)	Europe	Multiple	Cross-cutting products	Regulatory decisions
49	Nord *et al.* (2013)	Sweden	Aquatic Resources	Accounts	Technical advice
50	Daly-Hassen (2013)	Tunisia	Ecosystems	Accounts	Technical advice
51	Popa *et al.* (2013)	Romania		Cross-cutting products	Finance and investment decisions
52	Rebelo *et al.* (2013)	South Africa	Water	Raw data and statistics	Finance and investment decisions
53	Ashraf *et al.* (2013)	Pakistan		Raw data and statistics	Operational decisions
54	Punttila (2015)	Finland	Water	Accounts	Planning and policy decisions
55	Nunes and Ghermandi (2015)	Mozambique	Ecosystems	Accounts	Planning and policy decisions
56	Quintano and Barredo (2015)	Europe	Ecosystems	Accounts	Technical advice
57	Food and Agriculture Organization of the United Nations (2015)	Brazil, China	Multiple	Accounts	Technical advice
58	Reynaud *et al.* (2015)	Italy	Water	Accounts	Technical advice
59	Berghöfer and Schneider (2015)		Multiple	Indicators	Technical advice
60	Liquete *et al.* (2015)	Multiple: the EU-27 territory	Multiple terrestrial	Raw data and statistics	Operational decisions; finance and Investment decisions
61	Sumarga *et al.* (2015)	Indonesia		Accounts	Planning and policy decisions
62	Smith (2015)	Mongolia	Minerals	Raw data and statistics	Technical advice
63	Southern Palawan Technical Working Group (2016)	Philippines	Ecosystems	Cross-cutting products	Regulatory decisions
64	UN-REDD Programme (2016)	Ethiopia	Ecosystems	Accounts	Technical advice
65	Banerjee *et al.* (2016)	Guatemala	Ecosystems	Accounts	Technical advice
66	Jefferis (2016)	Botswana	Energy and minerals	Accounts	Technical advice

ID	Reference	Country	Natural capital stock	Natural capital information type	Government decision type
67	Vardon *et al.* (2016)	Botswana, Colombia, Costa Rica, Madagascar, Philippines	N/A	Accounts	Technical advice
68	Markandya (2016)	N/A	Ecosystems	Cross-cutting products	Technical advice
69	Estreguil *et al.* (2016)	Lombardy, Italy	Multiple	Cross-cutting products	Planning and policy decisions
70	Liquete *et al.* (2016)	Italy	Water	Cross-cutting products	Planning and policy decisions; technical advice
71	Hein *et al.* (2016)	Netherlands	Cross-cutting products	Planning and policy decisions	
72	Bayani and Barthélemy (2016)	Haiti and Democratic Republic of the Congo	Multiple: marine, rivers	Cross-cutting products	Technical advice
73	Weatherdon *et al.* (2017)	Italy, UK, Spain, Sweden, Denmark, Finland, Mediterranean	Ecosystems	Accounts	Technical advice
74	TD Economics & Nature Conservancy of Canada (2017)	Canada	Ecosystems	Accounts	Technical advice
75	Hayashi and Sato (2017)	Japan	Multiple	Accounts	Technical advice
76	Pistocchi *et al.* (2017)	Europe	Water	Accounts	Technical advice
77	Jayachandran *et al.* (2017)	Uganda	Ecosystems	Accounts	Technical advice
78	Mandle *et al.* (2017)	Myanmar		Cross-cutting products	Planning and policy decisions
79	Albert *et al.* (2017)	Germany	Multiple: grassland, rivers, cropland	Cross-cutting products	Planning and policy decisions
80	Ruijs and Vardon (2018)	Peru, Uganda, New Zealand, Australia	Land	Accounts	Technical advice
81	Firdaus (2018)	Indonesia	Multiple	Accounts	Technical advice
82	Vallecillo *et al.* (2018)	Europe	Pollination	Accounts	Technical advice
83	Lee *et al.* (2018)	Republic of Korea	Ecosystems	Cross-cutting products	Finance and investment decisions
84	Siepmann and Nicholas (2018)	Germany	Agriculture (other biological resources)	Cross-cutting products	Operational decisions; finance and Investment decisions
85	Lu *et al.* (2018)	China	Multiple: grassland, minerals, water, land	Cross-cutting products	Planning and policy decisions
86	Schwilch *et al.* (2018)	Multiple: 16 case studies from Europe	Soil	Cross-cutting products	Technical advice
87	Lee (2018)	Taiwan	Coastal	Raw data and statistics; cross-cutting products	Operational decisions

ID	Reference	Country	Natural capital stock	Natural capital information type	Government decision type
88	Masiero *et al.* (2019)		Ecosystems	Cross-cutting products	Technical advice
89	Liu *et al.* (2008)	China	Ecosystems	Raw data and statistics	Finance and investment decisions
90	Baker *et al.* (2012)	UK	Land	Raw data and statistics	Finance and investment decisions
91	Arkema *et al.* (2013)	USA	Ecosystems	Cross-cutting products	Technical advice
92	Day *et al.* (2013)	UK	Aquatic resources	N/A	Finance and investment decisions
93	Porras *et al.* (2013).	Costa Rica	Ecosystems	Cross-cutting products	Finance and investment decisions
94	Arkema *et al.* (2014)	Belize	Aquatic resources	Cross-cutting products	Technical advice, policy and planning decisions, operational
95	Abt Associates (2015)	USA	Ecosystems	Indicators	Technical advice
96	Arkema *et al.* (2015)	Belize	Aquatic resources	Cross-cutting products	Planning and policy decisions
97	The Department of the Interior (2015).	USA	Ecosystems	Indicators	Technical advice
98	Cabral *et al.* (2016)	France	Ecosystems	Accounts	Planning and policy decisions
99	Zheng *et al.* (2016)	China	Water, ecosystems	Cross-cutting products	Operational decisions
100	Arkema and Ruckelshaus (2017)	Multiple	Aquatic resources		Technical advice, planning and policy decisions
101	Levrel *et al.* (2017)	France	Ecosystems	Cross-cutting products	Technical advice
102	Verutes *et al.* (2017)	Belize	Ecosystems	Cross-cutting products	Planning and policy decisions
103	Bateman and Balmford (2018)	UK	Land	N/A	Finance and investment decisions
104	Bateman (2018)	UK	Land	Cross-cutting products	Finance and investment decisions
105	Bryan *et al.* (2018)	China	Ecosystems	Indicators	Technical advice, Planning and policy decisions, operational
106	Sutton-Grier *et al.* (2018)	USA	Aquatic resources	Accounts	Finance and investment decisions, planning and policy decisions

Table A3. Application of assessment criteria to case study literature from Colombia, Indonesia, Mongolia, Mozambique, Myanmar and South Africa

Table A3 lists six country-specific examples of how we could apply the full set of assessment criteria in Section 2. These cases were identified as "exemplary" by a range of leading organizations at the GGKP Natural Capital Expert Group meeting at Stanford University in March 2018. Here, these examples take shape as a review of case studies. Additional research would be required to fully understand these success stories, how the criteria should be applied, and to what extent each can be called an "exemplary use case" for natural capital in green growth planning.

Table A3 is available online.

SOURCE DOCUMENT REFERENCES

Reference list numbering corresponds to document ID in Table A2.

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